Making sense of metacognition

ALEX QUIGLEY
HUNTINGTON RESEARCH SCHOOL, UK

ELEANOR STRINGER
EDUCATION ENDOWMENT FOUNDATION, UK

Amy's geography teacher has asked the class to prepare a short presentation about rainforest ecosystems. To plan this, Amy reflects on how she learned best on the last topic – using the school textbooks – and decides to read the relevant chapter before drafting her presentation points. However, when reading it, she decides that the chapter isn't explained clearly enough to improve her understanding. She starts to panic, as she was relying on this.

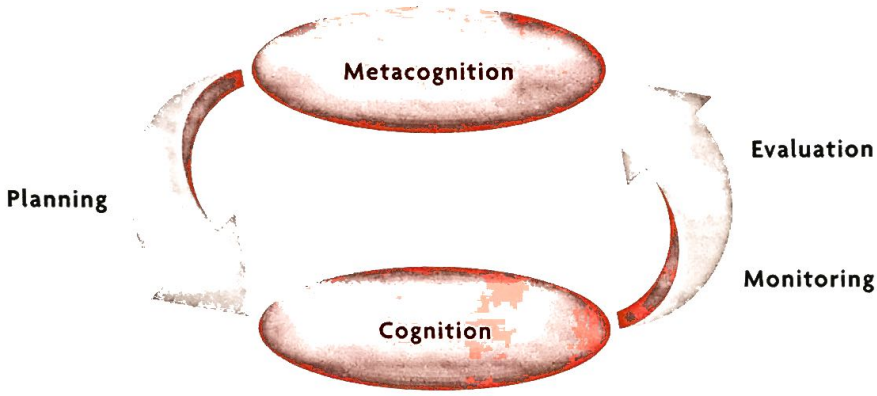
Then Amy remembers a geography website her teacher mentioned. She adapts her strategy and searches the website. This provides a more useful overview, and she uses the information to summarise some interesting facts. She reflects on the experience and decides that next time she will gather a range of resources before starting to research a topic, rather than relying on one source.

This short anecdote about Amy provides a familiar scene of schoolchildren grappling with their homework each evening in homes across England. When you dig beneath the surface of Amy's actions, you begin to consider how she thinks hard about her learning. Here, she is proving to be a successful learner, having internalised some effective strategies for *planning*, *monitoring* and *evaluating* her geography learning.

Most often, such learner behaviours are hidden in plain sight. Students like Amy go on to prove a success in geography and beyond, whereas some of Amy's peers simply flounder and fall away over time. Some teachers cultivate and nurture the metacognitive strategies used by Amy, explicitly naming them, guiding practice and promoting them daily, but many teachers do not do this so explicitly, so pupils may not develop the most effective strategies over time.

It becomes useful then to better define the key characteristics of effective learners, using well understood terms to underpin our practice in schools. The Amy example is a concrete example of **metacognition and self-regulation**. The Sutton Trust-Education Endowment Foundation's Teaching and Learning Toolkit (Education Endowment Foundation, 2018) suggests that it is one of the most effective approaches for improving pupils' attainment outcomes. So, how can teachers be helped to understand the terms? And how can the skills be developed and supported in the classroom? ›

FIGURE 1:
VISUAL MODEL OF COGNITIVE PROCESSES



Guiding teacher understanding of metacognition

Ask a staffroom full of teachers for a definition of metacognition and you will likely receive the familiar stock answer: 'thinking about thinking'. The problem here is that such a definition is vague and slippery. It certainly does not help a Year 5 teacher on a wet Wednesday afternoon, or a Year 11 maths teacher tackling trigonometry after break-time! Other definitions, such as 'learning to learn', are equally vague and can actually promote the misconception that metacognition is a generic skill that is not bound to subject knowledge – that we are not actually thinking about something.

There is a wealth of evidence to better understand metacognition so that teachers of every key phase, key stage and subject can support learners like Amy to thrive in and out of the classroom (e.g. Dignath and Büttner, 2008). If we can better define metacognition, we can go on to make it concrete for teachers and pupils, whilst dispelling some common misconceptions about what metacognition is, and what it isn't.

