NSW Department of Education

# Metacognition: a key to unlocking learning

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# Contents

# Executive Summary


Metacognition is often defined as 'thinking about thinking'. Metacognition has two main components: knowledge and skill. Metacognitive skill is broadly comprised of activities or strategies that monitor and control cognition. When combined with motivational, social and behavioural factors, metacognition forms part of a broader framework of cognitive self-regulation.

Metacognitive knowledge and skill start developing from a young age, but it is only through experience, explicit teacher instruction, scaffolding and modelling, as well as ample opportunities for practice, that students can develop into competent metacognitive adults.

There is good evidence that metacognition, as one aspect of self-regulation, is a predictor and facilitator of independent, life-long learning, as well as critical thinking ability. Research points to generally positive effects on a range of learning outcomes, and for different demographics of learners. Having said that, there is stronger evidence in some subject areas than others, and there are still open questions regarding the transferability of metacognition across contexts.

For teaching to be effective, teachers need a personal base of metacognitive knowledge and skill, and they must integrate metacognition into their pedagogy. This process needs to be supported through professional development, and curriculum-wide recognition of the importance of metacognition.

Finally, metacognitive assessment has progressed rapidly over the past two decades. Metacognitive knowledge is often assessed through self- or teacher-reported inventories. Metacognitive skill – as with most thinking skills – can be difficult to assess. Ideally, metacognitive skill should be assessed while it is being used, or 'during performance'. However, such assessment can be time consuming, and further work needs to be done to realistically bring research on effective metacognitive assessment into the classroom.

Overall, while there is still some lack of clarity about how to best define metacognition and some ongoing debate around effective implementation in the classroom, there is a large and growing body of evidence emphasising the critical importance of metacognition to learning success.

# 1. Introduction

**Context for this review paper:**

The NSW Department of Education is committed to preparing young people for rewarding lives as engaged citizens in a complex and dynamic society. Key to this purpose is creating opportunities for students to develop a strong foundation in literacy and numeracy, deep content knowledge, and to be engaged and challenged in their learning.

This review paper aims to support these goals by assessing the evidence base for the teaching of metacognition as a foundation for effective learning, and to provide broad guidance around the evidence base for effective teaching of metacognition.

Education research consistently suggests that the demands of an uncertain future will be best met by achieving some of the longest-standing goals of education, such that all students finish school with a strong foundation in the core skills of literacy and numeracy, deep content knowledge in a range of disciplines, and the ability to problem solve and reason ethically, critically and creatively.

In recent years, research has revealed metacognition – commonly defined as 'thinking about thinking' – as underpinning thinking skills (including critical and creative thinking), and as a key to improving learning. This paper explores some critical questions around metacognition and its evidence base – how it is defined, its impact on learning and how it can be developed in school contexts.

'Metacognition' was first coined in 1976 by developmental psychologist John H. Flavell. Since then, research into the effects of metacognitive instruction on student learning has grown steadily. Today, metacognition is considered particularly important in education research because of its ability to provide students with the language and skills to monitor, control and ideally improve their own thinking processes. When a student struggles with a problem or concept, metacognition can provide a personalised tool-kit of responses to draw from. It is no wonder then that metacognition is a sub-element of the critical and creative thinking general capability in the Australian curriculum, its importance is highlighted in the NSW Curriculum Review, and the OECD lists it as a key "skill for 2030" (ACARA, 2020; Masters, 2020; Schleicher, 2018).

> **"A 'metacognitive' approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them."**
> (Masters, 2020, p. 51)

There is a growing body of evidence, underpinned by a number of meta-analyses, showing a strong correlation between metacognitive instruction and student achievement (de Boer et al., 2018; Dignath et al., 2008; Education Endowment Foundation, 2018; Perry et al., 2019; Wang et al., 1990). However, the strength of this relationship can vary widely in different contexts, and studies often use subtly different definitions of metacognition.

There are a variety of theoretical and practical strategies for introducing metacognition into the classroom. The key aims of this paper are to clarify current understanding on when and how metacognition develops, how teachers can best facilitate this development, and what advantages it holds for the learner.

To that end, this paper starts by defining metacognition and discussing its development. Next, it explores what the evidence says about teaching metacognition in a school context, and what teachers need to know to teach metacognition well. Finally, the paper turns to subject-specific examples of metacognitive teaching strategies, as well as a discussion on metacognitive assessment.

This paper is underpinned by extensive research on the theory and practice of metacognition, and its importance in creating adaptable, lifelong learners. The paper concludes with thoughts about current research gaps, and the implications of existing research for teaching metacognition in schools.

# 2. Defining and developing metacognition

### What is metacognition?

Metacognition is a term used to capture certain types of knowledge, strategies and skills that relate to cognition. It is the aspects of a person's internal dialogue that reflect on thinking and understanding. It is the realisation that people have different world views and levels of understanding, and that this knowledge affects the way they set goals, make plans, deal with setbacks, evaluate success, and reflect on this entire process. It is also an understanding that these world views can change and develop over time. Ultimately, metacognition is about using all of this knowledge to improve the way we think.

As the name suggests, metacognition builds upon cognition. We use our cognitive abilities to make sense of the world; we use our metacognitive abilities to make sense of cognition. Hence, it makes little sense to discuss metacognition without referring to the cognitive state it refers to. The OECD highlights this relationship in their definition of metacognition as:

> **"… a second or higher-order thinking process which involves active control over cognitive processes"**
>
> (Mevarech & Kramarski, 2014, p. 36).

The boundary between cognition and metacognition is not always clear. The same mental activity – planning or decision-making, for example – can be performed in a cognitive or metacognitive way. The key difference is the goal of an activity:

> **"cognitive activities help to acquire, retain and transfer knowledge for task execution, whereas metacognitive activities allow one to regulate and govern task execution (i.e. how a task is carried out to ensure satisfactory level of performance)"**
>
> (Ku & Ho, 2010, p. 253).

