Teachers’ professional knowledge includes their understanding of the subject matter that they teach, as well as of pedagogy – areas such as learner behaviour, thinking, learning and motivation. There is a strong movement in education today which suggests that to be as effective as possible, what teachers do in the classroom should be research informed. But why?

The answer is that it has become increasingly clear over the years that many traditional teaching practices are limited or flawed. How do we know that group discussions, homework tasks, reading textbooks or listening to teacher explanation actually work? And even if they do, are they the best ways of achieving our goals outcomes? While professional
reflection has its place, memory is flawed and self-perceptions can be biased. Research offers a source of more objective information about how learning works best.

While educational research does, of course, have its limitations, it can provide some key information on which to base our professional decisions. Ultimately the decisions still lie with the teacher, but when you are research informed, these are based on something more than just a hunch or a popular belief – they are based on evidence.

As I discuss in The Teacher’s Guide to Research, one of the best ways to become research informed is to engage in your own practitioner research (or ‘practitioner enquiry’). Doing so can help new ideas to stick, and can motivate you to not just read educational research but to really interrogate it, extracting what you need to know and asking critical questions. Just as pupils benefit from doing practicals and projects – so teachers will find research ideas easier to take on board through a gradual process of practical engagement.

And what’s more, running your own research allows you to ask the specific questions that matter to you, rather than being limited to the agenda set by university-based researchers.

Running your own research allows you to ask the specific questions that matter to you.

Each of the examples in this booklet guide you through an entire teacher research project, from theory to implementation to analysis. Background reading is included (with further reading recommended), and an ethically-sound design for you to use is provided. There are also tips on ways to follow up on your project, as well as variations that you could consider.

This material is intended as a supplement to The Teacher’s Guide to Research. However, you are welcome to use it in any way you like, and to share it with colleagues. Good luck with you research, and feel free to ask questions via Twitter (@JW_Firth), and to sign up to my newsletter at jonathanfirth.co.uk.
Project 1: Using retrieval practice

The first of these projects looks at how to apply and investigate retrieval practice. If you aim to become more research engaged this concept a great place to start, as it can be applied to almost any lesson.

Retrieval practice means consolidating learning by actively retrieving information and ideas via a test, a discussion, or writing it down from memory.

This sounds a bit like formative assessment, right? Well, yes and no. As discussed in Issue 1 of Impact¹, assessing learners via asking questions can be used for formative purposes (finding out who knows what, and addressing it), but it also has a more direct effect on memory. Simply retrieving something from memory makes that information more secure, and less likely to be forgotten. It is a well-established psychological fact, but one often overlooked in education – the process of remembering is not a neutral event, but actually changes the content of our memories.

Research into retrieval practice dates back over a hundred years, but it is only really over the past decade or so that it has come to prominence again, and begun to be widely applied in classrooms. A study by Henry Roediger and Jeffrey Karpicke² found that after reading a text, learners who wrote down what they could recall from memory did better on a later test than those who simply re-read the text. The effect was stronger after a delay, meaning that the immediate benefit of retrieval might not be obvious to a learner – or to a teacher!

It might be of concern that adding additional quizzes would increase anxiety in an era where pupils are already struggling with exam stress. However, a valuable study by Pooja

Agarwal and colleagues\(^3\) investigated learner perceptions of this issue. In an investigation of middle school pupils, they found that 72\% reported that it made them less nervous for unit tests and exams. It could be the case that frequent low-stake quizzing builds confidence, making learners clearer about what they do and don’t know, and making exam outcomes less of a mystery.

**Key study in focus**

One possible criticism of retrieval practice is that involves consolidating simple, context-free facts. If so, can learners actually do anything with this information, such as use it in meaningful or creative ways?

A study by Andrew Butler\(^4\) attempted to contribute to this question. The study looked at how well learners (undergraduate students\(^5\)) could transfer learning that had been consolidated via retrieval practice to different but related scenarios.

In the first part of his study, Butler give learners scientific passages to read, after which they either re-read the passages (the ‘re-reading condition’) or did quizzes on them (the ‘retrieval practice condition’). They were then asked question that involved inference from the facts that had been learned. For example, one question was:

> “There are about 5,500 species of mammals in the world. Approximately what percent of all mammal species are species of bat?”

The learners hadn’t practised these inference questions, but had learned the relevant facts needed. Here, they had learned that there are more than 1,000 species of bat, and could therefore work out that bats must account for more than 20\% of mammal species.

These questions require direct inferences, but in a follow-up part of the study, the transfer of learning was more abstract. For example, having studied differences between bat wings and bird wings, they were asked questions like the following:

> “The U.S. Military is looking at bat wings for inspiration in developing a new type of aircraft. How would this new type of aircraft differ from traditional aircrafts like fighter jets?”

Such questions involve ‘far transfer’ – making inferences from one knowledge domain to another. This is widely recognised as being difficult for learners, but here again, learners from the retrieval practice condition did better than learners from the re-reading condition.

**Applying this in class**

The simplest starting point for applying retrieval practice in your class is the use of short quizzes. These can be used at the start, end, or during a lesson.

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\(^5\) Undergraduate students are commonly used as participants in psychology experiments; unless noted otherwise, assume this is the case for the other studies mentioned in this guide.
It’s important to remember that the purpose of the quizzes is to consolidate learning, not just to test what the learners know. It’s therefore important to ensure a reasonably high success rate. If the learner doesn’t retrieve the information, then the quiz is unlikely to be helpful. On the other hand, it’s also unhelpful to ask something too easy. An example of a good level of difficulty would be to ask a challenging question based on learning from the previous class, and to give hints if anyone is stuck.