Metacognition is a part of self-regulation: those self-directive processes that direct our learning. As shown in the example of Amy, it requires:

- **Knowledge of yourself as a learner** (such as how Amy considers how she had performed successfully on her previous topic)
- **Knowledge of appropriate strategies** (such as how Amy drafts her presentation points and searches the internet)
- **Knowledge of the task** (such as how Amy knows that such a presentation requires the essential information offered by the textbook).

An effective learner will monitor their knowledge and cognitive processes, and use this understanding to make judgements about how to direct their efforts. Let's take the following example. Try this straightforward mathematics multiplication: 155 x 3. You may find it easy, but you will still draw upon some tried-and-tested strategies based on your maths knowledge, and you will have a good sense of whether your answer is correct. Now, how about 145,343,233 x 3? Here, you need to reflect a little bit more. You may know that you have too limited an array of mathematical strategies for this challenge. You may be rapidly searching for a calculator, at least to check your answer. It is in those moments when you are selecting the best strategy that you are behaving metacognitively.

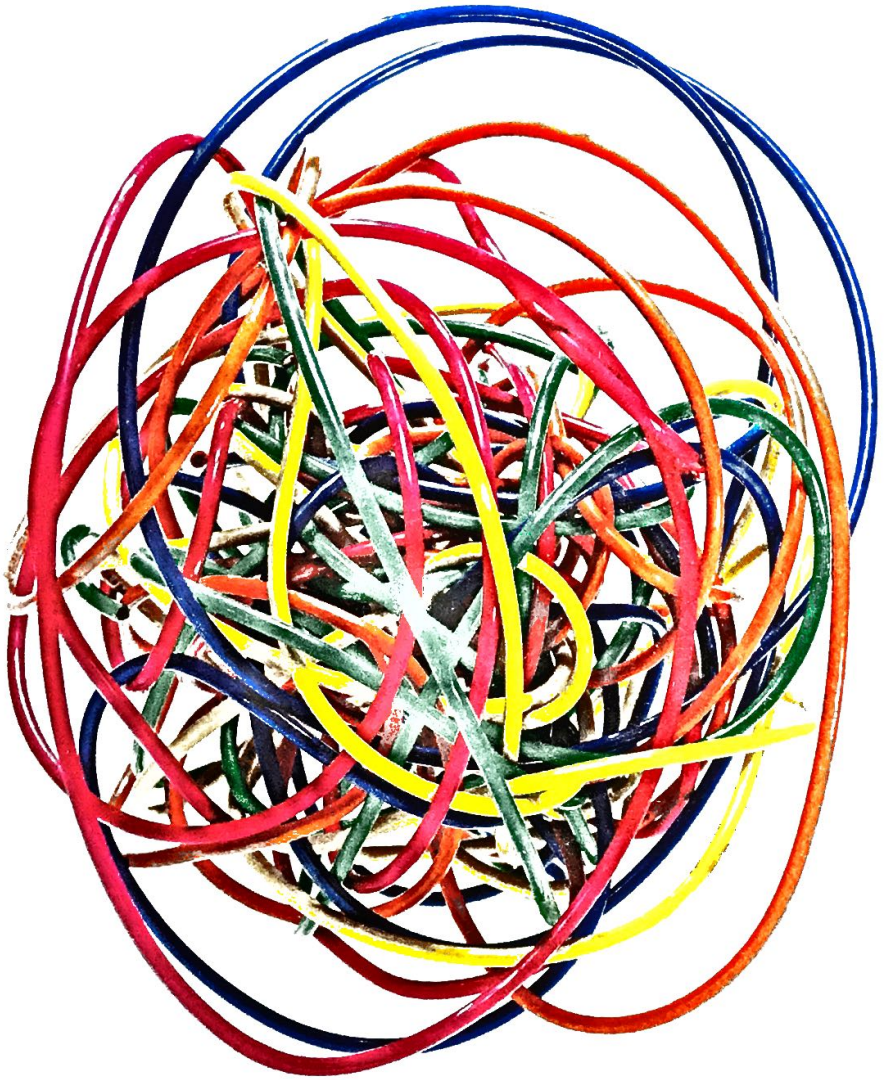
What we learn is that cognitive processes are controlled and adapted constantly. We are always making decisions about our learning in the moment. These decisions happen intuitively but, with explicit teaching and scaffolding, they can be better and more habitually enacted by pupils.

