Generative Learning

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Introduction

From to teaching to learning

This is an exciting time in education, especially for any teachers with an interest in educational research. The ResearchEd movement holds conferences all over the world with a series of books published looking at issues as diverse as SEND, Curriculum and Direct Instruction. Impact, the journal of the Chartered College of Teaching, has been published for the last couple of years and is brimming with articles, often from classroom teachers, on their application of research in the classroom.

What a great deal of educational research adopted by teachers has tended to focus on though is that which deals with the instruction phase of the learning process. Rosenshine's Principle of Instruction provides an excellent series of pointers in how a teacher can ensure that they present information in a way that increases the chance of it being learnt by the pupil. Likewise, the principles of Cognitive Load Theory set out how instruction can be planned in a way to best manage the cognitive load of a task and so avoid overwhelming the limited working memory.

What this book does in contrast is to look at the process from the other side of the desk. Generative Learning considers the learning experience from the point of view not of the teacher but that of the learner and asks what they should do with the instruction that they have been given to ensure that they are able to truly make sense of it and learn it in a way that allows them to apply it to new situations in the future. We could see generative learning as the reverse side of Rosenshine's coin.

The book you are holding, Generative Learning… in Action, is based on a theory of learning that suggests pupils create understanding of what is to be learnt through a process of selecting information, organising it and then integrating it into what they already know. It draws primarily on the work of Fiorella and Mayer and their 2015 book *Learning as a Generative Activity: Eight Learning Strategies that Promote Understanding* but we also draw on the work that influenced them and on further theories of learning that we have found useful in implementing Generative Strategies in our classrooms[1]. Primarily this book is a teacher-eye view on what could otherwise remain an academic theory. We have tried to be clear on how these strategies could be deployed most effectively in a range of subjects and settings but also, I hope, pulled no punches when it comes to discussing potential pitfalls to be avoided.

The place of Generative Learning in the education landscape

[1] Fiorella, L. & Mayer, R. E. (2015) *Learning as a Generative Activity: Eight Learning Strategies that Promote Understandin*g. New York: Cambridge University Press. All subsequent references to this text will appear in parenthesis.

In order to best understand the application of Generative Learning in the classroom, it helps to recognise how it fits into other elements of our practice. This awareness will help us to implement the eight activities effectively and with an awareness of potential pitfalls to avoid.

Constructivism

Generative learning falls into a broadly constructivist model of learning in which learning is viewed as something that happens in the mind of each learner and is shaped by their own experiences and the prior knowledge that they bring to the topic. For example if I were to be presented information about the salt plains of the Danakil Depression I would link this to knowledge I already hold about plate tectonic movement in this region and see this new information in light of this. Someone else might already know something about the impact of salt on trade in North Africa and so read this new information in those terms. We would both take something different from the presentation of the same material. This would suggest that learning is a highly individual thing.

However, this, as Richard Fox points out, is little more than common sense and he warns that constructivist claims about learning can be both vague and misleading[2].

"This vague idea, itself misleading and incomplete, can be developed in a number of ways that are not always compatible with one another. Moreover, as the claims become more bold and distinctive, they risk collapsing either into implausible philosophical positions or becoming empirically too narrow, respecting some aspects and types of learning to the detriment of others."[3]

So, to take the above example should we assume that there is no objective truth about the Danakil Depression that can be taught? That any knowledge is subjective and true only to the person holding it? These are the sort of 'bold and distinctive' yet 'implausible philosophical positions' that some radical constructivists reach[4].

One of Fox's criticisms of constructivism in particular can highlight potential pitfalls of generative learning that we as teachers should be aware of, *learning is an active process.* This is one of the key tenets of generative learning - that pupils need to go beyond passively being around the thing to be learnt and need to actively engage in it. In their introduction to Eight Ways to Promote Generational Learning, Fiorella and Mayer cite Wittrock (1989) in saying "…the mind… is not a passive consumer of information", rather, "…it actively constructs its own interpretations of information and draws inferences on them"[5]." However, as Fox points out, the human mind does both. It is perfectly capable of consuming information passively and responding to it, such as the iris narrowing when exposed to bright sunlight or the way our behaviour may change as a result