For instance, when a teacher decides to separate two distracted students, they are making a cognitive judgement. If the teacher goes home and thinks about this dynamic between the students, the effect of the teacher's intervention, and decides to adopt a new strategy tomorrow, then the teacher has made a metacognitive judgement.

Almost all theoretical structures of metacognition are underpinned by two main components: knowledge and skill. Categorising metacognition into its component parts is important, as it aids our understanding of metacognitive development and informs the use of pedagogical approaches that target different aspects.

### Metacognitive knowledge

Metacognitive knowledge can essentially be defined as knowledge about cognition. Metacognitive knowledge is important as it allows us to be aware of different ways of approaching cognitive problems. There are three main types of metacognitive knowledge: declarative, procedural and conditional (Jacobs & Paris, 1987). Declarative knowledge encompasses the basic knowledge of 'what' cognitive strategies are at our disposal. Procedural metacognitive knowledge refers to knowledge of 'how' to do a task or execute a strategy. Conditional metacognitive knowledge is of 'when' and 'why' certain strategies should be used relative to the task at hand. Veenman summarises this well with the WWW&H rule: What to do When, Why that is needed, and How to do it (Veenman, 2011; Veenman et al., 2006).

Another important aspect of metacognitive knowledge is the understanding that people vary in their metacognitive ability as well as their cognitive ability (Flavell, 1979). For instance, one student may be aware that they struggle more with mathematics than music, while their classmate needs to read a question aloud to understand it. Group work can help students gain metacognitive knowledge through building an awareness that other students might think differently and use different metacognitive strategies. Roche (2011, 2015, 2020) has widely discussed the success of group discussion in the early years of primary school as a way of making students aware not only that other viewpoints are possible, but that their peers have compelling thoughts and ideas worthy of consideration.

## Metacognitive skill

Metacognitive skill is often characterised as two processes which underlie metacognition: monitoring and control (Nelson & Narens, 1990, 1994).[1] Metacognitive control involves the regulation of cognition, like planning and implementing strategies to complete a task. Metacognitive monitoring assesses how well a certain strategy is going, and evaluates the chance of success or the need to rethink an approach.

Essentially, metacognitive skill comes down to the understanding and use of different metacognitive strategies which support the monitoring and control of our cognition (reviewed in Ku & Ho, 2010). Metacognitive strategies can be defined as:

> **"… sequential processes that one uses to control cognitive activities, and to ensure that a cognitive goal (e.g. understanding a text) has been met. These processes help to regulate and oversee learning *(i.e. monitor and control)*, and consist of planning and monitoring cognitive activities, as well as checking the outcomes of those activities."**
>
> (Livingston, 1997, p. 3 - italics added)

Metacognitive skill is developed through supported metacognitive experiences, ultimately leading to the progressive mastery of metacognitive strategies and the knowledge of how, when and why to employ them. The broad understanding that there are metacognitive processes that need to be practiced and developed underpins almost all current experimental, theoretical and pedagogical work on metacognition.

1 There are many different formulations of metacognitive skill (or ability, or regulation). Some emphasise planning, monitoring and evaluating, while others summarise everything as 'cognitive regulation' (see Dimmitt & McCormick, 2012; Lee et al., 2019). Aside from the confusion of using different terms to describe the same phenomena, there are essential components common to the majority of descriptions.

## Metacognition and its relationship to other thinking skills

Metacognition is a concept nested within an array of other concepts. Understanding these related concepts helps us to make sense of metacognition, as well as its research base. Perhaps the two most common related concepts are self-regulation and critical thinking.

### Metacognition and self-regulation

> "There is substantial agreement that the related constructs of metacognition and self-regulation have made an enormous contribution to cognitive psychology, literally changing the way that psychologists and educators view cognition and development."
> (Schraw, 2000, p. 315)

The most common concept used interchangeably with metacognition is that of 'self-regulation'.[2] However, self-regulation is often defined in a way that encompasses metacognition, amongst other things. Zimmerman, an influential theorist in this area, defines self-regulation as:

> "… more than metacognitive knowledge or skill, it involves an underlying sense of self-efficacy and personal agency and the motivational and behavioural processes to put these self-beliefs into effect"
> (1995, p. 217).

In other words, metacognition, when paired with motivation and behaviour,[3] is one of three aspects that make a self-regulated learner (Efklides, 2006). These aspects are interrelated: it is hard to be metacognitive without motivation or behaviour, and you can explore motivation and behaviour metacognitively. Hence, while it's important to develop metacognitive knowledge and skills, the behavioural and motivational aspects cannot be ignored. This is why a lot of educational research on metacognition is often couched in terms of self-regulation rather than metacognition alone. It is also why a lot of metacognitive teaching strategies contain components related to motivation and behaviour.

### Metacognition and critical thinking

Metacognition has recently received particular attention in the context of global curricula and 21st-century skills discussions placing a renewed focus on thinking skills. Perhaps the most discussed of these thinking skills is critical thinking. Understanding the relationship between metacognition and critical thinking can aid our understanding of both concepts, and this has practical implications for teaching.[4]

2 'Executive function' is another phrase often used either in place of, in combination with and/or to help describe metacognition and self-regulation (e.g. Bryce et al., 2015; Meltzer, 2007; Zelazo et al., 2003).
3 There are a number of different models of self-regulation, though most are quite similar. See Panadero (2017) for a high-quality review of self-regulated learning.
4 See for instance Wilen & Phillips (1995), which outlines a metacognitive approach to teaching critical thinking skills.

Metacognition is a pillar of critical thinking. The highly influential 'Delphi report' (Facione, 1990), compiled by a large group of U.S. experts on critical thinking, defines metacognition as a sub-component of self-regulatory behaviours. A similar definitional structure is used in the Australian Curriculum in placing metacognition within the critical and creative thinking general capability.[5] Essentially, metacognition is a key aspect of self-regulation, and self-regulation underpins critical thinking ability. There are of course other important components of critical thinking – such as disposition and cognitive ability – just as metacognition can be applied in a lower-order or 'non-critical' way. But overall, there is robust evidence for the foundational role of metacognition in critical thinking (Abrami et al., 2015; Ku & Ho, 2010; Magno, 2010; Wilen & Phillips, 1995).

