School Effectiveness Team

Closing the Attainment Gap

An evidence informed approach to teaching

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Metacognition

What does the evidence say about metacognition?

There is a strong evidence base to support the positive impact that metacognition has on learning. It has a research base stretching back to the 1970s, with Flavell and Zimmerman the most notable contributors.

In 2018 the EEF produced the guidance report Metacognition and Self-regulated Learning, which is a synthesis of over 1,500 research papers on metacognition. This report also provides 7 key recommendations for how teachers can incorporate the principles into their practice.

According to the EEF guidance report metacognition is:

"About planning how to undertake a task, then cognitively undertaking that activity, while monitoring the strategy to check progress, then evaluating the overall success."

Put more simply, it is about how learners plan, monitor and evaluate their learning. Commonly, it is referred to as thinking about thinking. However, that definition misses the purposefulness of metacognitive thought. For it to be genuinely metacognitive, then the thinking needs to be purposefully directing children's behaviour in relation to learning.

Broadly speaking metacognition can be split into two main parts:

Metacognitive Knowledge

Metacognitive Regulation

The graphic below illustrates these two sections, together with the three composite parts of metacognitive knowledge and regulation. For metacognitive knowledge these are:

1. Knowledge of Task
2. Knowledge of Strategies
3. Knowledge of Self

For metacognitive regulation they are:

1. Planning
2. Monitoring
3. Evaluation

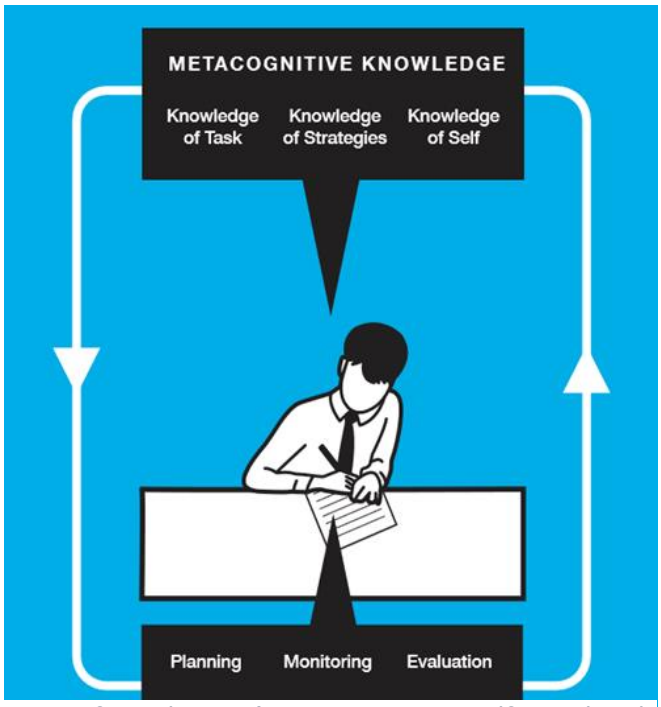

Image from the EEF 'Metacognition & Self-Regulated Learning' Guidance Report

To illustrate what this means in practice we could use the example of a Year 6 child and a spelling test. In the days approaching the test the children may display metacognitive knowledge in how they prepare for the test. They would use their knowledge of strategies to use retrieval practice to test themselves and use knowledge of self to ensure they always practised before dinner to ensure they were at their most focused.

During and after the test the child may use metacognitive regulation. While completing the test they may be monitoring the success of their preparation as they notice they are now confident with a couple of words they kept getting wrong when practising.

Afterwards, they may evaluate by recognising that when they practised using the retrieval practice strategies they had been taught, they were more successful as compared to when they had simply re-read the words as for previous tests.

Now, this sort of thinking has always been a feature of the most successful children. However, the acquisition of the capability to think in this way has commonly been left to chance or accepted as an innate characteristic of particular children. What we now know from the research is that metacognition can be taught.

However, a word of caution with this in that the research also says metacognition is domain (subject) specific and so must be taught alongside the learning you wish children to think metacognitively about. In other words, bolt-on metacognition lessons or interventions are unlikely to have a positive effect, it is about weaving the teaching of metacognition into the curriculum.