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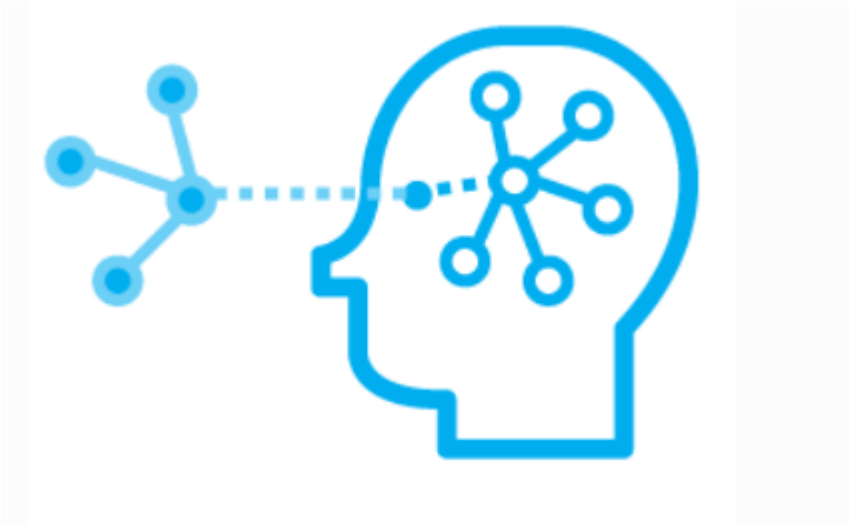
[2] Fox, R. (2001) Constructivism Examined, *Oxford Review of Education*, 27:1, 23-35.
[3] *Ibid* p. 24
[4] Glasersfeld, E. von (1993) 'Learning and adaptation in the theory of constructivism'. *Communication and Cognition.* 26 (3/4), 393 – 402.
[5] Fiorella, L. & Mayer, R.E. (2016) Eight Ways to Promote Generative Learning, *Educational Psychology Review* 28:717–741. p. 348

of some sort of sanction without us ever being aware that this had occurred. He explains “Our ability to perceive, to learn, to speak and to reason are all based on the innate capacities of the evolved human nervous system”[6]

All this really means is that we should be aware that although pupils *can* generate learning through the constructive and interactive methods discussed in Fiorella and Mayer’s work, it would be a mistake to think they can *only* generate learning in these ways.

Schema Theory



When we think about constructing meaning we often mean constructing *schema*. This way of thinking about how the mind stores information in the long term memory is a term used in both cognitive science and psychology. Perhaps most famously Jean Piaget looked at how cognitive function categorized and organised information in internal structures.[7] This was then developed further by Frederick Bartlett,[8] who made links to the schema and memory in psychology, which he stated involved "an active organization of past reactions or experiences".[9] This was later developed by RC Anderson who linked ideas of schema to educational psychology, especially in regards to reading, arguing that "every act of comprehension involves one’s knowledge of the world as well".[10] This is a statement which has significant implications for how we ensure learners have the required prior knowledge in order to access new information.

Schema (a singular collection of concepts) or schemata/ schemas (plural), are networks of information built around connected ideas. We have a huge range of schemata which include

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[6] Fox, R. (2001) p. 26
[7] Piaget, J. (1926). *The Language and Thought of the Child*. London: Kegan, Paul, Trench, Trubner, and Company.
[8] Bartlett, F. C. (1932). *Remembering*. Cambridge, UK: Cambridge University Press.
[9] An, S. (2003) Schema Theory in Reading, *Theory and Practice in Language Studies*, 3 (1), pp. 130-134
[10] Ibid

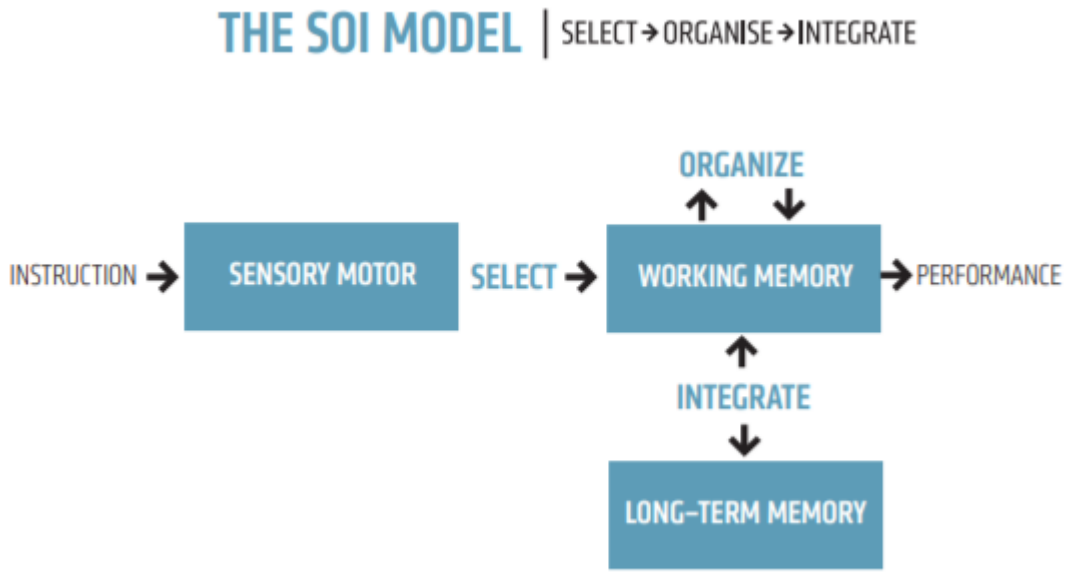
social schema which tell us how to behave in certain social situations, for example how to interact with friends, events schemas, for example when professional interactions and personal schemata where we hold certain information about ourselves, our behaviour and our abilities. Most importantly in the context of education we hold academic schemas, where we organise and categorise information about the topics and subjects we study.