In summary, metacognition has a long theoretical history, and definitions of metacognition are still actively debated in the literature. Part of the reason for this ongoing debate is the complicated relationship between metacognition and related concepts like self-regulation and critical thinking. There is broad agreement, however, that metacognition has a knowledge component and a skill component. Metacognitive knowledge is about the 'what, why, when and how' of cognitive strategies, while the skill component involves the monitoring and control of cognitive processes to effectively use cognitive strategies.

We will next turn our focus to the practical implications of these definitions, including how metacognition develops, what it looks like at different levels of schooling, and how development effects the way metacognition is taught.

## Metacognitive development

An understanding of how metacognition develops, and what we can expect children of different ages to be capable of, necessarily underpins approaches to teaching metacognition. In principle, the earlier you introduce metacognition to children in age-appropriate ways, the more time learners have to develop and deepen their knowledge, skills and experiences. So what does the research say is the optimal age for introducing metacognitive concepts to learners, and does age affect the way metacognition is best taught?

### Metacognition in the early years

Historically, researchers thought young children had relatively little metacognitive ability, however more recent research suggests otherwise (Sáiz Manzanares & Carbonero Martín, 2017; Whitebread & Basilio, 2012; Whitebread & Neale, 2020). It is likely that the metacognitive skills of young children were underestimated in part because of the challenges of assessing young children's metacognitive knowledge and skill given their language skills are also in the early stages of development (Veenman, 2005; Veenman et al., 2006; Whitebread & Neale, 2020). Innovative developments in metacognitive assessment that do not solely rely on children verbalising their metacognitive processes have

5 The Delphi report is structured as follows: critical thinking > self-regulation behaviours > self-examination > metacognition. ACARA are currently reviewing the Australian curriculum, so the exact wording of the following draft structure may change, but the current critical and creative thinking learning continuum is structured: critical and creative thinking > reflecting on thinking and processes> thinking about thinking (metacognition).

begun to shed new light on metacognition in preschool-aged children.[6] Researchers have found that the ability to be aware of what one knows (i.e. cognitive monitoring) seems to start early for most children and develop in similar ways with age; however, the ability to use this knowledge in strategic ways (i.e. cognitive control) appears to be

> **"influenced by children's early environmental and social experiences, and shows large individual differences in young children of the same age"**
> (Whitebread & Neale, 2020, p. 10; see also Bryce & Whitebread, 2012; Zelazo et al., 2003).

So what does this mean for teachers and parents? The natural development of knowledge and monitoring points to the level of expectation we can realistically place on young children. For instance, some evidence suggests that the majority of children do not fully grasp the concept of 'forgetting' until the age of 5 (Kreutzer et al., 1975; Van Overschelde, 2008). Similarly, the effect of environmental and social experience on the development of metacognitive control suggests a benefit to exposing children to these concepts as early as possible, in age appropriate ways. To this end, there is some evidence for the use of structured play to support early metacognitive development, particularly where that play has a social element (Elias & Berk, 2002; though see Lillard et al., 2013). In one study, 3-to-6-year-olds were better able to remember a list of words and use different memorisation strategies in the context of shopping for a tea party than the context of a 'lesson' (Istomina, 1975).[7] In another, 4- and 6-year old children were more effective at maintaining attention during a vigilance task when pretending to act as Batman would (White et al., 2017).

Social learning seems to be particularly important in preschool-aged children, though where the social engagement comes from can have nuanced effects. For instance, talking to adults about their learning can have positive effects on metacognitive development in children as young as 3 (Ornstein et al., 2010). On the other hand, there is evidence that 3-to-5-year-olds have some capability for controlling their cognition when faced with a familiar task, particularly in the absence of adults (Whitebread et al., 2007), suggesting adult-free learning can also be important.

The sum of this research suggests that preschool-aged children should be offered opportunities to explore metacognitive strategy use in a wide-array of contexts: with parents, teachers and peers, including through both play-based learning and ways that encompass explicit dialogue and reflection (Whitebread & Neale, 2020). Outside of formal learning contexts, the development of metacognition in young children can also have important positive effects on behaviour, motivation and emotion, establishing the basis of self-regulation (Bronson, 2000).

6 A more thorough discussion of metacognitive assessment is addressed later in this paper.
7 Memorisation strategies included repeating words, double-checking, and re-ordering.

## Metacognition in school-aged children

Assessing metacognitive development and ability in school-aged children can be just as difficult as in preschool-aged children, and the field is understudied. There are however some general points of agreement in the literature.

As in preschool, educators should take into account age-appropriate expectations of school-aged children. Evidence suggests that the part of the brain responsible for a lot of metacognitive style thinking – like planning and reflecting – does not fully develop until young adulthood (Weil et al., 2013). It has been suggested that as teenagers develop an interest in the similarities and differences between themselves and other people, including how and what other people think, they may be more receptive to personalised metacognitive instruction (Dimmitt & McCormick, 2012). As children develop deeper behavioural and motivational repertoires, this will also have an effect on their metacognitive ability. For instance, students in later years generally have a greater understanding of their cognitive strengths and weaknesses, what is required of them to be successful learners, and how to motivate themselves to achieve academic goals.

From an educational perspective, research suggests the most important determinant of metacognitive ability through the early schooling years is explicit instruction and support for the development of metacognitive skills (Dimmitt & McCormick, 2012). Essentially, development of metacognitive ability is a function of the number of opportunities a student gets to experiment with different strategies and figure out what works in an intentional way. This points to the crucial role of the teacher in presenting to students different types of potentially helpful strategies in the context of their current learning, modelling their application, and providing opportunities for students to test and apply them as part of the learning process. As Kuhn (2000) notes, development of metacognition is about gradually increasing the use of adequate strategies, “with the inhibition of inferior strategies as important an achievement as the acquisition of superior ones” (p.179).