Why does this matter for disadvantaged children?

The benefits are clear. For disadvantaged learners in particular, this summary of international evidence suggests that 'metacognition and self-regulation' as a high impact and low-cost approach to improving attainment.

If you picture the most successful child that you teach, you will undoubtedly picture a highly metacognitive child. However, if you picture the least successful child you will almost certainly be imagining a child who displays very few of these traits.

Our disadvantaged children are less likely to have had the characteristics of metacognitive thought modelled to them at home. Therefore, it is up to teachers to plug this gap by explicitly teaching them these processes.

Five practical strategies for teachers

1. Model the steps you go through when completing a task. These steps may appear implicit, but if the steps are explicitly modelled to children along with why it will give children an insight into yours and hopefully their own learning.

For Example, when modelling how to create a timeline on Roman history following the unit of work the teacher would start by explaining why a timeline is important, the idea that they can see the whole time period including the start date and the end date. The teacher would then work out how many key dates will need to be included in the timeline from the information previously taught about the Romans. The teacher would then start to organise the ideas into chronological order. Following these steps, the teacher would then start to write them onto the timeline.

2. Ask the right questions - Link the questions you ask to promote children in thinking about the metacognitive knowledge (knowledge of task, self and strategy).

Knowledge of task	Knowledge of self	Knowledge of strategy
Is this task too challenging for me?	Is this task asking for subject knowledge I can remember?	Are my notes effective for understanding this task?
What are the most difficult aspects of this task?	Do I understand the concepts that underpin this task?	Do I need to ask for help?
How much time should I devote to this task?	Am I motivated to stick at this tricky task?	What strategies can I deploy if I am stuck?
Are there any easy bits I can get 'done'?	What can I do to keep myself focused?	What can I do to ensure I remember what I've learnt?

3. Promote and develop metacognitive talk in the classroom (dialogic talk) - through the use of socratic questioning (identified below). The traditional method teacher poses a question, children's answers the question and then teacher provides feedback on that answer can be amended. Creating an environment where the teacher poses the question, a child answers the question and then the teacher and other children discuss, challenge and probe that response further.

1)Asking them to clarify. *Could you explain?*
2)Challenging and probing assumptions. *Do you agree?*
3)Demanding evidence. *Can you give me an example?*
4)Looking for alternative viewpoints and perspectives. *Is there another way of looking at this?*
5)Exploring implications and consequences. *What would happen if?*
6)Questioning the question. *Why did I ask that question?*

4. Using the "I, we, you" modelling strategy to embed the metacognitive strategy. The "I" part is simply where the teacher models the strategy with the explicit instructions. With "We" the teacher models the strategy a second time with the children input and questions on how and why the strategy is being used. Finally, for "You" the children independently practise the strategy.

For example, when modelling how to start a story, the teacher would model all of the how to start the opening sentences to "hook" the reader in. The teacher will then create another start to a different story with the children's input as a collective group through questioning. The third step will be for the children to create their own start of a different story.

5. Explicitly teaching children how to organise and manage their learning independently (teaching self-study to children) as per the example given above regarding the year 6 pupil and

her spelling test. Developing and teaching children the two most effective self-study strategies of **distributed practice** (implementing a practice schedule that spreads study activities over time) and **practice testing** (self-testing or taking practice tests). These are most effective in retaining key information for a longer period of time, they enhance learning and comprehension and can boost children's achievement.

What are the challenges for classroom teachers?

It is not a neat or highly tangible concept, you can't just start doing metacognition, it takes time to develop and requires more time to implement and for children to understand how to be more metacognitive and self-regulatory.

The biggest challenge is that metacognition is domain (subject) specific, it cannot be taught in generic lessons. For example, creating an intervention group of disadvantaged children to teach them "metacognition" would be unlikely to have a positive impact, however, teaching children metacognitive strategies for creative writing would be more likely to be effective.

Metacognition doesn't represent 'higher order' thinking and is no more or less important than mere cognition or subject knowledge. In other words, to teach students their times tables it is just as important that they can say what 3 times 5 is as have strategies to evaluate their success.