Quizzes for this purpose are best done individually, as each individual needs to have the opportunity to retrieve the information from their own memory, rather than being told it by a classmate.

Drawing on the Butler research, it would be interesting to extend your quizzes from basic facts to ‘transfer’ problems. That is, try setting a few questions towards the end that require learners to use the concepts or information in an unfamiliar context.

Your own research project

**ETHICS NOTE:** For this and all classroom-based research projects, ethical procedures must be followed. However, you should refer to chapter 8, ‘Ethics’, in the *Teacher’s Guide to Research*, or a similar section of another book. You should also discuss ethics implications with your department head or line manager school, and any external organisation with which you are working.

Retrieval practice makes for an ideal introduction to running your own research in a classroom context. A simple starting point would be to focus on the roles of retrieval and re-reading, as with the case of Carly (above).

1. Identify a pair of texts where learners currently learn via reading or watching a video. Ideally you will be drawing on authentic learning materials that you would normally use in the classroom rather than preparing something new.

2. Next, develop a simple quiz based on each of the texts. The texts and quizzes should be similar in difficulty; if this is proving hard, you could instead split a single text into two sections of similar length and difficulty.

3. Set each text as a homework reading task, on different days/weeks.

4. Following the homework reading, some pupils will do a quiz, and others will re-read the text in class. If you are doing this with more than one class, switch the texts, so that there is re-reading of text 1 and a quiz on text 2 (that’s why you prepared quizzes for both texts!).

5. Alternatively, if you only have one class, you could balance the texts by giving half of the class text 1 with a re-reading task and text 2 with a quiz, while the other half do the opposite (re-reading text 2 and doing a quiz on text 1). Of course, you will need to keep track of who did which task – a spreadsheet is ideal for this purpose.

6. Finally, include questions on these two texts in your next routine class test or prelim exam, and analyse the findings to see whether there was any difference between re-reading and retrieval practice.
Analysis

The basic analysis of this project will involve comparing the mean scores for two sets of data– responses to exam questions on the content of text 1 versus responses to exam questions on the content of text 2.

Mean scores, however, are limited as a form of analysis. If you find that the mean of one group is larger than the mean of the other, what does this actually show?

Using a statistical test will tell you how likely the results are to have occurred by chance. The ‘related means t-test’ is one that could be used. It allows you to compare scores from the same pupils on two tasks. If you are unsure about trying out a statistical test, why not speak to a maths-teacher colleague who could help you?

When drawing conclusions, there are some other things that you should think about. Were your two texts actually equal in difficulty, or interest value? If not, any difference could be due to the text rather than to your intervention (or you may fail to see a difference if the retrieval text was harder). This is where a counterbalanced design comes in (see points 6 & 7 above) – some pupils will do a quiz on one text and some on the other, and so you can calculate an average for both texts, helping to indicate whether the texts were balanced.

Options

If you feel that a significant number of pupils won’t do the homework reading, you could instead complete the reading during one lesson, and the quiz/re-reading could be done in the following lesson.

However, it would also be interesting to find out whether a quiz has an effect on completion of homework – perhaps pupils are more likely to do the reading if they know they are going to be quizzed on it! This is where educational research gets complicated, but also very interesting. A simple way to test for this would be to have an anonymous check box at the end of the second task, asking them to state whether they completed the homework or not (you could also ask how many minutes they spent on it, and how well they felt they understood it).

Another alternative design is to arrange a class discussion, with a set of questions for a pair or group to work though the day after reading a text. This still prompts retrieval, though it’s harder to be sure that everyone is actively retrieving the information – some may be sitting back and letting others do the talking.

If your subject doesn’t really use homework texts, you could get the same effect via a verbal explanation that you give. One explanation could be followed by a short test, while the other is simply repeated.

Follow up

Once you have found a useful technique, the easy and fun part is to apply it more widely. If your data suggest that quizzing was beneficial, this could be rolled out to future reading tasks. To save time, you could ask learners themselves to generate quiz questions. Classes could begin or end with a consolidation quiz. Note that many good quizzes are freely available through websites like Quizlet, saving you a lot of time.

And if it didn’t help? Even evidence-based techniques don’t work all the time and in all contexts. One of the benefits of teachers engaging in practical classroom research is the opportunity to find out what helps, and what is not worth the time and effort!
However, as such a result would conflict with years of research, it’s worth considering whether any biases could have affected the findings. For example, as discussed above, did the learners actually do the homework reading? If not then a quiz won’t help, and it would be worth trying out the technique in class instead. If they found the text too easy and got all of the questions right, you may likewise see no benefit of a quiz. However, there could still be applications of the technique – just try delaying the consolidation by a week or so.

See Chapter 8 of *The Teacher’s Guide to Research* for more about controlling variables in a research study.

**Limitations**

It has been suggested that retrieval practice can only be applied to very simple materials, of the type that can be tested through simple quiz items. The materials used by Butler have been criticised as not requiring true deduction but instead just word association.

In fact, it’s hard to demonstrate true transfer at all in an experiment, but it nevertheless plays an important role in real life situations, or even simulated ones such as exam scenario questions.

**Further reading:**

A book which focuses on this topic is *Make it stick* by Smith, Roediger and McDaniel. Retrieval practice is also discussed extensively in my own book, *Psychology in the classroom*. To be frank, it should be covered in any half-decent resource on teaching and learning.