Clearly, if schooling is to support students’ development of metacognition, teachers will need to have a view of what ‘good’ metacognition looks like across levels of schooling in order to effectively scaffold learning.

**Explicit instruction** – also referred to as **explicit teaching** – is when teachers: “…clearly explain to students why they are learning something, how it connects to what they already know, what they are expected to do, how to do it and what it looks like when they have succeeded. Students are given opportunities and time to check their understanding, ask questions and receive clear, effective feedback about aspects of performance.” (CESE, 2020). Explicit instruction has a strong evidence base for supporting student learning and is a critical part of effective metacognitive instruction.

## What does well-developed metacognition look like at different levels of schooling?

The specifics of good metacognition change with the specifics of the task or subject, as discussed further below, and can differ across ages and levels of learning. Broadly speaking, evidence consistently points to effective metacognition as being rooted in an extensive knowledge base about what metacognition is, which strategies are appropriate to apply to cognitive tasks, and how this all relates to an individual's own cognition. The successful choice and implementation of cognitive and metacognitive strategies leads to more effective metacognitive practice.

Of course, well-developed metacognition will look different in primary compared to secondary school-aged children. As students move through primary school, quality metacognitive practice will progress from being able to identify and describe thinking and learning strategies used during task performance in the early years, to being able to reflect on and adjust these strategies toward the later years of primary school. As metacognitive knowledge increases, opportunities for practice and experience allows the use of metacognitive skills to further develop.

As students move into secondary school, they may be able to incorporate alternative perspectives and opposing viewpoints into their thinking and learning strategy use. Hence, by the time a student nears the end of secondary school we might see a well-developed 'metacogniser'. At this level, a good metacogniser will: plan, organise, set goals, translate, evaluate, monitor and revise. A good metacogniser is able to be an independent learner. They can make decisions about what, how, and how long to study, and decide when they know something. They monitor what they know, what they need to learn, and adjust their learning behaviours accordingly. But above all, they know why they are controlling and monitoring their thinking; why they are using a particular strategy. As Larkin puts it:

> **"Why are you planning? And do you need to be planning right now? That's what metacognitive skilfulness looks like. You don't want students rote learning a process without understanding why"**
>
> (Larkin, 2020).

So how do we get students to be skilled and confident in their metacognitive knowledge and ability? The following section will outline the current understanding of best practice in teacher development and training, explicit instruction, and the construction of metacognitive learning environments that foster the development and practice of metacognitive knowledge and ability.

# 3. What do teachers need to know to teach metacognition well?

Broad educational research in a range of fields has shown that a key aspect of effective teaching is a deep understanding of content and pedagogy (Hattie, 2015). So, before discussing teaching strategies, it is important to touch on the knowledge and skills teachers need to effectively teach metacognition.

Zohar & Schwartzer (2005) give a partial description of what teachers need to know, which starts with a strong knowledge base:

> "First, teachers need to know a variety of thinking patterns (or skills, or strategies) on a cognitive level and on a metacognitive level. Knowing a thinking skill on a cognitive level means that a person is able to use that skill for solving a problem or for completing a task. Knowing a thinking skill on a metacognitive level means that a person is able to verbalize his/her thinking processes, to make generalizations about them, and to describe when, why, and how he/she is using them."
>
> (p. 1597)

The question then is whether having this level of understanding is common among teachers, and if not, what supports would help to develop it?

## Teacher knowledge and professional development

There is limited evidence on the current state of teacher knowledge about metacognition and metacognitive pedagogy. Our current understanding is informed by studies exploring professional development programs aimed at improving teachers' metacognitive knowledge. Broadly speaking, these programs are successful in making teachers more aware of, and comfortable thinking about, metacognitive processes. The programs are particularly useful for allowing teachers to question their preconceived notions of metacognition, and critical thinking more broadly.[8] Take for instance this comment from an Australian teacher who had taken part in an extensive professional development course on applying metacognition in Information and Communication Technology (ICT) learning:

> "At first I was not so sure about metacognition... Learning how to learn. I did not have much time for it. I did not know about it and was shying away from it. But now I say to the kids 'we have to learn about how to learn'. I have taken this approach on board with the kids. We can't just do things, we need to think about different ways and approaches to problems. This has been a big improvement for me"
>
> (Phelps et al., 2004, p. 64).

8 Preconceived notions also take into account the perception of teachers on student ability. Research in Israel has pointed out that some teachers erroneously regard higher-order thinking skills as inappropriate for low-achieving students (Zohar et al., 2001). Effective professional development needs to emphasise the value of metacognitive instruction for all students (Education Endowment Foundation, 2018; Sáiz Manzanares & Carbonero Martín, 2017).

More research is needed to improve understanding of how teacher professional learning can better support teachers' metacognitive knowledge base. The research base is stronger, however, for best-practice pedagogies when teaching metacognition. As explored further below in terms of student learning, it appears that explicit and prolonged instruction, modelling of behaviours and opportunities for practice and reflection are as important for learning metacognitive knowledge and strategies for in-service and pre-service teachers as they are for their students (Ozturk, 2018).

## What makes for good metacognitive instruction in the classroom?

> "Effective metacognitive guidance needs to be explicit, embedded in the subject matter, involve prolonged training, and inform learners of its benefits."
> (Mevarech & Kramarski, 2014, p. 49)

There is a strong body of research describing, in broad terms, best practice for metacognitive instruction. First and foremost, teaching – whether for children or adults – needs to be explicit:

> "growth in metacognitive abilities may not occur in the absence of instruction focused on developing those strategies"
> (Dimmitt & McCormick, 2012, p. 164; Baker, 2008).