Metacognition is time consuming to teach. Therefore, for it to be properly implemented curriculum time needs to be devoted to the explicit teaching of strategies where they arise in the curriculum.

Memory

What does the evidence say about memory?

As our understanding of cognitive science grows, we are learning more and more about memory, the process of learning and the implications this has for teachers. Here are some of the key messages that are worth knowing:

Long-term memory. This is a huge storehouse of vocabulary, concepts and procedures that can be likened to a filing cabinet or hard drive. The best way to think about long-term memory is a theoretical construct we call **'schema'**. A schema is an interconnected web of knowledge that resides in our long-term memory. For example, a biologist will have a 'cells' schema, with all the interconnected knowledge they know about cells. As you encounter new knowledge, it will connect with an existing schema and so the schema becomes bigger. The bigger the schema becomes, the easier it is to retrieve from the long term to the working memory - this is what happens as we move from a novice to an expert.

Working memory. This is the limited space in which we think and process information, analogous to a page on a notepad or the processor on a PC. Most researchers agree that the (magic number) four is the maximum number of new pieces of information that can be thought about at any one time. For challenging tasks and content, this capacity is likely to be lower.

One of the aims of education is to transfer information from the working memory to the long-term memory. Yet there is a problem, known as the 'bottleneck'. If working memory becomes overloaded, then new information is less likely to enter the long-term memory. The aim, therefore, is to ensure that cognitive load – the quantity of information a student is holding in their working-memory at any one time – is maintained at a commodious level.

To develop this idea further we should consider **Cognitive Load Theory.** There are two aspects of cognitive load which are usually considered to work in tandem:

4. **Intrinsic load** is related to the inherent difficulty of the subject matter being learnt. It is influenced by how complex the material is and how much a student already knows about the topic. For example, 2 + 2 + 4 has less intrinsic load than 93 x 543, whereas understanding the workings of the human respiratory system has more intrinsic load than knowing where the lungs are situated in a human body.

5. **Extraneous load** is any extra and unnecessary thinking that students have to do that does not contribute to learning. Unlike intrinsic load, extraneous load is related to how the subject material is presented rather than its inherent difficulty. As teachers, we can either heighten or reduce its effect.

We remember what we think about, not just what we have been exposed to. Daniel Willingham has written an excellent chapter on this topic in his book *Why Don't Students Like School?* For a student to remember an idea, she needs to have entertained it in her working memory – otherwise, there is no chance that it will transfer to long-term memory. Willingham also writes

"Things that create an emotional reaction will be better remembered, although an emotional response is not always necessary for learning." Repetition is also less effective than we might think we can see something countless times but not learn it. A £5 note provides a classic example of this. You may have looked at one innumerable time, but could you draw one from memory? Probably not. That's because when you think about a £5 note you think about its value, not its appearance.

Spaced practice (or 'spacing' or 'distributed practice') involves repeatedly coming back to information that we are learning in various short sessions, spaced out over time, rather than cramming in a long intense period. In 1885 Hermann Ebbinghaus ran a limited study (on himself) where he taught himself nonsense syllables and then tested himself on them days after the initial exposure to them, recorded how many he remembered, reviewed them again and then repeated the process over time. This resulted in the now-quite-famous 'Ebbinghaus forgetting curve'. Essentially this suggested that spacing out the reviews, with an increasing gap between them, helped him to remember the syllables. This has been replicated more recently. By allowing ourselves to forget and then having to retrieve that information from our memory, we are strengthening that memory.

Put very simply, **retrieval practice** is the act of having to retrieve something from your memory (often with the help of a cue). Recent research has shown that retrieval is critical for robust, durable, long-term learning. Every time a memory is retrieved, that memory becomes more accessible in the future. Retrieval also helps us create coherent and integrated mental representations of complex concepts, the kind of deep learning necessary to solve new problems and draw new inferences.

Why does this matter for disadvantaged students?

A 2016 North American study[1] compared low-income and high-income students' ability to use their working memory. The study involved mapping brain activity during a maths assessment and was able to show that differences in working memory had an impact on the test scores. The low-income students had less working memory capacity than their peers and relied more on their working memory when the high-income students were able to keep some in reserve.