There is even a website devoted entirely to this phenomenon - retrievalpractice.org. It is packed with useful advice and ideas, and is run by researcher Pooja Agarwal, who also has a book on the topic due out later in 2019.

Accessible articles related to this project include:


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Project 2: Beliefs about learning

We often ask learners about their progress, how they feel that their learning is going, and what they'd like go over. But just how accurate are pupils' insights into the learning process? And can they accurately predict their own future performance? This project explores research which suggest that beliefs about learning are often deeply flawed.

Case study

Pablo is a Geography teacher. At the end of his lessons, he often gets learners to write a short summary of what they have learned on a piece of paper, and to stick this up on the board. Typically these refer to the intentions of the lesson, and state that the pupils have learned everything that was asked of them.

Recently, Pablo has been reading research into forgetting, and has realised that even when learners are very confident that they have learned the material covered in a lesson, they may actually forget a great deal of it. In short, they may lack insight into how rapidly forgetting occurs. To test this idea, he gives his leaners a snap test on a topic one month on, and finds that the average grade is just 20%.

Naturally, educators want their learners to be able to retain and use what they have learned in practical, real-life situations. However, such situations are often much more unpredictable than the learning process itself. In a lesson, learners can usually answer questions on things which they have just studied. The answers are easy to access from memory because they have been studied so recently (and in the same context). But can we really say that it has been learned?

According to researchers Nick Soderstrom and Robert Bjork, we should make a distinction between performance and learning. In their view, immediate performance is a poor guide to learning – it can't tell us whether new material has been absorbed in such a way that it will be accessible when required for future situations.

Forgetting in long-term memory follows a ‘forgetting curve’, a decline which starts off steeply and then shallows out. What this means is that material covered in one lesson will be subject to a lot of forgetting, but if things can be retained for at least a few days, there is a much better chance that forgetting will be averted. This is, of course, important if information is needed for a future test or exam, and for life in general.

Overall, learners have a poor metacognitive judgement of what they have learned and what they have not. Simply asking them whether they have learned is not likely to lead to a particularly accurate insight. To be more specific, pupils tend to exhibit a ‘stability bias’ in memory (viewing the memory as fixed and unchanging), largely ignoring the harmful effects forgetting – and the benefits that would come with further practice.

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Key study in focus

A 1990s study by Thomas Nelson and John Dunlosky\textsuperscript{10} looked at ‘judgements of learning’ – a person’s subjective sense of whether they have learned, in terms of whether they anticipate being able to recall the information at a later point in time.

The researchers had noticed that learners’ judgements of learning tend to be very poor – on a scale between random guesses and perfectly accurate predictions, they were closer to the guesses! Wondering why this was the case, the researchers speculated that it could be because learners assume that something that is currently in their working memory will remain accessible to them, when in fact successful learning relies more on long-term memory (while the contents of working memory are forgotten very rapidly\textsuperscript{11}).

In order to test this idea, Nelson and Dunlosky conducted an experiment where participants were asked to give delayed judgements of learning. Each person was shown pairs of words such as ‘ocean-tree’, and was then asked the following question:

“How confident are you that in about ten minutes from now, you will be able to recall the second word of the item when prompted with the first word?”

Each participant then had to rate their confidence between 0% and 100%. The actual correct recall after ten minutes was approximately 45%.

The researchers noted that learners again tended to score very poorly on immediate estimates, but that the accuracy of their estimates was greatly improved by a delay. In discussing the implications of this, the researchers argue that metacognition can be divided into two main parts – ‘metacognitive monitoring’ of what the learner knows, and ‘metacognitive control’ of subsequent study time. Importantly, learners are likely to make poor choices about their study time if they cannot accurately judge their own learning. In a real life study situation, a learner may well look at a topic for a few minutes and think that they have mastered it, and then fail to come back and review or test themselves.

A follow-up study by Young Buia, Mary Pyc and Heather Bailey\textsuperscript{12} supported the findings of the Nelson and Dunlosky experiment but added another element. In their study, they investigated the effect of giving a learner a demanding/distracting secondary task to do. They found that judgements of learning became more accurate under these circumstances. This suggests that a similar benefit (in terms of accuracy of judgements) can be obtained by giving a learner a distraction which clears information from working memory.

Applying this in class

One starting point for this research is simply to raise awareness about the limitations of judging your own learning straight away. Simply getting a set of tasks right in class or being able to remember something in the here-and-now doesn’t mean that you have learned in a way that will actually last.


Pupils and teachers alike also need to be wary of checklists, exit passes and the like. It is tempting to think that certain areas of a course are ‘done’ once the material has been worked through, but this underestimates the inevitable forgetting that will take place, and neglects the importance of revisiting and consolidating content.

A preferable approach is to look at an initial study session as the first step in a process that will have several steps. One possible example of this is as follows:

- Initial study and consolidation of a new concept.
- Follow up of the concept after a week or two.
- Later still, using the concept in an applied task, in combination with other relevant new learning.
- A few months on, attempting a practice exam question that draws on the concept.
- Revising for the actual exam.

Your own research project

You can investigate your own learner’s judgements of learning, and help them towards a valuable insight about how rapidly forgetting can progress.

1. First, you need to identify a test or exam which has a numerical mark. Something like a progress test that covers a whole topic would be ideal, and it would be best if the learners have done a similar test before, so they know what it involves.

2. Next, ask learners to predict their mark on the test at around the time they finish working on the material – at the end of your last lesson on the topic, for example.