Metacognition is an inherently active process – it requires the individual to be aware of their thinking. Thus, the teaching, modelling and assessing of metacognition needs to be equally explicit, including an understanding and explanation of why approaching one's own thinking in a certain way is beneficial. As mentioned above, this is why it is critically important that teachers are confident in their own understanding of metacognition. The teaching should also be prolonged: continuous and embedded teaching allows for a diversity of teacher practices, ranging from direct instruction in initial stages, to student-driven practice with teacher oversight, and subject-specific approaches. In addition, there is strong evidence that students effectively develop metacognitive knowledge and skills through collaborative practice with peers (King, 1991; Larkin, 2006; Whitebread et al., 2007). Finally, teaching needs to progress in complexity, first being subject specific, and then as the students get more comfortable and experienced, the cross-overs and generalisability of certain metacognitive strategies can be pointed out (Larkin, 2020; see below for discussion on generalisability).

In a recent review of research on metacognition and self-regulation in schools, the UK-based Education Endowment Foundation outlines a seven-step model for explicit teaching of metacognitive strategies. This model, which can be applied to different subjects and student ages, involves:

> "1. Activating prior knowledge;
> 2. Explicit strategy instruction;
> 3. Modelling of learned strategy;
> 4. Memorisation of strategy;
> 5. Guided practice;
> 6. Independent practice; and
> 7. Structured reflection."
> (Education Endowment Foundation, 2018, p. 14).

Other studies suggest it's helpful to think about instructional strategies that promote metacognitive thinking in terms of three broad categories: planning, monitoring and evaluating strategies (Ellis et al., 2014). There are overlaps in the specific strategies that may be used in each category. For instance, modelling is considered to be the most important instructional method for teaching any type of metacognitive strategy (Ellis et al., 2014). Similarly, monitoring strategies have a number of cross-overs with evaluating strategies, as they are both targeted at analysing or describing task performance, the difference being whether that analysis is occurring during task performance (monitoring) or after task performance (evaluating).

| Categories | Examples of best-practice instructional strategies |
|---|---|
| **Planning strategies** | modelling, goal attainment, checklists, diagrams, mnemonics, graphic organisers, and guided practice |
| **Monitoring strategies** | modelling, diagramming, answer checking, and practice |
| **Evaluating strategies** | modelling, independent practice, self-testing and answer checking |

Given some of the strategies outlined above are quite broad in scope, this prompts the question of whether metacognition can be taught in a generalised way, and the extent to which metacognition is transferrable across subjects and contexts.

## Generalisability, transferability and subject-specificity

Metacognitive strategies can be thought of as generalisable in the sense that we can give broad classifications of metacognitive strategies (as above), and can also suggest habits of mind or behaviours that can be metacognitively beneficial regardless of context. For instance, reminding yourself or your students to look at a problem from multiple angles, or to plan how to approach a task, is useful in most, if not all, learning contexts.

However, this is not to say that all metacognitive knowledge and skill is necessarily transferable or context-neutral. Kramarski et al. (2001), for example, demonstrated that learning metacognitive strategies in multiple different subjects increased student achievement in 12-year-olds relative to learning metacognition in only one subject. Adey & Shayer (1993) in contrast found 11-year-olds improved their science, maths and English results as a result of metacognitive instruction in science alone. However, other studies suggest that transfer of metacognitive knowledge or skill is more likely to happen in the later high school and tertiary education settings (Zohar & Barzilai, 2015). An issue with comparing studies in this area is that the research in general suffers from wide variety in definitions and methodologies (Barnett & Ceci, 2002).

In other words, even if some (or all) metacognitive strategies are transferrable in some way, the evidence is mixed as to whether learners, in particular school-age learners, are successfully transferring them. Some research suggests that transfer is more likely when supported by teacher-guidance. Teacher guided transfer, or 'teacher cueing', is when the teacher suggests the possibility of skill transfer, e.g. "Have you seen a problem like this before? Perhaps like the one we looked at last week? How did you solve that problem?" If we accept teacher cueing as genuine transfer, there is stronger evidence for metacognition as a transferrable skill (Bereiter, 1995; Billing, 2007; Conner, 2007; Fuchs et al., 2003; Monteiro et al., 2020).

It's important to note that while, in theory, any generalised metacognitive knowledge or strategy may be capable of being transferred to a new context, some of the strongest evidence for the efficacy of metacognition on student learning comes from subject-specific strategies with explicit and specific learning goals in mind. This has implications for how metacognition should be approached as an embedded teaching practice.

# 4. Specific metacognitive teaching strategies

Metacognitive instruction has been developed in both general and subject-specific ways. Indeed, many subject-specific models of metacognitive instruction appear, to some extent, generalisable. Typically, however, research uses a subject-specific design in order to assess the effect of any metacognitive teaching intervention or to consider effects related to metacognition within specific content knowledge areas. As a result, there is a particularly strong research base for subject-specific teaching of metacognition. At the primary and secondary school level, the majority of research has focused on reading, writing, science and mathematics learning.[9] Hence, this section will mainly focus on the metacognitive teaching strategies for these four subject areas.

Before exploring specific teaching strategies, it should be reiterated that the success of metacognitive instruction is underpinned by teacher knowledge, skill and modelling, behavioural and motivational components of self-regulation, and the opportunity for guided practice in a range of contexts and problems. Teaching and developing metacognition must take a holistic approach.

## Reading programs

> **"Awareness and use of metacognitive strategies, such as self-monitoring of comprehension, appear to be key components of becoming an increasingly proficient reader, and the use of these strategies distinguishes skilled from unskilled readers"**
> (Dimmitt & McCormick, 2012, p. 169).