The study does not speculate as to why these differences might occur, and care must be taken in equating low-income in the US with disadvantaged students in the UK. It would also be wrong to conclude that the physical differences in the brains of students from lower-income families were somehow fixed as we know the brain has the ability to change throughout life. However, it does lead us to reflect how important working memory is to learning and therefore the practical strategies below could be even more beneficial for students from disadvantaged backgrounds.

[1] *Functional brain organization of working memory in adolescents varies in relation to family income and academic achievement (Finn et al, Developmental Science (July 2016), pp 1–15)*

Five practical strategies for teachers

1.Regularly ask questions that challenge students to think about subject material. A common misconception is that students will only learn if they have to answer 'hard' questions. In actual fact, questions need not be fiendishly difficult; instead, they should allow students to think productively about the subject material. Sorting, ranking, comparison and categorisation tasks are excellent ways to promote thinking.
For example: Mr Eastham gave pupils a collection of places and asked them to sort them into names of countries and names of cities.
For example: Miss Donald wrote a list of characters from the class text on the board and asked pupils to order them according to how much sympathy they should receive from the reader.

2. Start every lesson with 3 groups of retrieval practice questions:

Group 1 – questions from last week.
Group 2 – questions from last month.
Group 3 – questions from last term.

3. Ensure your curriculum (classwork and homework) revisits previously taught topics.

4. Question them on their prior knowledge and build new knowledge.

For example: Before teaching converting between different units of measurement with a year 5 class, Mrs MacGregor checked that pupils could name and differentiate between the metric units for length, mass and capacity and could also put them in order of size.

5. Address cognitive load through:

Teaching in short bursts followed by practice. If a process consists of many parts, then these should be grouped together and taught in separate chunks. We should isolate the parts, teach them and then provide opportunities for practice before we bring them together as a whole.
For example: When teaching adding fractions with different denominators, Miss Turner broke this down into the separate skills of finding the lowest common multiple, finding equivalent fractions, and adding fractions with the same denominator. She then finally combined these to add (and subtract) fractions with different denominators.

Avoiding split attention. Strain is placed on working memory when a child has to mentally integrate information from different places. Resources should include colour-coding, integrated labels and arrows. Related pieces of information should be placed in close physical proximity.

Reducing redundant information. Remove superfluous images and text from PowerPoints and other resources. Try to ensure that students are not expected to be listening to a teacher

and reading text at the same time and avoid speaking over the top of students whilst they are thinking about something else. Give lean and focused feedback.

Limit distraction. Cognitively challenging tasks should usually be completed in silence. Avoid too much sensory stimulation during tasks like extended writing or solving complex, multifaceted problems.

Use worked examples. These are completed or partially completed problems or tasks that students' study before and during the initial teaching of a new skill or process. These should be gradually faded away so that students gain independence.

Dual coding. Dual coding theory holds that if material is present in visual and verbal forms simultaneously then it is likely to improve learning but will not cause cognitive overload.
For example: When explaining how the heart pumps blood around the body, Miss Crofton had a clear labelled diagram on the board with arrows showing how the blood flows.

What are the challenges for classroom teachers?

Retrieval practice needs to be just that. It needs to be from memory and not from looking back in books and it needs to have an appropriate level of challenge.

To be really effective, the optimum intervals for retrieval practice are after one week, one month and six months. It is tempting to quiz every day for a fortnight after teaching, and then move onto other things, but this will not result in a change in long-term memory.
The prior knowledge of every pupil will be different! This makes it very tricky to build upon existing schema - but it's worth the effort.

It is tempting to try to focus on topics in which students are interested on the basis that they have more existing knowledge about them. However, this could mean students are not educated outside their current experience, and their working memories could still be overloaded.

"Fun" activities can seem like a good way to make lessons memorable and promote learning, however students remember what they are thinking about. If the task has too many superfluous factors it will be these that are remembered afterwards rather than the learning objectives.

Literacy - Vocabulary

What does the evidence say about vocabulary?