Schemas are not static stores of information and will be regularly adding information and reorganising them in order to assimilate new knowledge and develop new applications. Nor are they simply an ever filling pail, where we pour more information. Schemas are continuously involved in interactions between prior knowledge and new information which we are receiving, selecting and organising information before integrating this into the long term memory (The SOI model- see below).

When we receive new information about a topic we draw on our prior knowledge in order to make connections and create meaning. De-contextualised or seemingly random information is difficult to process so activating prior learning, highlighting links or providing a 'big picture' within which learners can place this information will help support schema development. For example, if I were to say to you *Danakil Depression*, as I did above, but then simply walked away, it is unlikely you would remember the term. It would hold no meaning to you. Perhaps, you would mistakenly file it under 'A mental health condition'. However, you now know it is a landform feature created by tectonic movement, is found in North Africa and is involved in the production of salt. This information, Danakil Depression, has been given context and can now be assimilated into your schema.

It is also important to note that schemas can, and often do, contain inaccurate information in this way and even false learning. These are the misconceptions which we see students really want to cling on to. For example, those who insist that February only has one 'r' in it or those who claim that (geog example here as you have good ones). These schemas need to be challenged and broken down in order to be rebuilt around the correct information. Certain misconceptions held in schemas which may have formed the basis of some of our students earliest learning experiences are incredibly important to restructure as this may continue to impact on the further development of the correct schema, for example with issues with phonemic awareness. If some of this is not correctly understood both reading and writing can be negatively impacted. To return to the example above, if you thought that North Africa was free from tectonic processes or had no natural resources, your schema would have to shift to accommodate contradictory information. And in this way, we generate learning.

The SOI Model



As well as being part of the constructivist tradition of learning, generational learning also falls more specifically within the cognitive constructivist tradition, in that it concerns itself with models of how the mind works to help explain the learning process. One model it relies on heavily is Mayer's SOI model of memory. This model suggests that learning occurs by the mind going through three processes.

- Selection - the mind has to decide which of the incoming sensory information to pay attention to.
- Organisation - the mind then has to place this information into some kind of context in order to consider how to make sense of it
- Integration - finally, the incoming information is linked to the learner's prior knowledge and is assimilated into the schema, or else the schema is altered to accommodate something that contradicts what was previously known[11].