3. You can ask for a second prediction at a later point. Ideally, this will be a few days after completing the topic, but prior to their revision and to the test itself. However if necessary, you can ask them on the day of the test itself, before they start.

4. Now the learners will sit the test as normal, and you will work out their mark. You are now ready to compare their actual mark to the two predictions they have made.

Analysis

Analysing your findings can be done using a statistical technique known as correlation. Nelson and Dunlosky used ‘gamma correlation’, but it is also possible to calculate a standard correlation coefficient, using a well known test such as Spearman’s rank correlation coefficient (‘Spearman’s rho’). This will provide a number which indicates the relationship between a pupil’s estimated score on a test, and their actual score.

This can then be done both for an immediate estimate and for a delayed estimate, to see which is more strongly correlated (a number closer to 1 indicates a stronger correlation; see The Teacher’s Guide to Research, chapter 10).

Options

An alternative would be to conduct a focus group to find out more about pupils’ views of learning. This could involve presenting a simple stimulus, such as a text or a short video, and asking learners to discuss how well they think they would remember it if they did a test.
later in the day. Alternatively, you could ask them to discuss the material covered so far in their course. For example, if you conduct a focus group in October, you could ask about the material which has been covered in the first few weeks of term.

The data gathered from a focus group will be less controlled, but will give a richer insight into learners’ thought processes – you might find out why they thought they would or would not remember. However, bear in mind (as discussed throughout this project topic) that opinions can be biased! A pupil doesn’t always have insight into how successfully they have learned.

**Follow up**

Once you have established some of the flaws inherent in learners’ estimates, you could look at ways of tackling them. This could involve using delays and quizzes, as discussed in projects 1 and 4! It could be an ongoing process to find the best way of improving the accuracy of estimates, and then using that information to tailor and improve study habits.

**Limitations**

Some of the most interesting aspects of the research into learner beliefs concern self-regulated study – revision, projects, and so forth – and you might question whether the area is as relevant when classroom learning is teacher-led. Indeed, it is probably for the best that teachers, as education professionals, are planning and making judgements about what to cover and when to do it.

Having said that, teachers are also subject to flawed metacognition. As noted in the introduction to this guide, one of the most valuable things about becoming more research aware is that it supplements your judgements with evidence. From time to time, you may realise that your own beliefs about learning need some adjustment!

**Further reading:**

The research implications for biased student judgements of their own learning is discussed in *The Teacher’s Guide to Research*, chapter 6. The issue of performance versus learning is also discussed in Jamie Thom’s 2018 book, *Slow Teaching*13. Accessible articles related to this project include:


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Project 3: The drawing effect

This project looks at how drawing a sketch can enhance a learner's memory, and explores the potential that drawing might have as part note-taking across a range of subjects.

Case study

Kandi is a Physics teacher who also teaches combined science to younger secondary pupils. One area that her pupils tend to find very difficult is the concept of energy, and, in particular, energy transformations. Kandi teaches them the relevant formulae and explains the theory behind the concepts in a clear and accessible way, but they still struggle, even when the ideas are put into the context of a scenario.

However, she has noticed that when her pupils try exam-style questions which involve images, they find this highly memorable. One example concerns heat loss among a huddle of penguins, and another concerns the changes in kinetic energy of a skydiver. Kandi notices that her pupils remember the illustrations from these questions for much longer than they retain the relevant theoretical ideas.

Many people – not just researchers – have observed that images can be highly memorable. Pictures tend to be remembered better than words, a phenomenon known as the ‘picture superiority effect’. Combining both an image and a word is even better, and tends to be better remembered than either alone – this effect is referred to as ‘dual coding’.

The mind also seems to have a vast capacity for retaining visual images. An early study by Lionel Standing suggested that our long-term memory capacity for pictures is “almost limitless”14.

Images are processed separately from words in working memory. This allows an image to be retained and processed for a period of time during a lesson activity or lecture, as the new information that is coming in to the mind is verbal. In contrast, words are quickly displaced by new incoming information (for more on the features of working memory, see Psychology in the Classroom, chapter 215).

This research area shouldn’t be taken to be evidence for a visual ‘learning style’, however. Although it is obviously the case that some learners are better than others at visual tasks, the general consensus among education and psychology researchers is that the concept of learning styles is a myth16 - nobody learns best by using only visual or auditory methods. Instead, any learner can benefit from visual scaffolding and mnemonics, and it is best to combine visual and verbal information in learning activities (i.e. to use dual coding - see above).

Key study in focus

Jeffrey Wammes, Melissa Meade and Myra Fernandes\(^{17}\) found that the simple act of drawing can produce significant mnemonic benefits. In their study, studying items by making a sketch led to much better recall than other forms of note taking, such as writing the items out.

The researchers drew on existing evidence regarding images (including the picture superiority effect), and also the idea that items which we actively generate tend to be better remembered than things that we simply read - a finding known as the ‘generation effect’ (and which fits with classroom approaches that emphasise active learning). In combination, the researchers reasoned, these two effects should mean that we remember notes much better if we take them in the form of a sketch rather than in words. It’s also possible that that the physical action of making a drawing will boost memory.

In a series of experiments, Wammes and colleagues studied people’s memory for lists of items (shown as words), comparing the act of drawing with other well-established mnemonic techniques such as repeatedly writing the words or mentally visualising the objects. Every time, drawing was found to be superior.