A visual model here is useful, as shown in **Figure 1** (adapted from Nelson and Narens, 1990).

This not a one-off process of discrete steps, but an ongoing cycle. As you progress through the task, you update your metacognitive knowledge (of yourself, your strategies and tasks), as well as updating your subject knowledge (in this example, Amy is learning about rainforest ecosystems, as well as learning about the best research strategies).

The cycle of '**plan, monitor, evaluate**' and the different aspects of metacognitive knowledge (**learner, strategies, task**) are recurrent triplicates that are helpful in making the understanding of metacognition concrete for teachers.

Teachers can then consider these when setting learning tasks and supporting pupils to complete them. In an expert learner (as most teachers are), these processes are unconscious and automatic. In novice learners, however, it can be valuable to make them explicit. For students like Amy, and for teachers, defining and better understanding metacognition can prove a crucial support factor for success in school.



Dispelling metacognition misconceptions

One of the important ways for teachers to better understand metacognition and to teach pupils such strategies is to first dispel some common misconceptions about metacognition.

Misconception 1: Metacognition is a general skill that should be taught separately from subject knowledge

This is perhaps the most common misconception about metacognition. The clue is in the word: without cognition, there is no metacognition. Contrary to the misconception, metacognition is specific to the task and subject, and stronger where learners have a strong grounding in subject knowledge. It is, for example, very hard to have knowledge about how one can learn, such as through applying different strategies, in a subject without solid knowledge of subject-specific content and skills. For example, Amy must have a sound knowledge of the rainforest and its various levels, alongside the notion of an ecosystem, for her to decide the relevant evidence required from her textbook.

Therefore, teaching and practising metacognitive strategies must be done alongside subject content. Generic 'learning to learn' or 'thinking skills' lessons may be able to impart some useful overarching idea, but pupils can struggle to transfer generic approaches to specific subject domains. Self-regulated learning and metacognition have been found to be quite context-dependent, so how you best plan in Key Stage 2 art may have significant differences to planning strategies in Key Stage 4 maths. This does not, however, mean that metacognitive knowledge and skills will automatically develop through content knowledge teaching.

Misconception 2: Metacognition represents 'higher order' thinking and is therefore more important than mere cognition or subject knowledge

We know that metacognition is the knowledge of cognition and the strategies to regulate and control it. However, it would be a mistake to see metacognition as somehow 'higher order', hierarchically, and therefore more important than cognition (as Bloom's taxonomy is sometimes misinterpreted as being a hierarchy that privileges 'evaluation' over 'knowledge'). As has been pointed out, it is very hard to have knowledge about how competent you are in a given subject domain, or how best you can learn, without solid subject knowledge (Pressley and Harris, 2006).

For example, a student can use metacognitive planning strategies when

Teaching and practising metacognitive strategies must be done alongside subject content

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drafting a GCSE essay about Shakespeare. But without knowledge of Shakespeare's plays, language and the relevant social context, the essay will not be successful.

Metacognition and cognition then display a complex interplay as our pupils learn. We should look to develop both concurrently and not create false hierarchies where they do not exist.

Misconception 3: Metacognition is only developed in older pupils

A common misconception with regard to metacognition knowledge and skills is that they are only developed effectively in mature young adults and not young children. We know from research, however, that children as young as three have been able to engage in a wide range of metcognitive and self-regulatory behaviours, such as setting themselves goals and checking their understanging (Whitebread and Coltman, 2010). They also show greater accuracy on tasks that they accept to do than on tasks they don't (Bernard et al., 2015).

There is clear evidence that the level of security and self-knowledge remains rather inaccurate until about eight years of age, with children being overoptimistic about their levels of knowledge (Clark and Dumas, 2016), but the overall trend suggests that forms of metacognition emerge early on in the lifespan. Ultimately, although older children do typically exhibit a broader repertoire of metacognitive strategies, younger children do generally demonstrate metacognitive knowledge, even at a very early age.

Metacognition in the classroom

All pupils develop metacognitive knowledge and skills in their time at school. And yet, some are more adept at doing this than others. They go on to make countless actions and decisions about their learning – many of which the teacher has little control over.

By improving their own understanding, teachers will be better able to support pupils to develop their metacognitive skills and knowledge

Recommendations from the evidence would suggest that teachers can be much more deliberate about teaching metacognitive awareness in the crucible of the classroom. A familiar example is 'shared writing', where the expert teacher (such as Amy's geography teacher) undertakes a written task. As she walks through an explanation of a jungle ecosystem, she verbalises the questions a geographer would ask of themselves, such as *'How many levels are there in the jungle ecosystem?'* and *'How could I organise that clearly in my writing?'*

As well as modelling and scaffolding explicit strategies, cultivating metacognitive talk between students can improve outcomes. For example, the 'dialogic teaching', as devised by Robin Alexander (2017), emphasises dialogue through which pupils learn to reason, discuss, argue and explain. A key element of the dialogic approach is to encourage greater quality of teacher talk, by going beyond the closed *teacher question – pupil response – teacher feedback* sequence. Importantly, in this and other successful interventions, dialogue needs to be purposeful and not just conversation, with teachers using questions to elicit further thought.

What an evidence-based understanding of metacognition offers us is a shared language with which to describe, define and teach effective learning. By improving their own understanding, teachers will be better able to support pupils to develop their metacognitive skills and knowledge. When we train our students to plan, monitor and evaluate, with conscious awareness within a given subject discipline, we offer them the knowledge and strategies to succeed, not only in the classroom but far beyond the school gates too.

This article is based on an EEF-commissioned evidence review examining these questions, drawing upon the expertise of Professor Daniel Muijs and Dr Christian Bokhove. A guidance report on metacognition and self-regulated learning for teachers and leaders was published by the EEF in April.

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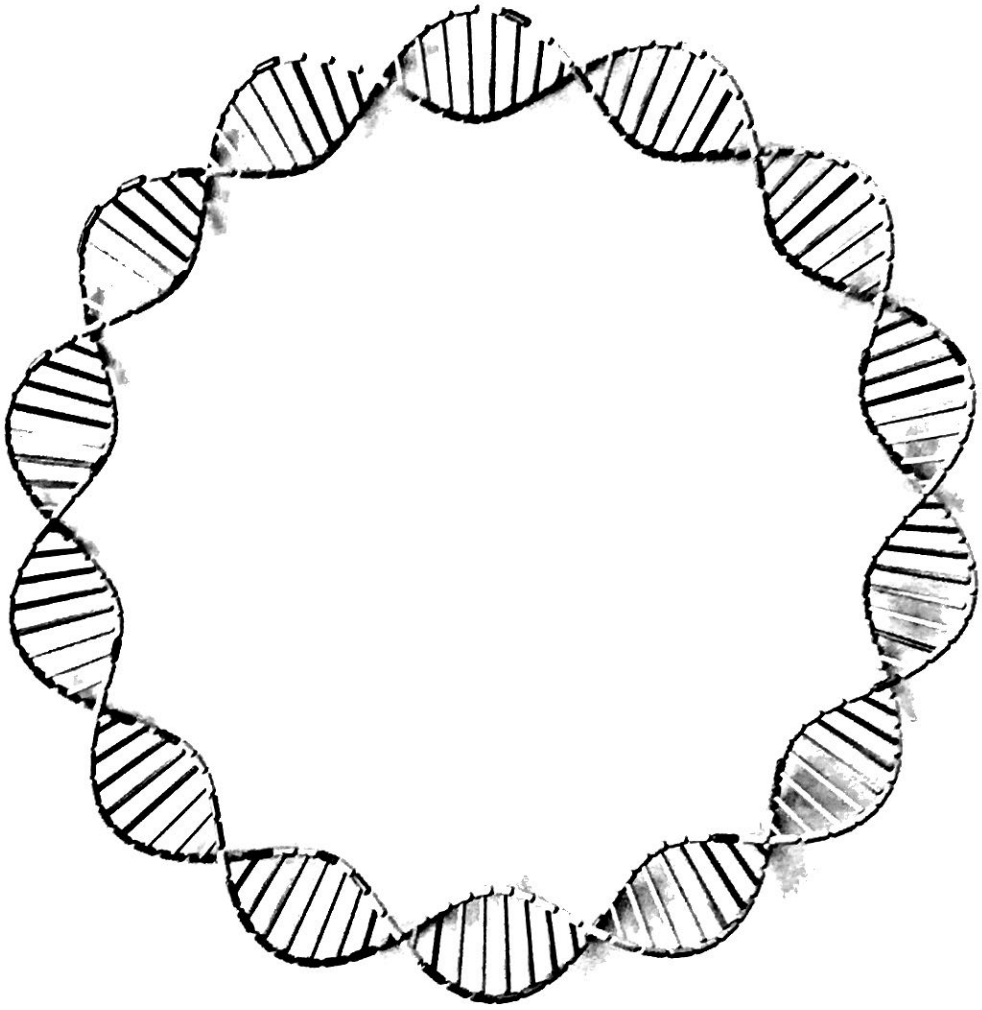

Cognitive skills for active learning in the early years

SARA BAKER
SENIOR LECTURER IN PSYCHOLOGY AND EDUCATION, FACULTY OF EDUCATION, UNIVERSITY OF CAMBRIDGE, UK

There is a lot of talk about active learning in the early years, as well as a host of related pedagogical approaches: experience-based learning, child-led learning, discovery learning, enquiry learning, guided learning. But what does active learning really mean?

The brain is an active agent, not a passive subject

Evidence on the developing brain shows that it actively organises itself and adapts to its environment. It seeks out meaning, and has expectations about the world, such as when we experience visual illusions (Wagemans et al., 2012). The fact that we can visually experience something that we intellectually know isn't really there tells us that the brain is doing work under its own steam. The brain has a job to do, and it will take the initiative to do it!

While the majority of brains are built to do a fixed set of jobs, like seeing, hearing and remembering, brains are also extremely clever and adaptable. Allowing room for responsiveness to one's experiences means that individual brains can be customised to suit the specific jobs and circumstances they are most likely to face. In other words, while there are some 'factory settings', brain plasticity in the early years allows room for resilience and a multitude of different ways in which individuals learn to respond to what happens to them (Bunge and Whitaker, 2012). The brain is an active agent of learning.

If we can pinpoint the early cognitive skills that support active learning, then we are well on our way to finding out how teachers can nurture these.

Active learning and the prefrontal cortex

Educational neuroscience offers a clue to a key set of skills that support actively engaged learning; the so-called executive functions. Executive functions are a set of skills that coordinate and 'project-manage' everything else in our brain, allowing us to adapt to changing circumstances in a context-appropriate way. Executive functions depend on the prefrontal cortex, a part of the brain that undergoes huge developmental changes during the preschool years. They make it possible to hold multiple thoughts in mind at the same time, to plan ahead and make decisions, to multi-task and switch between different activities, as well as to control impulses and think things through before acting.

Thus, a young child with strong executive functions will play the long game when faced with temptation; they will find it easier to concentrate on their activities in a noisy classroom, and transitions between different parts of the day will not be so challenging for them. A young child with weak executive functions, in contrast, will show more impulsive tendencies, will be distractible and less persistent with their work, and might experience more difficulties moving between activities or parts of their day.

Active learning and academic achievement

Some people are surprised to hear that children's early academic achievement is more a result of their executive functions than their age or their IQ. For example, in a US study of hundreds of children in Michigan and Oregon, McClelland et al. (2007) showed that preschoolers' maths skills were predicted by the amount of growth they demonstrated in their executive functions over the course of the academic year. In this study with middle-class children, the amount of previous school experience was less important in shaping their early academic skills than were the children's executive functions.

In a similar UK study of three- to six-year-olds, Steele et al. (2012) showed that children's ability to direct their own attention, a form of executive function, was correlated with their emerging maths and literacy skills, even when age and other factors were accounted for. These are two amongst many examples of research studies showing that early executive functions are key skills for early learning. We must bear in mind, however, that almost all of the existing evidence linking executive functions and early learning is of a correlational nature, and does not therefore imply that executive functions are necessary or sufficient for school achievement (Jacob and Parkinson, 2015).

Supporting active learning in the classroom

Cross-curricular competences like executive functions are best fostered through active, child-led approaches where children can practise these skills (Diamond and Lee, 2011; Perry et al., 2007). As someone recently wrote on Twitter, brain training works, and it's called school. Amadio (2013) highlights the challenges that school leaders and teachers face when trying to implement more active learning approaches that may support such key skills as executive functions. This is echoed in my team's current collaborative work with a group of Reception and Year 1 teachers in the UK. Our teacher-collaborators recognise the potential benefits of supporting children's agency in their own learning, but they are also realistic about the practical challenges that need to be overcome (Kittredge et al., under revision). For example, they are unsure about how much support to give children and when to step back. The lack of teacher-friendly assessment of executive functions in classrooms means that teachers won't necessarily find it easy to identify and track the development of key learning skills like executive functions. As with any development in teachers' practice, it will take time to embed (Kittredge et al., under revision).

On the following pages, we offer some examples of strategies that teachers might try in their Early Years classrooms to support active learning, with examples and some indicative research studies that may be useful for further reading. It is worth noting that these strategies can be applied further up the years, beyond ›

Children's early academic achievement is more a result of their executive functions than their age or IQ

› the Early Years foundation stage, to support active learning and executive functions in older learners, too.

Choice

Offering children choice means that they have to weigh up different options for themselves, exercising their reasoning skills and taking different factors into consideration in a sustained way throughout their daily lives (Diamond and Lee, 2011). They may really want to build a pipe-cleaner tower, but if that station is very busy they may choose to do another activity until there is more space for them. Offering them the opportunity to make some choices for themselves gives them practice and develops their decision-making skills. If a teacher always assigned children to stations, the children would miss out on the chance to exercise their executive functions.

Problem-solving

Another way that teachers can support children's executive functions is by exposing children to multiple different ways of approaching a situation (Diamond and Lee, 2011). For this to work, the activity has to be open-ended enough for there to be multiple avenues to explore in pursuit of the answer. This exercises children's flexibility and problem-solving, by getting children to think outside the box. This can be done in maths, for example, which is often thought of as a recipe box. Can teachers build up a range of approaches with children, for example, by showing children a variety of ways to add up? Problem-solving and puzzling through different options will force the children to actively think ahead and weigh up different solutions, rather than becoming adept at reproducing the same set of actions over and over in the exact same way every time.

The role of the teacher

What these strategies have in common is that they require appropriate support. Left to their own

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devices, choice and problem-solving could lead to chaotic classrooms where children have no sense of direction or boundaries. The role of the teacher, therefore, remains critical. In some cases this means contingent scaffolding that tunes in to the young child's perspective (Sanders and Mazzuchelli, 2013). Teachers will recognise that this is easier done in a small group or one-to-one than in large groups. This has implications for the structure of activities, such as how much whole-class carpet time is planned (Weisberg et al., 2016). Of course, plenaries have value, in building a sense of community and conveying important information that everyone needs. The point to remember is that the learning skills children are practising during whole-group direct instruction versus working in smaller groups will be very different.

The teacher can use the structure of the classroom to build additional scaffolds for children's executive functions, so the children can also be their own teachers (Barker and Munakata, 2015). Small things can make a difference, like curtains hung between stations to support concentration, and books arranged on a shelf from least to most advanced so that children know where to find the level of challenge they are looking for.

Active learning for all

Teachers will immediately ask themselves how such approaches are suited to learners of varying abilities. In a regular classroom full of eight-year-olds, some may have the executive functions of a typical five-year-old while others may have the executive functions of a typical 12-year-old (Gathercole et al., 2006). If teachers adopt strategies for active learning, with more onus placed on the child to lead their own learning, how does a child with weak English language skills make their own interests known to the teacher? If a child tends to day-dream and struggles to stay on task when given specific instructions, what will happen to them when they are given more freedom to select their own activities and ask for help at the appropriate times? In the face of such questions, teachers can reflect on the specific cognitive skills that might be holding a child back.

Psychology and neuroscience can help teachers understand the underlying cognitive skills of the vast range of children in their classrooms. Armed with this understanding, teachers are in a better position to make evidence-based decisions about applying research in their own classrooms. We know from our team's work with teachers as co-researchers that there is no magic formula. Professional judgement on a teacher's part is a critical skill that undergoes continuous development. Finding out which approaches work best, for which kinds of learning and for whom, is a key factor in supporting high-quality teaching in Early Years classrooms. This very important question requires teachers and researchers to work together to extend evidence-based practice and practice-based evidence on cognitive skills for active learning.

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