For the most part, children learn new vocabulary in an incidental way by hearing a new word spoken aloud or by reading the word in a book. Word learning is a continuous and lifelong process which means that a single exposure in a book or a classroom is rarely enough to secure deep and durable learning of a new word. In fact, each new encounter with a once-unfamiliar word in a new context strengthens a child's understanding of that word and broadens the associations that they can make with that word. Researchers into vocabulary development have revealed that human beings keep a sort of 'unconscious log' which is added to each time a new word is encountered in life. This means that a child might be developing their understanding of hundreds of words at any one time and that they often require multiple exposures to the same word before it is learnt securely.

Take the word *heavy* for instance. It appears to be a simple adjective that most young children would find fairly easy to learn. However, the meaning of *heavy* changes subtly depending on the context that it is used in. Three kilograms is extraordinarily *heavy* for an apple but not *heavy* at all for a rhinoceros! The word can be used metaphorically (a *heavy* burden or he pays a *heavy* price) but also to describe something of great density (*heavy* grey clouds) or even a style of music (*heavy* metal). To learn a new word securely, research evidence shows that a child requires multiple exposures to that word in multiple contexts over time.
Proficient readers require a wide vocabulary if they are to successfully access texts of increasing difficulty. Children need to develop both their word-depth (the ability to understand a word's meaning in a range of contexts) and their word-breadth (the number of words they can recognise). Researchers estimate that children must be familiar with at least 95% of the words in a text - and often more - to be able to comprehend its meaning which explains why word-depth is also important. For example, even though a child may have a superficial understanding of the word pneumonia ("I think it's some sort of very dangerous illness"), this basic level of comprehension might be just enough for them to understand a novel in which the narrator's parent has died from the condition.

The best way for children to develop their vocabulary is to read as widely as possible both in class and independently. This will give them multiple exposures to a range of vocabulary in a range of contexts. Written texts typically employ a far wider repertoire of vocabulary than is used in spoken language and, as a result, children who do not read at home or at school will have fewer opportunities to develop their vocabulary than their 'word-rich' peers. Coupled with this is the fact that a significant challenge of later primary school (and then secondary school) is that all children must develop secure knowledge of the specialised and technical vocabulary needed to access the curriculum. Increasingly, the language of the classroom becomes markedly different from the language used outside the school gates.

Aside from encouraging and supporting s in their reading, what else can primary school teachers do to support vocabulary learning? The first recommendation is to choose the target vocabulary carefully and strategically. In their book *'Bringing Words to Life'*, Isabel Beck and colleagues developed a model presenting tiers of vocabulary that divides words into three categories.

Tier 1 words are words used in everyday speech that are familiar to most children: *e.g. dog, plate and haircut*.

Tier 2 words are high-frequency words found in academic and literary texts rather than everyday speech: *e.g. impulsive, authority and established*.

Tier 3 words are subject specific: *e.g. metaphor in English or photosynthesis in science.*

This model reveals the need to explicitly teach Tier 2 and Tier 3 vocabulary, which will be unfamiliar to many pupils.
The second recommendation is to teach vocabulary through explicit instruction methods. These might include:

6. Providing multiple planned exposures to new words in different contexts.
7. Providing 'pupil-friendly' explanations of new words rather than dictionary definitions.
8. Teaching children about the etymology and morphology of new words.

Why does this matter for disadvantaged children?

Studies in the US have revealed the relationship between social disadvantage and the vocabulary size of young children. Hart and Risley (1995), who observed the oral interactions in 42 families over a two-and-a-half-year period, found that by the age of three there was a thirty-million-word gap between children from the most advantaged families and the most disadvantaged families. Middle class children typically heard over 45 million words, whereas children from the poorest groups have heard an average of 13 million words. This finding goes some way towards explaining why some children arrive in primary school with such large vocabulary deficiencies. In recent years, Hart and Risley's findings have been challenged by vocabulary researchers who suggest that it is the diversity and quality of vocabulary that a child experiences (and accompanying verbal interactions) that has a greater impact on vocabulary development than the amount of words that child has heard.