These results could potentially link to numerous factors that were already known to boost memory, for example using tasks which are active, meaningful, visual, and so forth. However, the researchers argued that their results could not be explained entirely in terms of any one of these factors. Instead, they suggested that drawing leads to a special and highly durable memory trace, formed of an elaborated integration of multiple types of memories. They labelled their finding ‘the drawing effect’.

It could be argued that the results were down to the fact that drawing takes a lot longer than thinking or writing, but the experimenters were careful to control for this – when comparing drawing with writing, for example, both conditions were allocated the same amount of time, and the ‘write’ condition were told to write the words repeatedly until the time was up. This is important for the classroom; learning time is limited, and the study showed that drawing isn’t just superior because it takes longer to do.

Applying this in class

The drawing effect is easy to apply to just about any subject, should you choose to do so. In any situation where learners are asked to take verbal notes, they could be encouraged to draw pictures instead (or as well). For example in History, the six demands of the Chartists could be represented as sketches rather than written out in text.

Of course, sometimes terminology is vitally important to exam success, and using drawings doesn’t mean that words can’t be included in notes, too. Again, the principle of dual coding suggests that it is worthwhile to combine both images and text.

Your own research project

This principle lends itself to an experimental task. You could use non-essential materials and engage learners as co-investigators, to help to raise awareness of the usefulness of images.

1) Identify a suitable stimulus. You could mimic the experiment of Wammes and colleagues and use lists of words, or try something more ambitious and authentic such as a short YouTube video.

2) A randomly selected half of the class will be instructed to write verbal notes, and the other half will be asked to make sketches with minimal use of words.

3) If using a video, you may choose to pause it periodically, so that learners are not overloaded with information.

4) Give both groups of learners the same overall amount of time to complete their notes, whether verbal or visual.

5) After a reasonable delay – for example, at the end of the lesson/period, or the following day – give all learners a test on the material to see what they can remember. The results of this test provides the data that you will analyse.

6) Try reversing the groups, so that both halves of the class have a chance to try out visual note taking.

7) Investigate other types of learning materials relevant to your subject. It may be the case that in your context, drawing is much more useful for some tasks than others.

**Analysis**

If you are comparing groups, you can (as with Project 1) compare mean scores, and then elaborate your analysis by using inferential statistics. The independent t-test for two samples is appropriate when you are comparing two groups composed of different individuals.

If you try the same task and materials with multiple classes you can combine the data for a more reliable outcome, but it would be best if all aspects of the procedure (e.g. how long they are given to take notes) were kept the same.

**Options**

To delve into the issue in more depth, you could look at the quality of the drawings produced. Do people who are better at sketching gain more benefit? Or perhaps they gain less, because highly artistic pupils are better at spontaneously producing effective mental imagery? It would be interesting to find out!

You could also try different types of test at the end – perhaps the effect works better with a written test than a multiple-choice test, for example.

**Follow up**

If you do find a task that seems to work particularly well with visual note taking, why not share this with colleagues? Your findings could make the basis of a really interesting talk, or an article in a teaching magazine – one linked to your professional body or subject teaching association, perhaps.
Limitations

As noted, the drawing effect is a relatively recent finding, and there is still some debate about exactly why it happens.

A limitation of the Wammes et al study was that the item lists used were simple: individual words. We can’t be entirely sure that the principle will generalise to the more complex materials studied in class. And it’s also possible – as seen in the case study of Kandi, above – that learners will remember the image but forget the underlying idea. However, this is a matter for further investigation, and is certainly an area where classroom teachers can usefully contribute to a developing area of research.

It’s also worth considering individual differences in pupils’ visual abilities. A fascinating study by Allison Jaeger and colleagues\(^{18}\) presented a visual analogy of a balloon inflating to learners who were studying the El Nino weather phenomenon. They found that the analogy helped, but being given this image at the same time as information about El Nino was only helpful to those learners who scored low on a visual working memory test.

A possible explanation for this finding is that those learners with better visual skills were already able to maintain the image in mind, and therefore didn’t need to have it repeated during the task. Ironically – and directly contradicting the idea that some pupils are ‘visual learners’ – those with better visual working memory abilities benefited less from visual input in the lesson.

Further reading:

One of the best sources on dual coding and the use of visuals in computer-based learning is Richard Mayer’s *Multimedia learning*\(^{19}\). Weinstein and Sumeracki’s *Understanding how we learn: A visual guide* (illustrated by Oliver Caviglioli)\(^{20}\) is also really good on dual coding, and it practices what it preaches in terms of images and learning!

Accessible articles related to this project include:


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Project 4: The spacing effect

One of the most basic decisions for any teacher (or learner) concerns the order in which tasks should be undertaken. However, this choice is far from straightforward. The next project explores the spacing effect in the contexts of learner revision.

Case study

Aminah wanted to tackle the level of forgetting she observed among her senior pupils during an exam class. She decided to make use of the spacing effect, a memory phenomenon whereby learning is more effective if practice is delayed rather than occurring in intensive study sessions.

In her classes, she used exit pass sheets that learners would complete at the end of each lesson, testing them on key content. Her usual practice was to verbally question pupils at the beginning of the following class. In order to increase spacing, she decided instead to do the verbal questioning two weeks later, rather than in the subsequent class.

However, when Aminah put this intervention in place and compared test results on the topic, there was very little difference compared to previous years. Aminah looked again at the research on the spacing effect and noticed that in most studies, information and questions are repeated exactly, and her verbal questioning had not involved verbatim repeats of the exit pass questions. On the basis of this reflection, Aminah decided to return to her practice of consolidating in the next lesson via verbal questioning. However, she additionally used a repeat of the same exit pass question sheet from each lesson three weeks later.