Perhaps the strongest evidence for the efficacy of metacognition on student learning comes in reading and writing programs. There is strong evidence that better readers use metacognitive strategies (Baker, 2008; Mokhtari & Reichard, 2002; Paris & Jacobs, 1984). It has been suggested that the development of reading ability is directly related to the development of metacognitive awareness around the reading process. For instance, as students become better readers, they tend to reflect on reading as a 'means-getting process,' reaching beyond the decoding of words and letters. They also become more aware of strategies to use when they do not understand a word or sentence (Baker, 2008).

The pioneering research of Palinscar & Brown (1984), which focused on teacher-guided strategies for predicting, clarifying, summarising and questioning texts through student group work approaches, developed the still

9 Research from higher education has shown varying levels of success across an even wider array of subjects, suggesting the need for more research in understudied secondary school subjects.

popular 'reciprocal teaching' approach to foster comprehension. While many other successful reading strategies have since been developed, most retain a focus on comprehension monitoring. With the right tools in place, there is some evidence that the positive effects of short-term comprehension interventions are still felt up to a year later (Souvignier & Moklesgerami, 2006). In fact, evidence suggests that short reading strategy programs (around 6 sessions) are just as effective as programs of up to 50 sessions (Willingham, 2007), though the early primary years may need more prolonged and repetitive instruction (Van Keer & Verhaeghe, 2005).

In a particularly influential report, the National Reading Panel in the USA (2000) reviewed the research on effective reading strategies instruction. Part of the report looked at metacognition-based instruction models, and highlighted which of these had the strongest research support. The most effective metacognition-based teaching models were those

> **"... that involve teacher and student working together with a relevant text to actively identify effective reading strategies (e.g., think-alouds)"**
> (Dimmitt & McCormick, 2012, p. 169; National Reading Panel, 2000).

Of these reading comprehension strategies, those designed to encourage the monitoring of comprehension and to get students to relate sentences to one another had the strongest positive effect (National Reading Panel, 2000; see also Willingham, 2007).[10]

It is worth noting that similar metacognitive reading strategies can differ in their effectiveness. Student characteristics such as age, language used at home and current reading ability, as well as the types of texts used, can all impact the success of metacognitive strategy instruction (Lan et al., 2014).

## Writing programs

The importance of metacognition to writing was first noted indirectly in descriptions of models of writing (Emig, 1971; Hayes & Flower, 1980). Growing understanding of the process of writing has led educators (particularly in the U.S.) to shift from a focus on the product of writing to its process (Harris et al., 2009; Nystrand, 2006; Sitko, 1998). As the name suggests, the 'process approach' to writing instruction emphasises to students that writing is a process, not a product alone, which more readily allows for the development of metacognition in writing (Harris et al., 2009). Interestingly, research has shown a link between metacognitive awareness and reduced writing anxiety (Balta, 2018).

Similarly to reading, students who are more experienced writers are better at a range of metacognitive skills, like planning, revising and detecting problems (Sitko, 1998).[11] Many researchers see writing as 'applied metacognition'. The process of coming up with an idea, drafting, editing and revising – which underpin successful writing – are inherently metacognitive processes (Hacker et al., 2009;

10 There are an abundance of online resources for metacognitive reading strategies. See for instance https://cehs.unl.edu/secd/reading/. This website also has resources for writing and mathematics strategies.

11 Sitko (1998) uses the terms planning, translating and reviewing, but the essence is the same.

Zimmerman & Risemberg, 1997). Research on metacognitive approaches to writing instruction tend to focus on critical forms of writing, like essays and reports, though there is also good evidence that explicit instruction on planning and modelling can improve creative writing ability, across a range of text types (Alshreif & Nicholes, 2017; Jia et al., 2019; Kaufman & Beghetto, 2013; Stolarek, 1994).

In reviewing the role of metacognition in teaching children to write, Harris et al. (2009) conclude that there is strong empirical evidence that teaching metacognitive strategies improves students' writing. While the strategies may vary depending on the age group and type of writing, Harris et al. (2013) describe a general approach to writing development called 'Self-Regulated Strategy Development' (SRSD). SRSD is an evidence-based approach, with instruction structured into

> "six flexible, recursive and highly interactive stages with a gradual release of responsibility for writing to students"
> (Harris et al., 2013, p. 539).

The six stages include:

- Develop and activate knowledge needed for writing and self-regulation
- Discuss it – discourse is critical!
- Model it
- Memorise it
- Support it
- Independent performance

## Science programs

The majority of research on metacognition in science education focuses on students studying science at the secondary and university level. Interestingly, many studies note a number of benefits of a metacognitive focus, including increased academic performance, positive changes in student attitudes toward science learning and higher quality classroom discussions (Chen et al., 2016; Georghiades, 2000; Jahangard et al., 2016).

Given that scientific inquiry is foundational to the discipline of science, many authors suggest that effective science teaching will by extension contain a strong metacognitive component (Avargil et al., 2018; Eilam & Reiter, 2014; Zohar & Barzilai, 2013, 2015). As Dimmitt & McCormick (2012) point out, inquiry, investigation, questioning and collaborative theory and knowledge building are metacognitive as well as scientific processes (p.171).[12] Nevertheless, studies show that an explicit focus on metacognition is also important in science, just as in other subjects.

Meta-analyses of research on the use of metacognition in science education have shown that the most common practices are reflective writing and metacognitive prompts (Zohar & Barzilai, 2013).[13] Reflective writing is seen as a useful metacognitive tool for students to outline concepts they do or do not understand, and for teachers to gain an insight into any misconceptions (Balgopal & Montplaisir, 2011; Vestal et al., 2017). Reflective writing may take the form of journal writing, reflective essays, or responses to reflective prompts (see Zohar

12 This could potentially be argued for any subject that uses a strong empirical methodology to discover knowledge.
13 A slightly less common, but potentially more science-specific tool is the use of concept maps and other types of visual aids to help understand specific (e.g. heart anatomy) and general (e.g. graphing data) concepts of science.