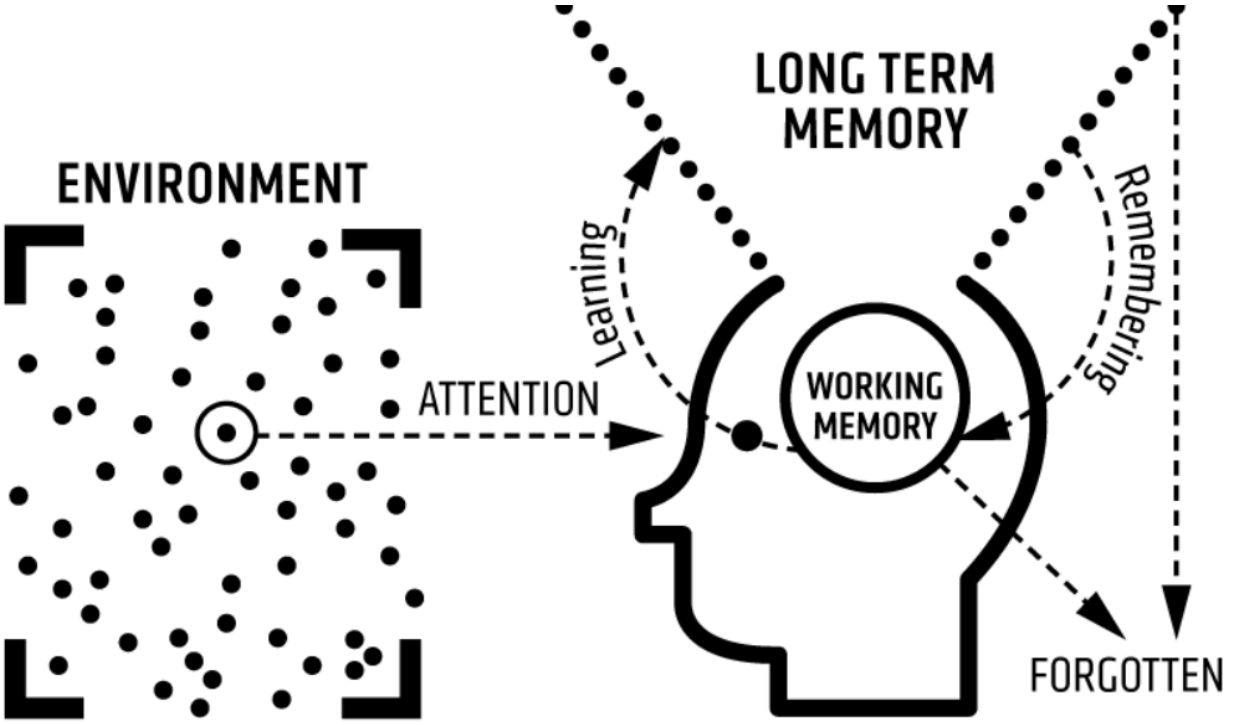
When information is put together in this way, the mind can generate learning. Fiorella and Mayer describe this form of learning like this:

"A process of making sense, in which you try to understand what is presented by actively selecting relevant pieces of information, mentally organising them, and integrating them with other knowledge you already have" (p. vii)

Cognitive Load Theory

[11] Mayer, R.E. (2014). Cognitive theory of multimedia learning. In R.E.Mayer (Ed.), *The Cambridge handbook of multimedia learning* (Second Edition, pp. 43–71). New York: Cambridge University Press

The SOI model uses the same kind of multi-store memory model as Cognitive Load Theory (CLT). This model suggests that the mind is assailed with information constantly and this information is held in our sensory memory for just a fraction of a second. Our attention picks up on some of this information and this is then held in our working memory. For example, where I am now sat I can see piles of books and pieces of paper, various pens and pictures. I can hear a dog barking in the distance and the sound of a radio playing elsewhere in the house. I can still smell the slightly burnt toast from breakfast and the unlit scented candle by my desk. All of this information would hit my senses whether I was aware of it or not but only by paying deliberate attention to it have I become aware. Almost all incoming information is discarded without us knowing.



Willingham's Simple Memory Model

Created with Nick Rose, Harry Fletcher-Wood and colleagues from the Institute for Teaching in winter 2019.

Once information is in our working memory we can think about it. Our working memory is very limited and can only hold a few pieces of information at any one time and has to rehearse it constantly to avoid losing it (think about how you have to repeat a phone number to yourself as you desperately look for a pen. If something else enters your working memory whilst you are doing this, the numbers are lost). Generative Learning is taking place in the working memory. It is here that new information can be thought about and processed and linked to prior knowledge.

This is because the working memory is linked to our long term memory. This memory store is, to all extents and purposes, limitless. Our long term memory contains our schema, our web of interconnected knowledge, about any given topic. This schema allows us to do things without

troubling our limited working memory as they have become automated. Every time we draw something out of our long term memory the ability to recall it again becomes stronger. The goal of Generative Learning is to encode things strongly into our long term memory and to make them easy to recall in the future.

Cognitive Load Theory suggests that any task we do places a 'load' on our working memory. If the load is too great our working memory capacity will be overwhelmed and we won't be able to learn it. This load comes from two sources. The first is the intrinsic load which is how complex the task itself is. The second load is the extrinsic load which is everything else in our environment or in the way the task is designed[12]. For example, there is an intrinsic load in asking pupils to work out 354 ÷ 7 but the load would be greater if we added the distracting sounds of gunfire or asked them to work it out in a novel way they hadn't encountered before.

We may wish to consider CLT when planning Generative Learning strategies as we want to ensure that the pupil attention is being given to incoming sensory information that will help them to learn and to ensure that the activity itself isn't so complex that it adds to the extrinsic load and risks overwhelming the working memory capacity.