The ‘spacing effect’ is a phenomenon whereby delaying practice can boost memory. For example, if you were planning to go over a list of foreign language vocabulary twice, it would be more effective to do the second practice session after a delay of a couple of hours rather than doing both sessions back-to-back.

What’s more, a longer delay can often be better than a shorter one. However, there are a couple of caveats. Learners need to fully grasp the material in the first study session, to the point that they are getting practice questions correct. If you build in a delay without learners having taken in the new concepts or information properly in the first place, there will be rapid forgetting.

It’s also important to consider the difficulty of the material itself. If it’s very hard (which, of course, depends on the learners) or involves a lot of arbitrary terminology, a shorter delay is a good idea. If, in your experience, learners tend to retain the new material for days or weeks, then the follow-up can be delayed for longer.

Key study in focus

A useful exploration of the spacing effect by psychologist Melody Wiseheart and colleagues used flashcards to present learners with 32 obscure trivia questions, along the

lines of “What European nation consumes the most spicy Mexican food?” (the answer was Norway!). After an initial study session, learners were given a chance to re-study the facts—for some, this happened just minutes later, but for others the gap between study and re-study was over three months. Hundreds of learners took part in the study.

Later (sometimes as much as a year later—a timescale relevant to school), participants were tested. Findings showed that the benefits of a delay increased up until a point, after which they started to decline again. When the final test was going to be one year later, a delay between study and re-study of around 20 days was best, though this ‘optimal’ gap was shorter if the test took place sooner.

**Applying this in class**

The spacing effect is easy to apply to teaching practice. The main principle is to schedule in a delay between an initial learning session and later practice sessions as part of your planning. For example, after working on the seven times table in maths, practice would be best scheduled several days later, rather than happening later the same day.

Spacing makes practice more difficult, so you may see more errors than normal in the re-study session. However, it has benefits over the long term: learning is more durable, and less likely to be forgotten (i.e. you are boosting *learning* rather than just *performance* – see Project 2). Therefore it’s worthwhile to reassure learners that it’s ok for the practice session to be challenging! Indeed, if practice feels easy, it’s probably been done too soon.

Another simple application is to avoid teaching concepts and skills in a single session, instead splitting the learning across two or more sessions. Katherine Rawson and John Dunlosky\(^{22}\) helpfully state this more specifically: learners should practise concepts until they have got them right three times, and then study them on a further three occasions spaced out over days or weeks.

In terms of whole topics, a review by psychologist Doug Rohrer\(^{23}\) found that although learning is already spaced out to an extent (there are generally days or weeks between lessons), learning a topic over a greater rather than smaller number of weeks appears to lead to better memory for the content. Teachers could therefore consider extending the duration of a topic rather than teaching it in an intensive block, and conducting review sessions after a time delay rather than straight away at the end of the topic.

The great news about spacing is that you don’t need to prepare any new materials at all. It simply requires that you think about when things are done, and consider a reorganisation of this timing, perhaps looking at the year as a whole.

**Your own research project**

A classroom research study into spacing could look at learners’ existing revision habits, and the extent to which they space out their study sessions. This needn’t mean actually telling them to do something different – a data gathering exercise to simply establish popular study habits would be valuable. While particularly relevant for older learners, it could also be done with primary pupils who have tests to revise for, or homework that

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involves revision. Two key questions to ask are: how long does a typical study session last for, and how long do pupils leave a topic before coming back to it and revising it again?

1) First, establish a class-wide method of logging study sessions. This could be a paper-and-pencil log which learners fill in, or an electronic system (some learning apps have their own method of tracking study time built in).

2) The log should state the topic studied, when the study session started, and when it ended. It should also include the date. Optionally, you could include the time of day.

3) Use the study log procedure in the classroom first, to ensure that learners are aware of how it works and that they get into the habit of recording their study start and end times.

4) Now, move on to home-based revision. Again, it is important to provide regular reminders, so ask learners each day that you see them, perhaps at the start of class, to bring out their study logs. If they have failed to fill them in, they can do their best to complete any missing information from memory.

5) Gather in the information about each learner's study times. To minimise workload, it might be best if the learners could be taught to enter their own information onto an online form – a site such as SurveyMonkey could be used for this purpose. It would also be best if the final analysis could be done anonymously, so that learners are not motivated to lie about their revision!

Analysis

One of the simplest steps you can take is to calculate a mean study session time. This could be done across the whole class, or per pupil. The latter might facilitate giving more targeted feedback to learners, but you may wish to keep such information confidential.

You could also calculate the mean time between covering something in class and the date of a learner's next revision session. This would give an indication of whether learners are making best use of the spacing effect or not. They may also be leaving too large a space – for example, learning a topic in September and then not revising it until April would probably be too long an interval, as a large amount of forgetting would take place.

Options

As well as study times, you could also look into how pupils are studying – re-reading, highlighting, self-testing, and so on. It would also be interesting to find out where they are studying, for example, if all of their revision is done in the one place.

If setting up a learning log seems too difficult to administer, another option could be to provide revision task sheets (or to adapt existing tasks) which prompt learners to write a date and a start/end time on the sheet itself.