& Barzilai, 2013 for review). Reflective writing has the added benefit of giving teachers an alternative view into a student's understanding of content, allowing them to address conceptual misunderstandings that can often go unnoticed by teachers, and account for delays in learning (Abraham et al., 1990; Alters & Nelson, 2002; Thompson & Logue, 2006).

Metacognitive prompts are another tool that allow teachers to identify misunderstandings, and reinforce specific values and strategies in science. Prompts remind students to monitor and evaluate their thinking. For instance, Zohar & Barzilai (2015) describe metacognitive prompts to reinforce content knowledge around the controlling of variables, through questions like "Do you think that you are using the rule that we had studied in the previous lesson?" or "What can you do to improve your current investigation?" These prompts form just one part of a much broader teaching plan, but Zohar and colleagues found positive effects on students' meta-strategic thinking (see Zohar & Barzilai, 2015).

There is more limited although promising evidence for effective metacognitive teaching at the primary school level. Hackling & Sherriff (2015), for example, provide a case study of an 'exemplary primary science teacher' in Western Australia. The authors argue that the success of the teacher's approach comes down to enhancing opportunities for reasoning in the classroom through the use of metacognitive scaffolds,[14] prompts and strategies, as well as language and concept development.

## Mathematics programs

Most early studies into the role of metacognition in mathematics explored models of effective problem-solving (Garofalo & Lester, 1985; Polya, 1949; Schoenfeld, 1985), and had a particular focus on the use of self-questioning.[15] In the proceeding decades, numerous pedagogical methods for introducing metacognition into mathematics learning have been developed (Mevarech & Kramarski, 2014; Yimer & Ellerton, 2010). There is evidence for positive effects of metacognitive instruction on student learning across all grade levels, particularly in the areas of arithmetic, algebra and geometry (Desoete & De Craene, 2019; Lee et al., 2018). Interestingly, as with reading and writing, there is evidence that better mathematicians tend to know and practice more metacognitive strategies (Mevarech & Kramarski, 2014; Vestal et al., 2017).

A particularly well-studied model of metacognitive instruction in mathematics is the IMPROVE model (Mevarech & Kramarski, 2014; Mevarech & Kramarski, 1997).[16] IMPROVE was designed to be broadly implemented, from individual lessons to whole curricula, and from Kindergarten to Year 12. There is evidence that the IMPROVE model can positively impact student performance up to a year after the learning intervention took place (Mevarech & Kramarski, 2014). The IMPROVE model is underpinned by four types of metacognitive questions, as outlined in Mevarech & Kramarski (2014, p. 69):

14 In this case, metacognitive scaffolds were frameworks of reflective questioning that can promote discussion. For instance, the teacher started each class with a set of lesson goals set up as 'WILF' (what am I looking for?) questions and answers. This allowed students to be explicitly aware of the learning goals for the lesson and prompted evaluation of current knowledge or ability to achieve those goals (Hackling & Sherriff, 2015).

15 It's worth noting that the literature also has a large focus on motivational aspects. There is some consensus that the difficulty of a certain problem for a student is based more on the student's perception of difficulty than any objective measure of the problem itself (Artzt & Armour-Thomas, 1997; Geiger & Galbraith, 1998; Yimer & Ellerton, 2010).

16 IMPROVE stands for Introducing, Metacognitive, Practicing, Reviewing, Obtaining, Verifying and Enrichment.

- Comprehension questions: what is the problem all about?
- Connection questions: how is the problem at hand similar to or different from problems I have already solved? Please explain your reasoning.
- Strategic questions: what kinds of strategies are appropriate for solving the problem, and why? Please explain your reasoning.
- Reflection questions: does the solution make sense? Can the problem be solved in a different way? Am I stuck? Why?

All of these questions can be expanded upon in the context of specific problems, and require content knowledge, teacher modelling and instruction, as well as plenty of opportunity for practice in order to be effective. In line with other metacognitive teaching interventions, there is good evidence that this mode of instruction is particularly beneficial when it involves small-group work (Kramarski & Mevarech, 2003; Mevarech & Kramarski, 2003).

There are a number of high-quality reviews which provide evidence-based metacognitive teaching strategies and point to their positive effect in mathematics learning.[17] For instance, a recent meta-analysis found metacognitive training had a significant positive impact on students' algebraic reasoning (Lee et al., 2018). Mevarech & Kramarski (2014) outline a number of strategies and present strong evidence for how metacognition helps students solve 'complex, unfamiliar and non-routine problems'.

The benefits of an explicit focus on metacognition for mathematics instruction has been long-recognised. The Singapore mathematics curriculum for example was modified in the 1990s to include an explicit focus on metacognition across all year groups (Kaur, 2019).[18] Singapore consistently ranks highly on international mathematics tests (e.g. PISA, TIMSS), though it's unclear to what extent the metacognition focus has contributed to their performance due to a lack of internationally comparable data from prior to the new curriculum. Lee et al. (2019) outline some examples of how metacognition was introduced into the Singapore maths curriculum, and what this looks like in practice in a few schools. For instance, there has been a particular focus on the way students approach problems, similar to the IMPROVE model outlined above.[19]

A natural question arising from the use of metacognitive teaching practices is that of measurement: how can teachers assess if the metacognitive teaching strategy is working for their students? While it's beyond the scope of this paper to consider the question of assessment in depth, the next section highlights some of the research around effective forms of metacognitive assessment.[20]

17 Desoete & De Craene, (2019) and Mevarech et al., (2018) each outline a wide-range of metacognitive teaching strategies targeted at different age groups, as well as the evidence for the efficacy of those strategies.

18 Singapore has a "pentagonal framework for mathematical problem solving", consisting of skills, concepts, processes, metacognition and attitudes (Ministry of Education Singapore, 2012).

19 There has also been a focus on training teachers to ask metacognitive questions of their own teaching, using a reflection model based on emotive, critical and creative reflection (Lee et al., 2019).

20 It should be noted that some researchers have warned against rushing toward school-based or system-wide standardised assessment of metacognition – particularly large-scale summative assessment – before the work of teacher professional development and full curriculum integration is done (Zohar, 2020).