Self-regulated learners - self efficacy and independence

One of the key aims of Generative Learning strategies is to develop metacognitive skills through the process which will then motivate students through self regulation and self efficacy to become independent learners- the ultimate aim for many educators. Fiorella and Mayer call Metacognition and Motivation the 'Mighty M's' (p.10) and metacognitive strategies are woven throughout Generative Learning strategies as examined in their work.

Metacognition, in its most simple definition, is thinking about how we learn. The most successful learners are able to reflect on their learning processes, considering the strategies they have available to them to tackle different problems, selecting the most appropriate ones to apply to the task in hand, whilst developing an awareness of their strengths and gaps in their own learning. This allows them to have greater agency over their learning, making decisions not only in relation to strategies they could employ but also in terms of what they need to restudy in order to close any gaps in knowledge and understanding. Here we have students who are in control of regulating their own learning or as BJ Zimmerman describes them in his *Handbook of Self Regulation and Learning Performance*[13] self-regulated learners who 'personally activate and sustain cognitions, affects, and behaviors that are systematically oriented toward the attainment of learning goals.'[14] This is a learner who is motivated to drive their own learning forward and is therefore able to engage with learning activities in a much more independent way. They have the self efficacy

[12] Sweller, J. (1988) Cognitive load during problem solving; Effects on learning, *Cognitive Science,* 12, 257 - 285.
[13] Zimmerman, B.J. & Schunk, D.H (2011) *Handbook of Self Regulation of Learning and Performance*. Oxon: Routledge
[14] Ibid, p.1

available to know that it is within their ability to solve new and complex problems as they reflect back on their past learning experiences and successes. Students who have good self efficacy are also much more motivated in their learning, primed to work towards personal goals and use a range of effective strategies to achieve them.

Each of the Generative Learning strategies is designed to teach students strategies which allow them to actively engage in their own learning and reflect back on what they have, and have not, learnt and set their own goals to progress towards.

The research origins of Generative Learning

So, if we put together the various theories and models of learning discussed above we can see that Generative Learning is based upon the idea that for learning to take place students must engage in a number of generative cognitive processes, after which they are able to transfer what they have learnt into solving new problems. Fiorella and Mayer use the definition of learning in their work which was discussed above in light of the SOI model of learning. This SOI model of learning also makes clear that we are a 'pattern-seeking species' who seek to 'make sense and order from the world around us'. [15] As we interact with the world around us we are in the continuous process of collating information into our existing understanding to create new meanings and understanding.

Generative Learning also is related to research into 'transferable knowledge and skills' as discussed by Pellegrino and Hilton in 2012[16] and ways in which independent learners can be developed using various computer based platforms.

Its research origins can also be found firmly rooted in the work of Piaget (1926) and Bartlett in 1932, the latter of whom developed the idea of learning as 'an act of construction' whereby new information was assimilated into existing schemata (p.15). This idea that learning is based on an architecture of the mind whereby memory and understanding is constructed, and perhaps even more importantly, reconstructed, is the main focus of generative learning as a theory.

Like Bartlett, Piaget's work on schema also focuses on the idea that learning and the cognitive processes involved is more than the act of memorisation, research extended by Katone in 1940[17] and Wertheimer in 1959 [18], and it is how we select, organise, collate and then finally integrate this information into new schemas which is important.

However it was not until the 1970s and the extensive work of Merlin C. Wittrock that the concept of Generative Learning was developed. Wittrock explored the relationships between existing

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[15] Myatt, M. (2018) *The Curriculum: Gallimaufry to Coherence*. Woodbridge: John Catt, p.23
[16] Pellegrino, J. W., & Hilton, M. L. (2012). *Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century.* Washington, DC: National Academies Press.
[17] Katona, G. (1940). *Organizing and Memorizing*. New York, NY: Columbia UniversityPress
[18] Wertheimer, M. (1959). *Productive Thinking.* New York, NY: Harper & Row.

knowledge and concluded that 'people tend to generate [. . .] meanings that are consistent with prior knowledge', and, with the right activities, we generate strong links between new and prior learning. This idea is a powerful one for educators and learners as they seek to find ways to embed information and knowledge. As Paul Kirschner and Carl Hendrick remind us in *How Learning Happens* 'new information which is not related to existing knowledge it is quickly shed'[19]

These ideas that underpin Generative Learning, then led Fiorella and Mayer to a series of activities which they argue actively encourage students to select information from the learning materials which they can then organise and integrate into the schemas alongside their prior knowledge on the topic. This list represents the activities which they found to be the most effective in terms of Generative Learning, but there are other activities which could fall within this definition.

They found the most effective activities are:

1) Summarising
2) Mapping
3) Drawing
4) Imagining
5) Self -testing
6) Self- explaining
7) Teaching
8) Enacting

Fiorella and Mayer examined research undertaken for each of these activities and determined effect size, possible applications in the classroom and boundary conditions. Our book will aim to build on their work, and the work of those they draw on, by looking at each of these activities from the perspective of a classroom teacher putting them into action.

Research base and effect size

The table below relates to the studies cited by Fiorella and Mayer and indicates the number of valid tests where key conditions were met and how many of these had a positive effect size (vs. no strategy used). It is worth noting that some strategies have a much higher research base than others and where this has been considered to be of significance it has been explored in the coming chapters. For a full list of all the research studies used, please refer to the original text.

Strategy	Positive/Research Base	Effect Size

[19] Hendrick, C. and Kirschner, P. (2020) *How Learning Happens*: *A Seminal Work in Educational Psychology and What it Means in Practice*. Oxen, Routledge. p.114

Summarisation	26/30	0.5
Mapping	23/25	0.62
Drawing	25/28	0.4
Imagining	16/22	0.65
Self-Testing	44/47	0.62
Self-Explaining	44/54	0.61
Teaching	17/19	0.77
Enacting	36/44	0.51

Chapter 1
Learning by Summarising

What is learning by summarising?

Before you begin to read this chapter, just take a few minutes to recap what you have learnt about Generative Learning so far. You can either write a short summary or summarise it verbally.

What processes did you go through in order to be able to summarise?
What information did you select?
How did you decide what should go first in your summary?
Did you reorganise anything?

Summary is a process which we use all the time, as we retell stories, think about earlier conversations and reflect on what we may have done yesterday. We don't go over every detail, we abbreviate, select important points and redact what we do not need in order to distill the essence of these things.

Summarising in terms of Generative Learning is employing these same processes, requiring students to collate and reorganise the main points from their learning at different points in the learning process. This can be using longer summaries at the end of a learning sequence, or they may intersperse summary in order to support their comprehension.Summaries can also be verbal or textual and there are benefits and restrictions with both.

This is most effective where the learning isn't reliant on material which is spatially complex, for example diagrams and tables in a science textbook, where ideas have already been condensed or synthesised.

Why use learning by summarising?

When asking students to summarise we are asking them to engage again with the select, organise and integrate cognitive processes of generative learning. Summarising, according to Wittock,[20] is an effective generative approach as it 'forces students to engage with the generative strategies.' (p.24) This activity means they have to extract the key information, make links and associations within the new material and then make associations with material which is already stored in their existing schemas. This, he concludes, will lead to deeper learning. Moreover, using single sentence summaries, where they write or verbalise a summary after each paragraph, significantly supports the comprehension of students with 'lower' reading abilities but is also important for those with a 'higher' reading ability (p.24). This could indicate the process of summarising short sections of learning can support the students' ability to select key information.

Summarisation has been shown to boost learning and retention as it requires students to attend to both the higher meaning of the material as well as the gist. Studies by Bretzing and Kulhavy (1979) and (Craik & Lockhart, 1972) [21] both indicated that summarisation yielded greater benefits in terms of comprehension due to the requirement to manipulate material in order to form cohesive summaries.

Furthermore, Peper and Meyer examined the relationship between note taking, summary and learning outcomes. They found that students who take notes but couple this with summary at the end of their notes performed 10-15% better than their peers who just took notes in problem solving assessment and 13-17% better in recall than those who did not summarise their learning.[22]

How to use summarisation in the classroom

Summary has long been a staple in the English classroom. Indeed it is a key component of one of the Assessment Objectives in the English Language GCSE, where students need to show they can select and synthesise information from texts, often appearing in the form of a summary question.

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[20]Wittrock, M. C. (1974). Learning as a generative process. Educational Psychologist, 11, 87–95. Wittrock, M. C. (1989). Generative processes of comprehension. Educational Psychologist, 24, 345–76.
[21] Dunlosky, J. *et al* (2013) Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology. *Psychological Science in the Public Interest* 14(1) 4–58, p.11
[22] Busch, B and Watson, E (2019) *The Science of Learning: 77 Studies that Every Teacher Needs to Know*. Oxen, Routledge., p. 69

In English I have frequently asked students to summarise key points from a text we are reading, limiting them to no more than 30 words, sometimes reducing that down to no more than 10, to ensure that they have retained the salient points. These are then shared and discussed in order to explore which elements have been chosen, which may have been omitted and if this is a clear representation of the section. This is a way in which I also encourage the development of metacognitive strategies as students reflect on their learning and how they have presented it in their summary form. I also ensure that some of their summary work is a closed book, ensuring that they pay much greater attention to the original learning materials and give them opportunities to make connections between different information in their summaries, for example summarising the ideas about gender in two poems.

I have also often used shorter, single sentence, or even single word, summaries to support comprehension of complex or longer texts, encouraging students to write their own paragraph summaries in margain, or identifying or creating topic sentences to support this. This also allows me to quickly check students have an understanding of the gist of the text and ensures that false learning is not becoming embedded. Again this enables students to reflect on their own learning, exploring the text in small steps and exploring how their overall understanding of the text has developed.

Using *Cornell Notes* is another useful method which can combine different Generative Learning strategies discussed in this book; summary, drawing, mapping and self-testing. It can be an effective strategy across all subjects and works for lectures, videos and use of textbook resources.

In this method students are given a divided page, where they make notes during a lecture or whilst studying, add questions or identify key points in the margin and write a textual summary at the bottom.

As students take notes in the main section they can include diagrams, maps and drawings, as well as keywords and phrases spatially. Here they will be selecting and organising the information, supporting their summary where they will continue with these processes and then incorporate information from their prior learning, hence drawing on prior knowledge and strengthening and building on existing schemas. There is more detail regarding using Cornell Notes in the case study for this section.

Learning by summarising across the curriculum

- In **history,** when reading a longer text the learner could summarise either line by line or each paragraph.
- In **science,** after watching a video clip explaining a principle, the learner could select the key information and organise it into a summary. This could be done either verbally or in writing.

- In **PE,** after watching a demonstration from the teacher, the learner could be asked to summarise to the rest of the class the key points to remember.

Case Study of learning by summarising

Adam Riches is an Assistant Principal, Head of English and author of Teach Smarter.
In this case study he explains how he has taught his pupils to use a strategy for summarising that he himself had found useful as a student.

Cornell note taking isn't something that is new to me. Ironically, I was first introduced to it at university by my American lecturer when we were discussing computational linguistics. At the time, I was struggling to pick out the key information during lectures about topics and he showed me how I could condense my notes into a much more succinct and formulated revision tool. Of course at the time, I didn't consider the learning benefit from a teaching perspective and because of this it was some time before I revisited the method in an academic context.

Something that is apparent is that a lot of things in education are assumed, especially when you pick up a class later in their school life. One of the common assumptions is that students know how to take notes...mainly because they automatically (most of them) write when they are in lessons. Often, they know how to follow instructions and engage from the board, but when you drill down, they have no idea *how* to take notes because they have never been taught.

It follows that when students then revise independently, without a teacher to give instructions and a board to follow on, they simply resort to default - they write down everything; much like me at university. There might be some titles and highlighting, but for the most part, the notes will be very general. This makes the information encoded within those words harder to access and it also means that the process in which they were recorded was most likely very passive.

To combat this shortcoming, I resorted to teaching Cornell note taking early in Year 10. BY introducing students to an alternative way to note taking which significantly surpasses rote note taking, not only was I able to foster more confidence in the analysis of texts and decoding of teaching, I was able to teach self-efficacy. This allowed much more efficient and valuable independent study and best of all, much richer outcomes from the reams of information available for students online.

Starting with the most basic approach, I adopt the idea of breaking the page up to have a clear title, one column for key point / key idea being discussed and one column for notes. At the bottom of the page, a summary box finishes off the sheet. Nothing flash and of course, although taking the Cornell format, I don't often encourage pages and pages of notes - the students aren't in lectures afterall.

As an introduction, I actually populate the key point / key idea box for the students as a way of modelling the approach and scaffolding their adoption of the technique. As the scaffolding is gradually withdrawn, they fill in this box by themselves. The right hand box could (and should)

be filled with any note taking that the students wishes - words, pictures, diagrams, mind maps - it's totally up to them, but for me, I always say, no sentences. This allows the students the opportunity to break free of the confines of long winded encoding.

The summary box is the most important for me and I stress the importance of completing this in the right way. This is where understanding is checked and misconceptions can be quickly picked up by the teacher. Flicking through 30 summary boxes or circulating and checking when they are being completed can significantly reduce your marking workload and quickly highlight any misunderstandings that have emerged. . Moreover, a well written summary serves as an excellent revision tool for an idea or topic, with a fraction of the cognitive load.

Can an American university approach really be effective for students sitting the GCSEs? Yes. Not only do students buy into their learning differently, teaching becomes significant;ly more efficient. More efficiency means more time, more time means more learning.

Cornell notes are great for any resource. As I've mentioned, the students are rarely lectured (although at times this approach is adopted by many and can be very effective) because secondary education is more fluid. Cornell note taking is exceptionally good for engagement in video based resources, when students use audio resources and when they engage with texts. The method ads clarity and logic to unseen and unheard stimulus and this makes the recording of said content much more effective than if the students had just gone at it in the "traditional way".

It works. It is quick and easy to teach. It will make learning easier for your students.

Potential limitations of summarising

When using summary as a learning strategy, the highest effect is achieved when time is devoted to its direct teaching, including how to select key points, remove irrelevant material, select and generate topic sentences. Therefore, without specific instruction students, especially those who may have limited ability to construct written or verbal summaries due to the age or verbal or written literacy, may struggle to create a successful summary of their learning. Students failing to omit irrelevant information or copying points verbatim, will not be engaging with the valuable selecting and organising cognitive processes which will lead to integration and encoding into the long term memory. Removing study notes or original learning materials can both avoid this opportunity and employ aspects of retrieval (discussed in the Self- Testing Chapter) which can also be seen as an effective learning strategy in itself.

The time required to invest in this strategy could therefore outweigh the potential benefits. In one study, teachers were given 90 minute training on teaching summary. This was followed by five 50 minute sessions of explicit teaching of how to produce an effective summary, in which

the process was modelled, time was devoted to practising application, whilst students were coached and guided in their practise. Although students in receipt of this teaching outperformed those without this input, the level of investment required may make this approach impractical in some contexts.[23] The time cost here leads Dunlosky et al, to rate summarisations as low utility in comparison to other learning strategies.[24]

Using longer summaries infrequently can have a greater impact than frequent summary as students may expend more effort when the summaries follow a longer sequence in the learning process. Simply asking students to create summaries of their learning at numerous points could limit the impact of the learning strategy as students no longer are motivated to 'think hard' about the original learning materials.

Try it out

Use the space here to summarise your main learning points from this chapter.
Think carefully about what the key points around you want to include (select), the order you wish to present them in (organise) and how they link to the idea of Generative Learning as a whole (Integrate).

Further reading

Dunlosky, J. (2013) Strengthening the Student Toolbox, *American Educator* (3) 12 -21 Available at https://www.aft.org/sites/default/files/periodicals/dunlosky.pdf

[23] Dunlosky, J. (2013) Strengthening the Student Toolbox, *American Educator* (3) 12 -21 Available at https://www.aft.org/sites/default/files/periodicals/dunlosky.pdf p.9
[24] Dunlosky, J. *et al* (2013) p.15

Allison, S. (2018) Supporting Retrieval Practice with Cornell Note Taking on *Class Teaching* (blog) Available at https://classteaching.wordpress.com/2018/09/24/supporting-retrieval-practice-with-cornell-note-taking/

Needham, T (2020) Insights from Learning as a Generative Activity Part 3: Learning by Summarising on *Tom Needham* (blog) Available at https://tomneedhamteach.wordpress.com/2020/06/08/insights-from-learning-as-a-generative-activity-part-3-learning-by-summarising/

Chapter Two
Learning by Mapping

What is learning by mapping?

Mapping as a generative activity refers to a group of different techniques in which the learner represents text, whether written or spoken, as a spatial organisation of words with lines connecting them to show relationships. These different techniques are sometimes referred to as 'mind maps' but thinking about the different ways they can be deployed helps us to appreciate their power in the classroom.

- *Concept map* is a network in which words represent key concepts and lines connect them to show how the words are linked - these lines are often annotated with a description of the link.
- *Knowledge map* is a more specialised form of concept map in which the links are confined to predetermined types (i.e. this leads to… this is part of… this is a characteristic of…).
- *Graphic organisers* are more specialised still and include a structure which is used to categorize information more tightly. This might include:
    - Matrix for compare and contrast
    - Flow chart for cause and effect
    - Hierarchy for classification

Why use learning by mapping?

Concept mapping can provide a number of important roles for learners. One of these is to help pupils organise what might seem like disparate information into a more logical form. John Hattie explains that "(t)he mind does not relate well to unstructured data… We need to find the organisation, structure, and meaning in whatever we learn."[25] The way we find this organisation, structure and meaning is through the construction of schemata about a topic. For example,

[25] Hattie, J. (2014) *Visible Learning and the Science of How We Learn*. Routledge: Oxon. (p. 115)