Follow up

The obvious follow up to this project is to conduct one or more awareness raising sessions with learners, teaching them about the benefits of study which is more spaced out
over time. However, the details of what you will raise depend on the findings. Some possibilities include:

- If you find that learners are engaging in very long study sessions, encourage them to divide these up into half-hour blocks, with a short break after each one.
- If you find that learners tend to study one topic in a single evening, encourage them to do half on one day, and then return to it the next day (or the next week).
- If you find that learners are tending to do their revision very late at night, this could stimulate a discussion about healthy sleep habits.

Limitations

The spacing effect has been demonstrated in all areas of learning. However, while there are clear benefits, this has to be balanced against practicalities. The time available to master a topic is limited, and sometimes learners have little choice but to do a bit of cramming (if your exam is tomorrow, then it is clearly better to cram than to space work over several days!).

Traditionally it was thought that the spacing delay should gradually increase – revising one day later, one a week later, then a month, and so on. However, Carolina Küpper-Tetzel and colleagues24 found that when dealing with timescales relevant to school there is no real advantage to complex ‘expanding’ schedules. In a school situation it is probably a lot easier to plan a regular schedule, for example by revisiting content once every month.

Further reading

A very useful book which puts the study of memory into a practical setting with hundreds of lesson ideas is Love to teach by Kate Jones25. Spacing is also discussed in a lot of detail, with practical links to teaching, in Psychology in the Classroom26. Accessible research articles related to this project include:


TERMINOLOGY NOTE: be careful when citing evidence for this concept, as some research studies use the terms interleaving and spacing interchangeably.


Project 5: Staff use of research

This final project concerns the research process itself. Rather than investigating pupils, it looks at how other teachers use research, although the underlying principles could also inform research with your classes. It will focus mainly on teachers using research, but the same issues arise when it comes to their carrying out research. This project could be done by any member of staff, though is perhaps especially useful for a head of department or the leader of a school-wide research centre (see The Teacher’s Guide to Research, chapter 15).

Case study

Ashley, Saad and Karen are three teachers who want to launch a research centre at their school. They decide that in order to do so, they will carry out an investigation to find out what kind of activities their colleagues already engage in, for example reading journal articles.

Each of the them agrees to interview members of their own department and two others, thereby gathering information on nine school departments overall. However, as time goes on, it becomes apparent that their data are difficult to interpret. Each of the investigators has asked slightly different questions, and conducted the interviews in their own way, and in different settings.

The largest problem that arises, though, is the issue of how people view the issues under investigation. The team asked the other teachers ‘how often do you engage in research activities?’, but there appears to be a wide variation in terms of how their colleagues interpret the term ‘research’.

What motivates teachers to engage with research? Richard Ryan and Edward Deci’s ‘self-determination theory’ is a major psychological theory of motivation which can help to answer this question. The theory suggests that three factors are especially important in fostering motivation: the individual’s experience of autonomy, competence, and relatedness.

Autonomy means a person’s freedom to choose what they do, and how and when they do it. Competence relates to their skills, although a key factor is whether the person feels competent (this is also called their ‘self-efficacy’). For example, does a teacher think that they have enough skills to read and use research? Finally, relatedness pertains to whether the actions have social significance in the person’s life. Is the activity relevant to their friends and loved ones, for example?

Even when teachers are motivated to use evidence and engage in research, different people may interpret a source in different ways due to their existing knowledge and biases. This can be an interesting area of investigation in itself, but can also be useful preparation if you plan to share research ideas in writing or with colleagues who have different academic backgrounds to yourself.

It’s worth noting that the motivating factors do not include some of the most cited barriers to research, such as time. However, competence is an issue that could potentially impact on time, because things take longer if you feel unskilled. A study by Kennon
Sheldon and colleagues found supporting evidence that autonomy, competence and relatedness were more motivating than simple rewards or other possible factors in terms of the life events that people found most satisfying. They also found that self-esteem was important.

These ideas link into another psychological theory, ‘social identity theory’. This body of work, which dates back to the 1970s but is still a major area of research today, suggests that the way we see ourselves – our identity – is in large part composed of how we categorise ourselves as members of particular social groups, such as religion, social class or nationality. You probably categorise yourself as a teacher – do you also categorise yourself as a researcher? An intellectual? A manager? People’s social identities are complex, composed of multiple groups that we identify with, and they also vary across different situations. According to Henri Tajfel and John Turner, we are then motivated to make sure our ‘ingroups’ are successful, as their success boosts our self esteem.

Key study in focus

Given the importance of social identity, what effect does it have if people think that others are engaging in an activity – or think that they are not? Health researchers have shown that young people often believe that their peers are engaging in more drinking and drug taking than is actually the case. This false belief that something is the ‘social norm’ can motivate them to fit it, making them more likely to use substances themselves.

However, the same effect can also apply to prosocial behaviour. An experiment into environmental behaviour – specifically, reuse of hotel room towels – by Noah Goldstein, Robert Cialdini and Vladas Griskevicius investigated how this might work. Their research involved gathering data about whether real hotel guests in the USA had reused their towels or not. In half of the rooms, a standard sign was displayed, encouraging guests to help the environment by reusing the towels. In the other half, a similar sign stated that “almost 75% of guests use their towels more than once”. This version presented the idea that towel reuse was the social norm, and indeed, it led to an increase in towel reuse, which went from 35% to 44%.

A second experiment in the same study added an additional element which aimed to engage the guests’ social identity. In this version, a sign said “75% of the guests who stayed in this room” had reused their towels. This time, the percentage of reuse rose to 49%, suggesting that a massage about a social norm is much more powerful if it implies that the people described are part of our ingroup.