## Assessment of metacognition

Given the evidence that a focus on metacognition can improve student learning, it is important to consider how teachers can track or assess students' metacognitive development and gauge the success of different metacognitive teaching strategies used.[21]

Selecting the right type of assessment for any purpose requires careful consideration of that purpose – what you are trying to assess and why (CESE, 2015). Generally speaking, teachers may approach the assessment of knowledge differently compared to skills, and this tends to also apply to the assessment of metacognition.

Metacognitive knowledge is often assessed through student self-reported or teacher-reported inventories based on student observation (Mokhtari & Reichard, 2002; Schraw & Dennison, 1994; Weinstein et al., 1988; Whitebread et al., 2009). These inventories typically take the form of statements about metacognitive strategy knowledge or use, and are scored with a Likert scale or similar measure. Statements in the inventories may be broad, like "I am aware of what strategies I use when I study" (Schraw & Dennison, 1994, p. 473) or specific, like "I discuss what I read with others to check my understanding" (Mokhtari & Reichard, 2002, p. 258). This is a generally accepted method for assessing metacognitive knowledge, though inventories as a mode of assessment are not without criticism – for instance, they are not independently verifiable, and respondents may select what they think is the 'expected' answer (Pressley & Afflerbach, 1995; Schraw, 2000).

Given that good metacognition requires more than just knowledge of a strategy, it is important to measure both metacognitive skill and knowledge where possible. However, the assessment of skills can be more difficult compared with assessing knowledge. This is particularly true of thinking skills, which are often not directly observable and difficult to define.[22] Historically, metacognitive skills have been assessed in similar ways to metacognitive knowledge, that is, mostly through student self-reporting or teacher-judgement methods. However, these types of assessment tend to only take place before or after metacognitive skill is applied to a task, rather than observing the skill as it is being applied, which can call into question their validity and accuracy (Veenman, 2005; Whitebread et al., 2009). As students can be aware of strategies without being able to use them effectively, assessment of how successfully metacognitive skills are being applied, at the point of application, is therefore important. As Ku & Ho (2010) summarise,

> **"any non real-time measurement that requires participants to recall their cognition after task completion would give an incomplete picture of the actual thinking process"**
> (p. 254-255).

21 This section is necessarily brief. There are a number of high-quality reviews of assessment broadly (CESE, 2015), and metacognitive assessment specifically (Lamb et al., 2017; Schraw, 2000), that treat assessment in greater detail than can be done here.

22 When it comes to metacognitive skills, assessments are more likely to measure cognitive regulation or control rather than monitoring (Ozturk, 2017; Pintrich et al., 2000; Pressley & Afflerbach, 1995).

Hence, there is growing consensus that the most accurate way to analyse metacognitive skill is during task performance in the school context (Sáiz Manzanares et al., 2019; Schellings et al., 2013; Veenman & van Cleef, 2019). In other words, metacognition should be measured as students apply it in the assessment task. The most common method for achieving this is the 'think-aloud' protocol, where a participant is given a task – such as reading a text and identifying errors, or solving a physics problem – and asked to verbalise their thoughts as they complete the task (Veenman, 2005). Think-aloud protocols have been widely used to examine a range of cognitive and metacognitive skills (see Ku & Ho, 2010 for a brief review).

While there is some evidence that the think-aloud protocol is a valid assessment of secondary student and adult metacognition (Bannert & Mengelkamp, 2008; Ericsson & Simon, 1993; Pressley & Afflerbach, 1995), it may actually hinder the accurate analysis of metacognition in young children, especially in the 3-to-5-years age range (Whitebread et al., 2009). A potential solution to the problem of analysing metacognition in preschool- and primary-age students involves observing both verbal and non-verbal indicators (Whitebread et al., 2007, 2009). However, such an approach can be extremely time consuming, and is currently unrealistic for teacher use. Another potential assessment method is the use of log-files to code and track student actions in computer-based tasks (Veenman et al., 2014).

Even the best assessments can be validly criticised. In the case of assessing thinking skills like metacognition, inference and interpretation of students' behaviour and language is less than ideal, but it may be acceptable if it is the only available means to assess a skill that is not directly observable. This issue has led to a call for mixed-methods of assessment (Marulis et al., 2016; Sáiz Manzanares et al., 2019; Whitebread et al., 2009), something echoed in discussions of thinking skill assessment more broadly (Lamb et al., 2017).

The need to rely on inference and interpretation relates to an important issue in metacognitive assessment, particularly as it is used in education research. Namely, if different researchers categorise metacognition differently, how comparable are their results? Schraw (2000), Veenman (2005), Ozturk (2017) and Whitebread et al. (2009) all provide interesting analyses of the common issues in metacognitive assessment. Suffice to say that issues around definitions, assessments and interpretation of meta-analyses are closely linked, but this is a well-known issue in the field and an area of active research.

# 5. Concluding thoughts

While there is a strong evidence base for the importance of an explicit focus on metacognition in school education, there is still a lot of work to be done on the synthesis of theory, practice and assessment of metacognition.[23]

The question of how best to embed metacognitive practice within school instruction remains an active one. Given the evidence of how metacognition can support student learning, this is an important area for exploration. Jurisdictions, including Shanghai, Hong Kong, Singapore and Finland, which have moved toward a greater focus on metacognitive skills in their school curricula, can help to inform models of effective practice and implementation (Perry et al., 2019).

If, as the research suggests, metacognition is an important key to unlocking learning, then it is worthy of a greater focus in Australian classrooms. For such a change to occur, teachers will need to be well supported by education systems, through the provision of resources, tools and professional learning opportunities, in order to become expert metacognisers themselves, and better support the metacognitive development of their students.

23 Despite being written two decades ago, Schraw (2000) provides a list of issues or 'themes' in the metacognition literature that are still mostly relevant today.

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