Daniel Rigney has created the notion of 'The Matthew Effect' from his research into sources of inequity. He described those s who are 'word-rich' as possessing knowledge of 7,100 words, while those s who are deemed to be 'word-poor' have knowledge of less than 3,000 words. Good readers gain new skills very rapidly, and quickly move from learning to read to reading to learn, whereas poor readers become increasingly frustrated with the act of reading and try to avoid reading where possible. This is why vocabulary size strongly correlates with reading ability.

In all, this highlights the fact that unless schools and teachers address the gap between word-rich and word-poor children, the gap will continue to grow. Therefore, a curriculum that is designed to encourage the explicit teaching of Tier 2 and Tier 3 teaching of vocabulary is likely to be a manageable and realistic way of addressing the word gap in primary schools.

Five practical strategies for teachers

1. Prioritise the teaching of Tier 2 and Tier 3 words
Each subject has its own unique language, and this varies dramatically from the language pupils habitually use to communicate. Tier 2 and 3 vocabulary is unlikely to be familiar to pupils, and it is therefore essential that we prioritise the teaching of such words if ours are going to be able to talk and write like experts. However, as will be discussed it is vital that the specific words and amount of them to be taught are chosen carefully so as not to overwhelm s nor provide them with vocabulary they are unable to apply in lessons.

Tier 2 words can often act as "false friends" with their meanings often varying between disciplines (i.e. "factor" in maths versus geography). Subsequently we must ensure these words are explicitly taught rather than relying on any incidental learning of this vocabulary.

2. Teach new words through explicit methods to complement incidental learning.
When prioritising the instruction of either Tier 2 or 3 vocabulary, some suggested explicit strategies include:

9. Provide simple pupil-friendly explanations of new words with lots of real-life examples.
10. Ask children to draw a picture to represent each new word they have been taught.
11. Consistently signposting synonyms. This is particularly effective in demonstrating how Tier 2 vocabulary can enhance the accuracy and sophistication of written or oral work.

3.Teach children about the morphology and etymology of new words.

Much of the subject specific vocabulary used in school has roots in ancient Greek and/or Latin. Etymology is based on the study of the origin of words.

For example, "deposition" in regards to river processes come from the Latin "deponere" meaning to "throw or lay down".
Morphology is the study of the structure/parts of words, such as stems, root words, prefixes, and suffixes. For example, the word "reappear" is based upon the root word appear (to become visible), with the prefix "re" (again, back or repetition). Once the understanding of the prefix is established this can be used to develop the understanding of further vocabulary such as "refill" and "review".

4. Provide multiple opportunities to hear, see and read new words. For example, by providing pupils with rich oral and written language environments which will enhance opportunities for implicit learning as well as through direct teaching and low stakes quizzing of complex vocabulary before s apply this vocabulary in tasks such as extended writing.

5. Select words and phrases to be taught as part of curriculum planning.
Vocabulary instruction has often been considered as a bolt on to curriculum planning, however for vocabulary instruction to be truly effective, literacy strategies must be embedded within the subject or discipline. As a result, vocabulary instruction should be aligned with curriculum development.

When doing so, teachers should consider:

The Tier 2 and 3 vocabulary they wish to teach. It is important to prioritise words that are linked to the studied content rather than from decontextualized word lists.

The links between subjects so that cross curricular vocabulary is identified and subsequently any potential misconceptions can be planned for.

The opportunities for repeated exposure to the chosen vocabulary so that s hear, see and use new vocabulary multiple times.

What are the challenges for classroom teachers?

Choosing the correct vocabulary. The temptation can be to identify and simply attempt to teach too much new vocabulary. An effective professional development opportunity might involve asking teaching staff to identify the essential Tier 2 and Tier 3 vocabulary that they will teach explicitly, and cumulatively, within each subject.

Ensuring that the vocabulary being taught is aligned to the curriculum rather than being a list of spellings and definitions that are disconnected from the content being taught.
Ensuring that once identified curriculum planning is designed to ensure that pupils have repeated exposure and chances to apply the word – otherwise they are unlikely to use it when needed later.

Developing motivation. Children's attitudes and self-perception matter in all aspects of literacy, including vocabulary instruction and learning. Teachers may need to use collaboration or competition to stimulate motivation.