The findings can easily be applied to teachers’ research engagement, by simply providing information on who is engaging, and how. Curiously, though, even the simple act of guessing the social norm has a benefit. A study by Simon Bartke, Andreas Friedl, Felix Gelhaar and Laura Reh found that when they had previously been asked to estimate the

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social norm for charitable giving, the amount that people themselves give was larger than in a group who were simply told the norm (both groups gave more than a control group).

The idea of letting people know about a social norm is a form of nudge psychology. It may seem manipulative, but the key thing is to be open about it, and to ensure that information provided is accurate. Used well, such strategies can motivate behaviour more than incentives, and with little or no cost (you can read more about ‘nudges’ in Chapter 14 of *The Teacher’s Guide to Research*).

**Applying this in your school**

The principles behind motivation, social identity and the use of nudges to engage teachers can be applied throughout a school. The ideas can not only help us to question why some teachers engage with research and others do not, but they can potentially be applied to try to increase research engagement.

Drawing on self-determination theory, we can predict that boosting levels of research competence, autonomy and relatedness should, in principle, motivate people to use research more. This could imply that a school offer training/professional learning to increase skills, give teachers more control over what research they use and how they engage with it, and develop team-based processes.

The research into social identity and social norms fits well with the idea of relatedness. It suggests that teachers will be motivated to do something if they see it as part of their social role, and all the more so if they think that most other people are doing it.

The principles can apply to groups of learners, too. Do your classes feel competent in the new skills, and are they learning step-by-step to build new skills upon existing foundations? Are they connected to one another, and respected? Do they have some element of choice about what to study, and do they see positive study behaviour as the norm? If not, these are areas that could be addressed.

**Your own research project**

What research evidence do teachers engage with, and why? A simple questionnaire could be prepared, asking people about what sources of evidence they use. This can provide some basic data that could then be shared around the school as part of an identity-based nudge. However, as highlighted by the case study, it’s important to be specific. Teachers may well be engaged in research activities, but without viewing themselves as research engaged. They may see the term ‘research’ as only applying to active data gathering, for example, or assume that they are only being asked about educational research.

1) First, you should give some thought to what you really want and need to find out about. This may relate to the skills that are already present among the staff. For example, perhaps you want to find out who can do statistics, who has previously applied for funding, who is confident at doing research write-ups, and so forth. Other possible skills and experience to ask about might include programming and running online experiments, designing questionnaires, and working on an ethics panel. When you have decided what you need to find out, write these targets down.

2) For each target, write down one or more questions that can be used to investigate it. If one question is enough, then that is all you should use – don’t add extra questions on the
same issue unless you really need to. Also, keep the questions closed if you can – for example, rather than leaving an open box for teachers to state their experience, you could ask how often they do each activity, giving them a range of choices (approximate number of articles read per school year, for example), or use simple yes/no questions (‘have you ever done x?’).

3) Review the wording of the questions, taking advice from a colleague if possible. Make sure they are as specific as possible, with no vagueness and no chance that they could be misinterpreted. For example, rather than asking ‘how often do you read research’, could you specify what type of reading you mean?

4) Ensure that you include some questions relating to research in a person’s subject area. This is important, not least because of the transferrable skills involved in research (for example, a Biology teacher who has previously published their own research will have many of the skills needed to research and publish in education, too).

5) The questionnaire should otherwise be kept as short as possible. There is no need to ask for name, age, etc, though it would be useful to find out the person’s subject area. You could also include an optional check box to tick if they want to get more involved in the research activities at the school.

Analysis

This is not a fully realised research project, because you won’t have anything to which to compare your results. For example, if 20% of teacher say that they regularly read education journal articles, is that good or bad?

Research studies typically use a control group. One way to include this in your analysis would be to survey another school. However, perhaps more importantly, your current results can act as a baseline for future investigations. If you now launch a programme of professional learning and/or a research centre, you will be able to repeat exactly the same survey (after a couple of years, perhaps) and find out whether the level of research engagement has increased. These comparisons could potentially be publishable, as it will demonstrate the effect (or lack of it) or an intervention.

Looking at the findings in much more detail, you will also be able to identify gaps in the professional skills among the staff. Did nobody answer ‘yes’ to the question about research funding? This could be an area where it would be worthwhile running a workshop, or bringing in a visiting speaker.

Finally, the people who checked the box to get more involved (see point 5, above) can be invited to one or more meetings, and could form the core team of a new research centre.

Options

In addition to finding out what people are already doing, it would also be interesting to explore factors that worry teachers or limit their engagement with research. However, it’s important to be careful, as this might touch on issues that cause workplace stress. Investigating anything to do with anxiety requires considerable caution by a researcher, and it would be a good idea to have an independent external partner look over your plans if you are thinking about doing this.
Follow up

Once a research programme or research centre has been established, you will also want to keep track of how things are going. This could be done through open interviews or focus groups, allowing participants to raise issues that you may not have thought of. You could also analyse secondary data on research activities that are running in the school. For example, how many staff attend research seminars or staff reading groups? How many submit research proposals to the school's ethics board, or download support and training materials? These numbers may give you an easily-accessed insight into what proportion of the staff are engaging with research at any given point.

Limitations

And of course, teachers’ perceptions of their own competence may be inaccurate, either overestimating, or – perhaps more likely – underestimating their ability to carry out research activities.

Further reading:

*Psychology in the Classroom* contains a chapter on motivation, which covers self-determination theory among many other valuable and practical insights. Accessible articles related to this project include:

