Thinking Matters

Whole School Metacognition

Developing a Thinking School

Participant Handbook

www.thinkingmatters.com

Thinking Matters

Trainers and consultants to those who believe that thinking matters.

At Thinking Matters we have created a practical, evidence-based approach to developing student metacognition. We provide professional development for educators to nurture a pedagogy that enables students to master a range of thinking skills, intelligent learning behaviours and metacognitive tools. We also provide bespoke guidance to leadership teams on transforming the culture of their organisations so that explicit thinking and continual self-improvement is at the centre of everything they do.

Across the globe, our unique approach results in organisations that forge independent thinkers and learners who develop the attitudes and dispositions to succeed in an ever-changing future.

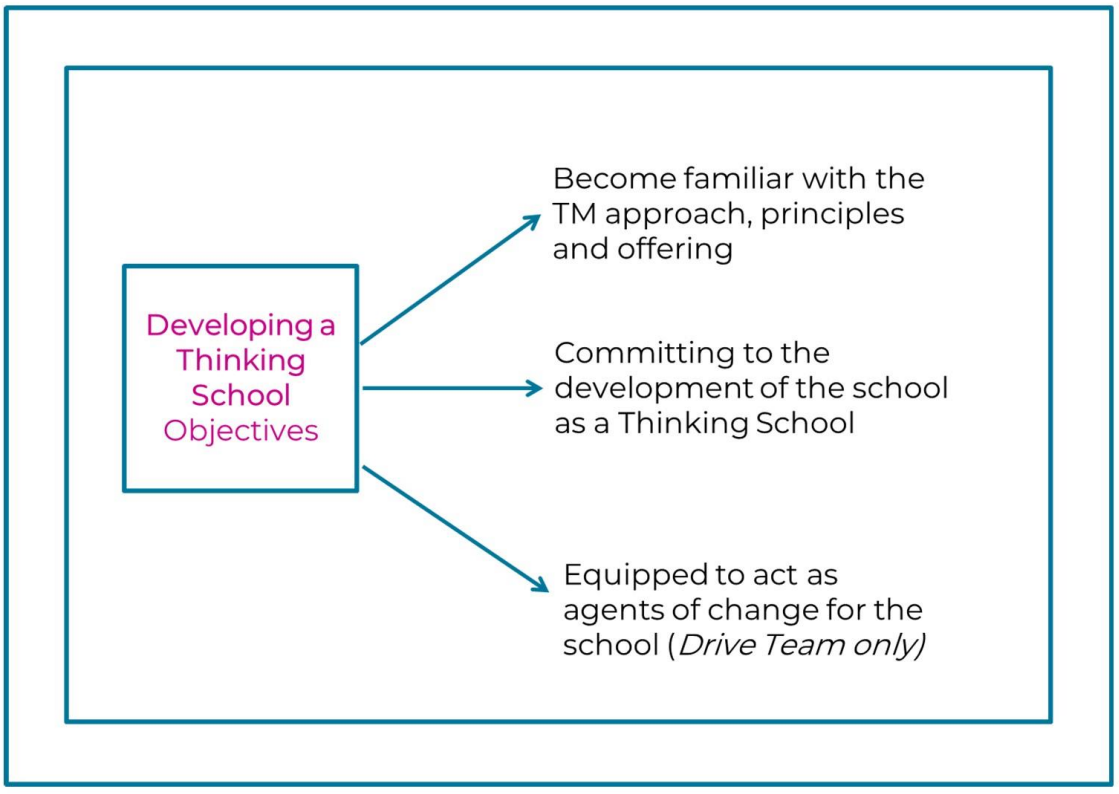


Table of Contents

PART ONE:

Introduction to Thinking Schools

Why our school is embarking on this journey

A statement from School Leadership, which outlines the school's vision and commitment to developing a whole school approach to the teaching of thinking and the development of student metacognition.

The SPARE Model *(Burden and Williams, 1996)*

SETTING – the school's context generally and specific to the intervention; level of preparedness; values and purpose.

PLANS – willingness to make change; plan for how the intervention will be implemented and evaluated.

ACTION – how the plan is put into operation and monitored; professional development; clear expectations.

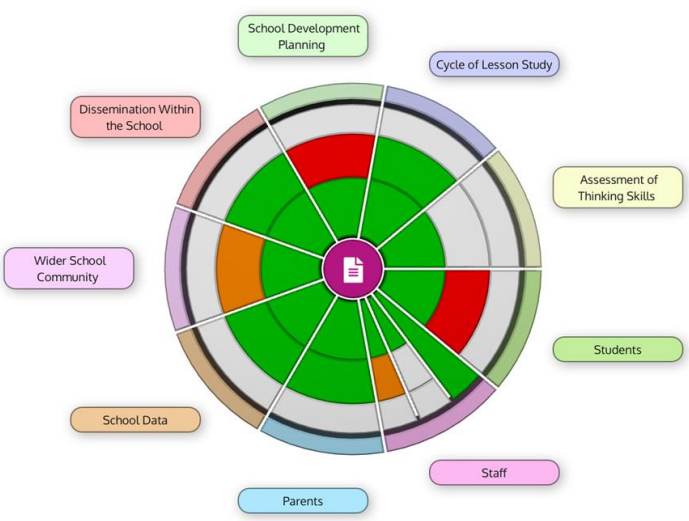
REACTION/RESULTS – relate outcomes to intervention and participants' reactions – analysis of data; responses.

EVALUATION – what has worked well? How could it have worked it have better?

Thinking School Accreditation

For schools that plan to apply to Thinking Schools @Exeter for accreditation as a Thinking School, the accreditation criteria may provide a map to guide the way forward.

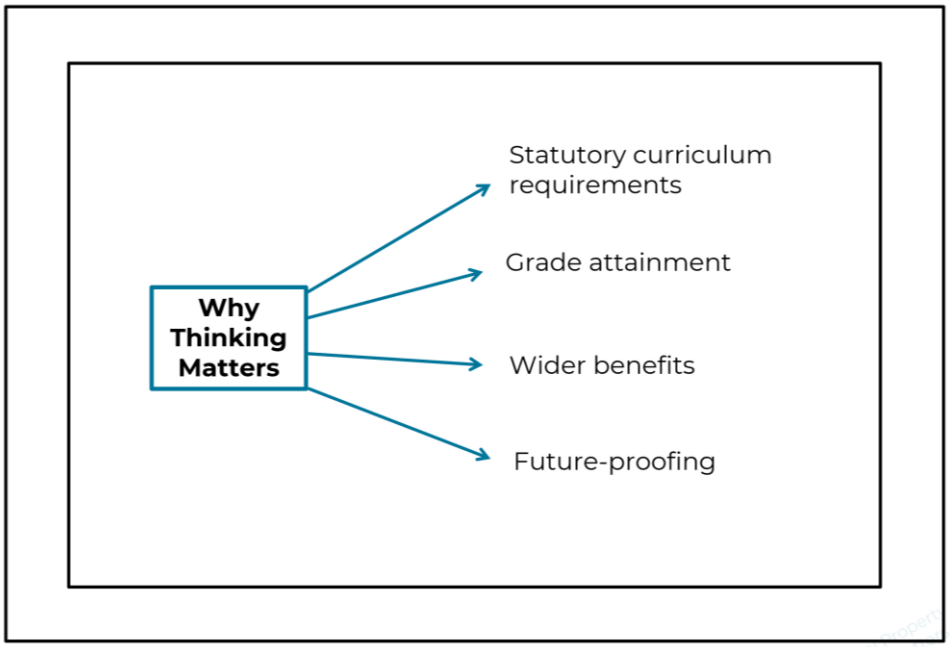
The Thinking Matters Evaluation Wheel provides a helpful tool for documenting progress.



PART TWO:

Why Thinking Matters

Why Thinking Matters



The Impact of a Thinking School Approach

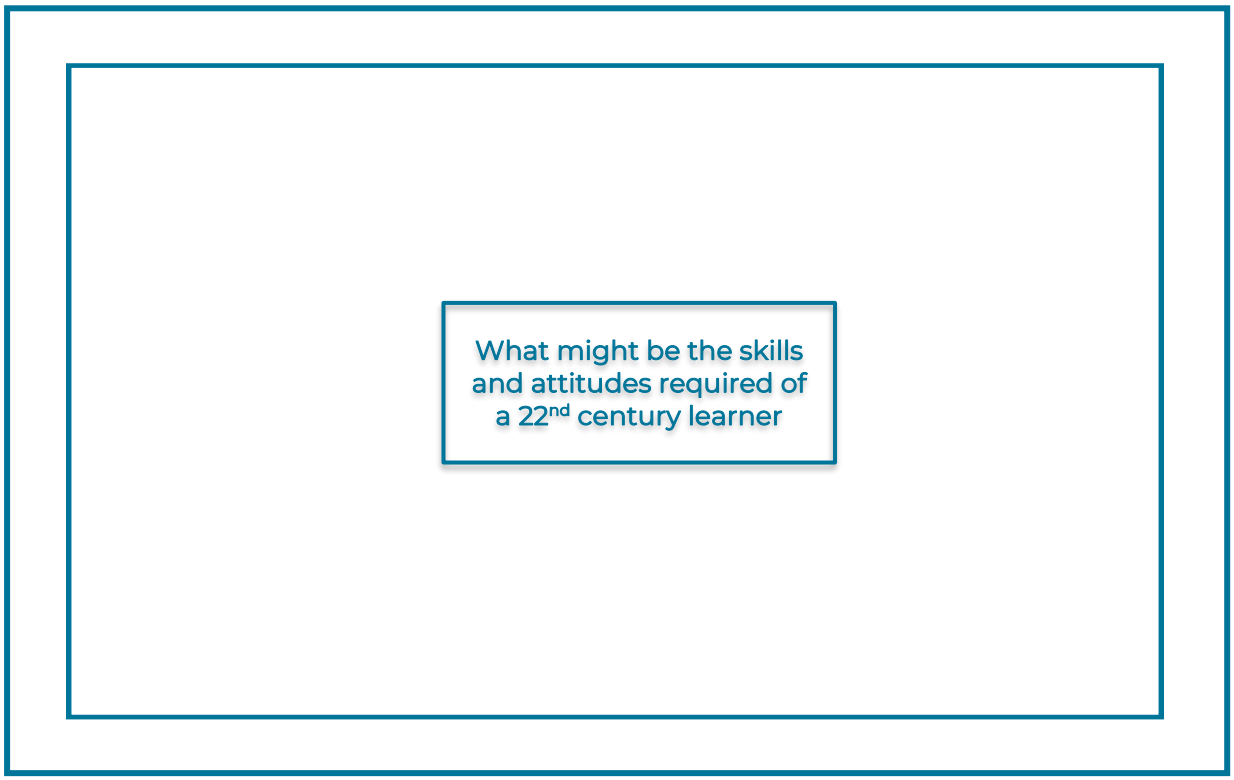
- National Evaluation outcomes:
  - The average of Progress 8 results across the 2016 to 2018 period for accredited secondary Thinking Schools in England indicate what would be termed 'High impact' (0.67), yielding more than a whole grade extra growth.
  - The primary impact measures relating to reading, writing and mathematics would be viewed as 'Moderate' to 'High' over the 2016 to 2018 results (equivalent to between 0.5–0.6 extra grade growth) for accredited primary Thinking Schools.
  - The picture of impact provided by this evaluation of 2016 to 2018 national student outcomes in England shows a relatively stable positive picture both for accredited Thinking Schools and for those schools who have been supported by Thinking Matters. This would tend to suggest that this positive impact is not cohort-dependent as the data is representative of different cohorts of pupils.

Walters, D. (2017). *Ground your practice in evidence, because thinking matters: a national evaluation of the impact of the Thinking Schools approach on the achievement of primary and secondary age pupils in England (2016 to 2018).*

- Case studies of progress in individual schools accessible at: https://www.thinkingmatters.com/thinkingschools/case-studies

22nd Century Learners and Thinkers

TASK question: What skills and attitudes do young learners who may live into the 22nd century need?



Reflective Lens Questions

- In what ways are the pupils in this school being prepared for the 22nd century?
- What employment opportunities are we thinking about in the 22nd century?
- What implications do your responses to the preceding two Reflective Lens Questions have for how we design education in our school?

You may also like to consider the task above from the point of view of parents, students and employers.

- The Wider Benefits of Thinking Schools
  - Develops skilled, independent, reflective learners
  - Greater motivation – for children and teachers
  - Improved discipline and attendance
  - Improved attitudes, behaviours and coping strategies
  - Improved teaching and lesson quality
  - Creates a common thinking language throughout the school

University of Exeter (2012). *Report on the Evaluation of the Impact of Thinking Schools*. https://www.thinkingmatters.com/thinkingschools/benefits

PART THREE:

What is a Thinking School?

Definitions of Thinking and Learning

Learning: the acquisition of knowledge or skills through experience, practice or study, or by being taught.

Thinking: the process of purposeful, self-regulatory judgment. Giving reasoned consideration to *evidence, contexts, conceptualisations, methods and criteria.*

Metacognition

The Education Endowment Foundation's (EEF) '*Metacognition and Self-Regulation Guidance Report'*[1] defines metacognition as being:

"*about pupils' ability to monitor, direct, and review their learning. Effective metacognitive strategies get learners to think about their own learning more explicitly, usually by teaching them to set goals, and monitor and evaluate their own academic progress*."

Metacognition and self-regulation are rated by the EEF's Teaching and Learning Toolkit[2] as 'high impact for very low cost', based on extensive evidence.

A Description of a Thinking School

The late Emeritus Professor Bob Burden, formerly of the Cognitive Education Development Unit at the University of Exeter (now Thinking Schools @Exeter), offered this view of a Thinking School as:

"*... an educational community in which all members share a common commitment to giving regular, careful thought to everything that takes place. This will involve both students and staff learning how to think reflectively, critically and creatively and to employing these skills and techniques in the co-construction of a meaningful curriculum and associated activities. Successful outcomes will be reflected in students across a wide range of abilities demonstrating independent and co-operative learning skills, high levels of achievement, and both enjoyment and satisfaction in learning. Benefits will also be shown by the ways in which all members of the community interact and show consideration for each other, and in the positive psychological well-being of both students and staff."* (Burden, 2006)

[1] https://educationendowmentfoundation.org.uk/tools/guidance-reports/metacognition-and-self-regulated-learning/
[2] https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/

Sentence-Phrase-Word Routine

Reflect on the text and identify a:

- **Sentence** that was meaningful to you;
- **Phrase** that moved, captured or provoked you;
- **Word** that captured your attention or struck you as powerful.

Collective Teacher Efficacy

The centrality of whole staff involvement within a Thinking School has been significantly validated by John Hattie's most recent meta-analysis[3] which has indicated that *Collective Teacher Efficacy* (CTE) has the strongest positive correlation with student attainment. CTE is the collective belief of teachers in their ability to positively affect students. With an effect size of d=1.57[4] CTE is strongly correlated with student achievement.

The Thinking Matters Guiding Principles

It is imperative that the vision and values of Thinking Schools reflect the following principles that have been identified by Thinking Matters:

- **Student-centred** – student-centred models are needed for improving thinking; student-centred here means that metacognitive tools and strategies are taught to and used fluently by students.
- **Inclusive** – there is an underlying belief that all students can think, that thinking capacity can be improved and that all learners have innate abilities to think in a variety of ways.
- **Evidence-informed** – educational practice and policy are established on a robust evidence base of research and enquiry.
- **Progress-focused** – the acquisition and development of metacognitive strategies and intelligent learning behaviours leads to more effective learning if it is integrated into content planning.
- Commitment of the **whole school community** to:
  - *use a common language of thinking and learning;*
  - *make thinking and learning explicit;*
  - *aspire to nurture independent thinkers and learners.*

Guiding questions

- What implications do these principles have for how we design education?

- What connections do they have for the challenges and opportunities ahead?

- What implications do they have for teachers and school leaders?

[3] https://visible-learning.org/hattie-ranking-influences-effect-sizes-learning-achievement/

[4] Hattie, J. (2007). https://visiblelearningplus.com

Cultures of Thinking

The Thinking Matters approach supports schools in the creation of whole school '*cultures of thinking*'. As thinking becomes more explicit and visible, and as thinking routines and metacognitive practices are nurtured across the school, Thinking Schools observe a changing culture within the school community. Harvard University's Ron Ritchhart[5] introduced the idea of *enculturation* as the *key to deep learning* and to the development of the metacognitive strategies and intelligent learning behaviours needed by students as they face the complexities of our challenging world. He has identified eight 'forces' that 'shape culture' as represented in the following, and which are embedded within the Thinking Matters approach:

[5] Ritchhart, R. (2015). *Creating Cultures of Thinking: The 8 Forces We Must Master to Truly Transform Our Schools.* USA.

Seven Starting Points:

How to Recognise a Thinking School

For schools commencing their journey as Thinking Schools, the following 'starting points' have been identified as potentially useful considerations. They may provide useful reference points as the school seeks to establish a baseline of practice as detailed in the 'setting' phase of the 'SPARE' model.

❖ Thinking Skills

- explicit use of cognitive processes

Many different models and theories have been developed for defining and organising a range of thinking skills. Thinking Schools focus on the explicit teaching of fundamental cognitive processes and use a common language of thinking, which leads to better understanding and effective construction of knowledge for students.

❖ Tools and Strategies

- explicit use of tools and strategies to construct ideas

There are many different kinds of visual mapping techniques. Teachers typically use graphic organisers, conceptual and 'systems' mapping, as well as strategies such as Edward de Bono's Six Hat Thinking.

❖ Intelligent Learning Behaviours

- students are self-managing and independent

Educators interested in the area of developing thinking often start by differentiating thinking 'skills' (such as cause-effect reasoning and the ability to make inferences) from thinking 'dispositions' (such as persistence, remaining open-minded and being metacognitive). Dispositions are often related to the field of emotional intelligences and the emotional and social aspects of learning.

❖ Knowledge is a Foundation for Thinking

- thinking is infused through relevant curriculum content

In Thinking Schools an understanding of memory and the development of memory skills to embed and recall knowledge related to curriculum contexts is central. Careful planning weaves together curriculum requirements and the development of thinking.

❖ Reflective Questioning
- high-quality questioning and listening skills

Reflective questioning is the use of prompts and questions to engage students in both thinking about '*what*' they know (factual memory) and also '*how*' they know (critical reflection). High-quality questions guide students to think about their thinking (metacognition) the dispositions that they are drawing on and how they are collaborating with others as they are learning.

❖ Collaborative Networking
- interdependent thinking

The techniques for cooperative learning are many and there are models for establishing collaborative groups, classrooms and schools. The research on cooperative learning in schools and the need for high-quality collaborative groups in the workplace connect to the recent evolution of social networking through new technologies as learners engage with other learners around the globe. This is more than group work. It is learning how to think interdependently.

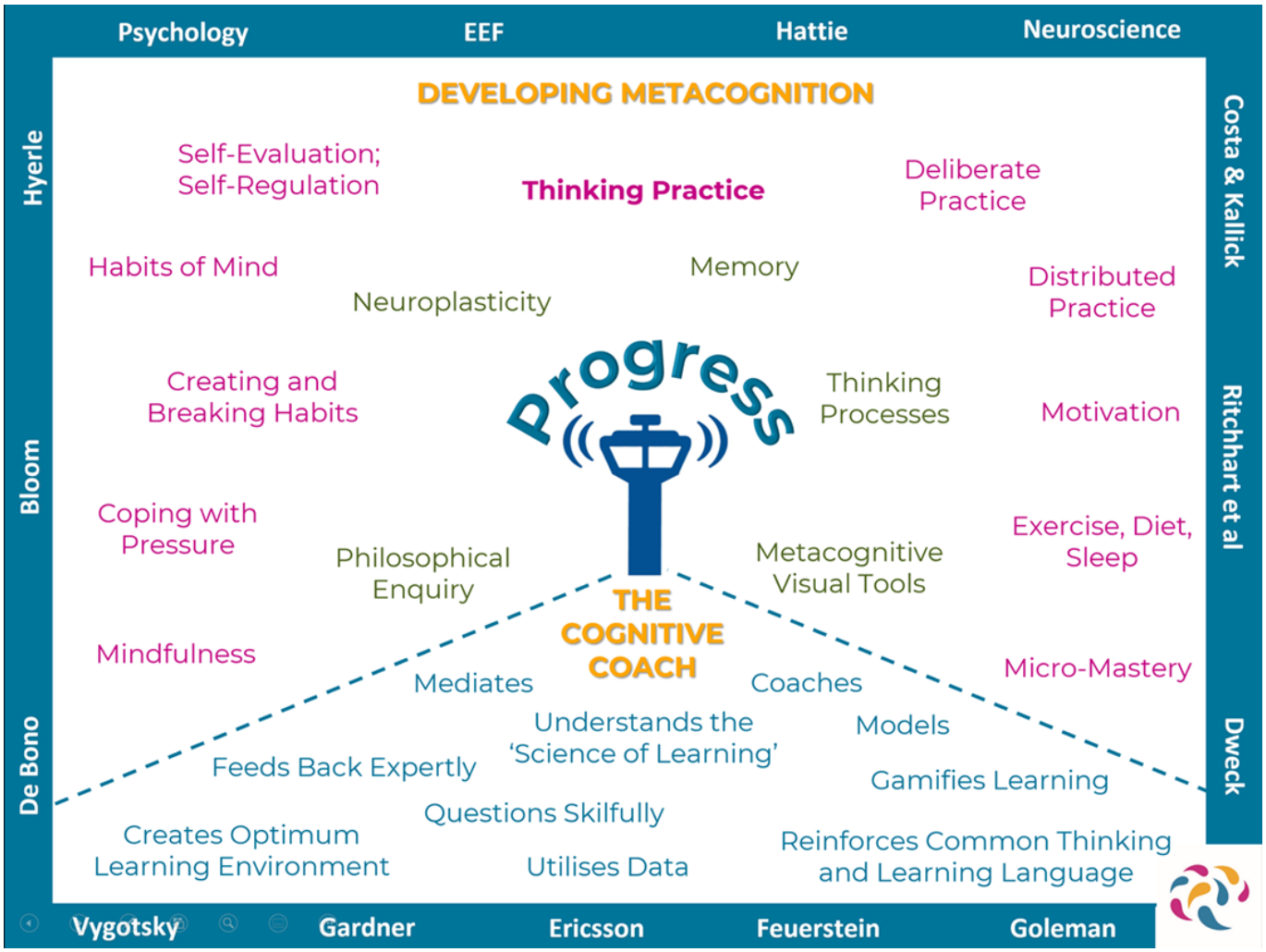
❖ An Environment Conducive to Thinking and Learning
- the physical environment and resources are organised to facilitate student independence

How the classroom, school, and surrounding area are physically structured has a great effect on teaching and learning. In Thinking Schools students will be involved in determining those aspects of the environment that best facilitate the social and emotional aspects of learning.

PART FOUR:

Overview of the Big Picture

The Thinking Matters Big Picture



Developing the Metacognitive Knowledge of Students[6]

We approach any learning task or opportunity with some *metacognitive knowledge* about:

- our own abilities and attitudes – (*knowledge of ourselves as a learner*);
- what strategies are effective and available – (*knowledge of strategies*); and
- this particular type of activity – (*knowledge of the task*).

[6] Metacognition and self-regulated learning: Guidance report, EEF, February 2019.

Focus on the Control Tower – the Iceberg Model

Adapted from: Spencer, L.M. and Spencer, S.M. (1993). *Competence at Work: Models for Superior Performance.*

Levels of Metacognitive Learning

The following framework (Perkins, 1992)[7] defines four levels of metacognitive learner and can help teachers identify where their students are and how much support is required:

1. Tacit learners are unaware of their metacognitive knowledge. They do not think about any particular strategies for learning and merely accept if they know something or not.
2. Aware learners recognise some of the thinking processes they use, such as generating ideas, finding evidence, etc. However, thinking is not necessarily deliberate or planned.
3. Strategic learners organise their thinking by using problem-solving, grouping and classifying, evidence-seeking and decision-making, etc. They know and apply the strategies that help them learn.
4. Reflective learners are not only strategic about their own thinking, but they also reflect upon their learning while it is happening, considering the success or failure of their strategies and revising if appropriate.

The Teacher as Cognitive Coach

In their summary literature review, Hawkins and Smith[8] cite a selection of authors in defining 'coaching'. Consider how the following definitions may inform your understanding of the definition of a **Cognitive Coach** in schools:

- Parsloe (1999) – *"A process that enables learning and development to occur and thus performance to improve."*
- Whitmore (1996) – *"Unlocking a person's potential to maximise their own performance."*
- Caplan (2003) – *"A coach is a collaborative partner who works with the learner to help them achieve goals, solve problems, learn and develop."*
- Grant (2000) – *"A collaborative, solution-focused, results-oriented and systematic process in which the coach facilitates the enhancement of work performance, life experience, self-directed learning and personal growth of the coachee."*

There is also an interesting definition from Neuro-Linguistic Programming:
"A coach will ask you to look at certain processes or explore particular issues. This focuses your attention in certain ways and on certain areas. But over weeks and months you find yourself starting to look at those processes or issues for yourself and to ask yourself the kinds of questions a coach would ask you."[9]

---

[7] Perkins, D. (1992). Smart Schools: Better Thinking and Learning for Every Child. Free Press, New York.

[8] Hawkins, P. and Smith, N. (2006). *Coaching, Mentoring and Organisational Consultancy.* McGraw Hill.

[9] McDermott. I. and Jago Piatkus, W. (2001). *The NLP Coach.*

Zone of Proximal Development (ZPD)

The concept of the *ZPD* was introduced by the psychologist, Lev Vygotsky[10] (1896–1934), and refers to the difference between what a learner can do without help and what he or she can achieve with guidance and encouragement from a skilled partner. The term *proximal* refers to those skills that the learner is close to mastering. It involves an understanding that learning is about:

- 'upping the ante' – but not too fast and not too far!
- finding the 'sweet spot' just outside the comfort zone.
- resetting ideas about what we are capable of.
- pushing ourselves so that bodies and brains have to adapt upwards to rebalance at a higher level.

Three important components should be focused on to aid the learning process by supporting the learner to move through the ZPD:

- The presence of a '*more knowledgeable other*', i.e. someone with knowledge and skills beyond that of the learner.
- Social interactions with a skilful tutor who engages in 'cooperative or collaborative dialogue' with the student, allowing them to observe and practise their skills.
- *Scaffolding*[11], in which the *more knowledgeable other* provides supportive activities to guide the student through the ZPD, which is tapered off or withdrawn as the student gains independence, much as a scaffold is removed from a building during construction.

How might the Cognitive Coach utilise knowledge of learning zones to support student metacognition and self-regulation?

The Cognitive Coach uses thinking practice opportunities to:

- Introduce order into learning experiences so that students are more easily able to manage otherwise random, complex stimuli upon which it may be difficult to remain focused.
- Enable students to see associations, comparisons and connections between various stimuli.
- Provide cognitive tools that enable students to reflect upon and understand phenomena.
- Provide tools and strategies that help students to understand systems, laws and rules that govern certain phenomena.

[10] Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

[11] Wood, D., Bruner, J., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Child Psychiatry*, 17, 89–100.

Furthermore, the Cognitive Coach:

- Reinforces and models the intelligent learning behaviours that underpin effective learning.
- Listens attentively to the meaning behind the student's questions in order to appreciate the level of understanding or misunderstanding.
- Reflects back to the student an appreciation of what the student is saying.
- Asks questions that generate higher, more challenging and demanding thinking by:
  - Modelling interest in the ideas being explored;
  - Helping students to construct understanding;
  - Facilitating the illumination of students' own thinking to themselves.

The Cognitive Coach knows how to:

- teach 'learning to think' little by little;
- build thinking capacity;
- listen intently;
- ask purposeful questions;
- utilise tools, strategies and systems deftly and seamlessly.

It is therefore important that the Cognitive Coach takes time to appreciate the nuances that often underpin key messages from educational research.

The Goldilocks Principle[12]

In the well-known fairy tale, Goldilocks preferred things to be 'just right' (porridge – not too hot/cold, bed – not too hard, soft, etc.) This principle when applied to aspects of classroom practice (such as pitching a learning task or providing feedback) is therefore about getting things not too much, not too little, but 'just right'.

The Bananarama Principle

This principle is named after the Bananarama and Fun Boy Three hit single, 'It Ain't What You Do', and highlights that research findings often suggest that impact is often more strongly influenced by *how* something is done rather than on *what* is done.

[12] Elliot Major, L. and Higgins, S. (2019). *What Works? Research and Evidence for Successful Teaching.* London.

Metacognition and Self-Regulation – Student Independence and the Cognitive Coach

The EEF's *Metacognition and Self-Regulation Guidance Report*[13] identifies three essential components of self-regulated learning that can help teachers support their students' development as successful learners:

- Cognition – the mental process involved in knowing, understanding, and learning.
- Metacognition – the ways learners monitor and purposefully direct their learning.
- Motivation – our willingness to engage our metacognitive and cognitive skills and apply them to learning.

Cognition, metacognition and motivation all interact in complex ways during the learning process. It is impossible to be metacognitive without having different cognitive strategies to hand and possessing the motivation and perseverance to tackle problems and apply these strategies.

In Thinking Schools, in which the concept of the student as 'control tower' is central in practice, there is an important distinction, as highlighted by Ritchhart et al, between the teacher fostering a thinking taxonomy and seeking to raise student metacognitive awareness and the students themselves developing "*a greater awareness of the significant role that thinking plays in cultivating their **own** understanding*"[14] (emphasis added). They go on to cite Biggs (1987), who further explained that:

> *"To be properly metacognitive, then … students have to be realistically **aware** of their own cognitive resources in relation to the task demands, and then to plan, monitor and control those resources."*

Biggs considers this awareness of "*one's own learning processes and one's control over them*"" as 'meta-learning' – a sub-component of metacognition. The effective Cognitive Coach will centrally focus on this nurturing of student independence and agency in developing metacognition.

The Metacognitive Cycle[15]

When students undertake a learning task therefore, they start with their knowledge of self, strategies and task, then apply and adapt it, which is *metacognitive regulation*. It is about "*planning how to undertake a task, working on it while monitoring the strategy to check progress, then evaluating the overall success.*" *(EEF, 2019)*

---

[13] Metacognition and self-regulated learning: Guidance report, EEF, February 2019.

[14] Ritchhart, R., Church, M. and Morrison, K. (2011). *Making Thinking Visible: How to Promote Engagement, Understanding, and Independence for All Learners.* (page 15).

[15] Metacognition and self-regulated learning: Guidance report, EEF, February 2019.

The metacognitive regulation process is cyclical rather than a "*one-off process of discrete steps".*

Stage	The metacognitive student will plan, monitor and evaluate:	The effective Cognitive Coach will combine explicit teacher input with interactive questioning and feedback:
Planning	During this stage, learners think about the learning goal the teacher has set and consider how they will approach the task and which strategies they will use. Learners may ask themselves: *o What am I being asked to do?* *o Which strategies will I use?* *o Are there any strategies that I have used before that might be useful?*	~ encouraging pupils to think about the goal of their learning (set by the teacher, or themselves) and to consider how they will approach the task. This includes ensuring they: - understand the goal, - activate relevant prior knowledge about the task, - select appropriate strategies, and - consider how to allocate their effort.
Monitoring	During the monitoring stage, learners implement their plan and check on the progress they are making towards their learning goal. They may decide to make changes to the strategies they are using if these are not working and may find it helpful to ask themselves: *o Is the strategy that I am using working?* *o Do I need to try something different?*	~ emphasising the need, while undertaking the learning task, for pupils to assess the progress they are making. This includes: - the self-testing and self-questioning activities that are necessary to control learning, and - making changes to their chosen strategies.
Evaluating	Finally, the learner evaluates the overall success and determine how successful the strategy they have used has been in terms of helping them to achieve their learning goal. To promote evaluation, learners may ask themselves: *o How well did I do?* *o What didn't go well? What could I do differently next time?* *o What went well? What other types of problem can I use this strategy for?*	~ appraising the effectiveness of their plan and its implementation.

The EEF Guidance also highlights the importance of teachers:

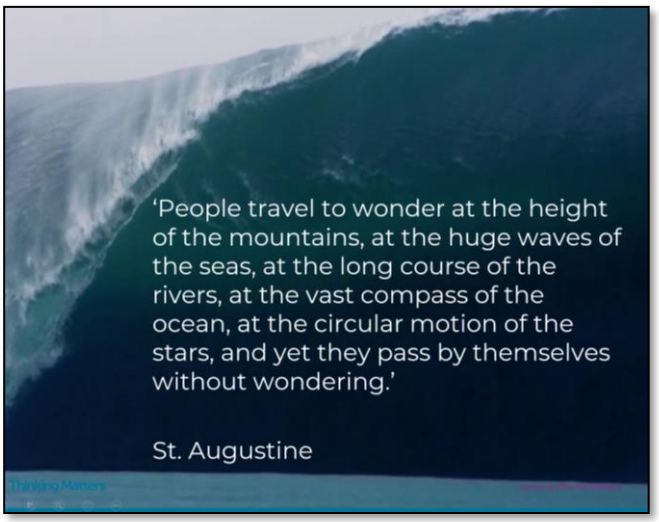
- modelling own thinking to help pupils develop their metacognitive and cognitive skills
  i.e. the Cognitive Coach makes explicit what they do implicitly and makes visible the expertise that is often invisible to the novice learner, and

- setting appropriate levels of challenge
  - working within students' ZPD. It is important not to pitch activities too far beyond students' current level of knowledge/skill to avoid Cognitive Overload, whereby they try to hold too much information in working memory and therefore thinking fails.

The Difference Between the Brain and the Mind

The brain is the organ at the centre of the nervous system, which coordinates our movements, thoughts and feelings.

The mind is a philosophical concept and a manifestation of thought, perception, emotion, determination, memory and imagination.



The Science of Learning

In a Thinking School, it is important that practice is informed by a shared understanding of how students learn and of pedagogical approaches that will have the most significant impact for the learners, informed by robust research evidence. With the increase in scientific knowledge about the workings of the brain, interest has grown incrementally across the educational community in the potential implications of this for teaching and learning. The *Science of Learning* has therefore evolved in recent years as a field which brings together research from neuroscience, psychology, education and other related disciplines to inform our understanding of the learning process.

Brain Structure and Functioning

Whilst we appreciate that all of our brain is used when learning, the Cognitive Coach may find it helpful to increase their understanding of which parts of the brain are involved with learning for particular purposes and some of the key neural functions important in learning.

- The structure and functioning capacity of the brain is immensely complex. The adult brain has around 80 billion neurons (brain cells), many of which can connect with thousands of other neurons.

- Each individual person's brain is unique, adapting to varying environments and responding to experiences and learning. This adaptability is known as *neuroplasticity*. The brain has the capacity to make connections and to remain 'plastic' throughout our lives.

- The cerebrum is the largest part of the brain and is divided into two hemispheres. The *corpus callosum* is a bundle of nerve fibres which form a

'bridge' between the two hemispheres. The multiple connections of the corpus callosum allow the two hemispheres of the brain to communicate.

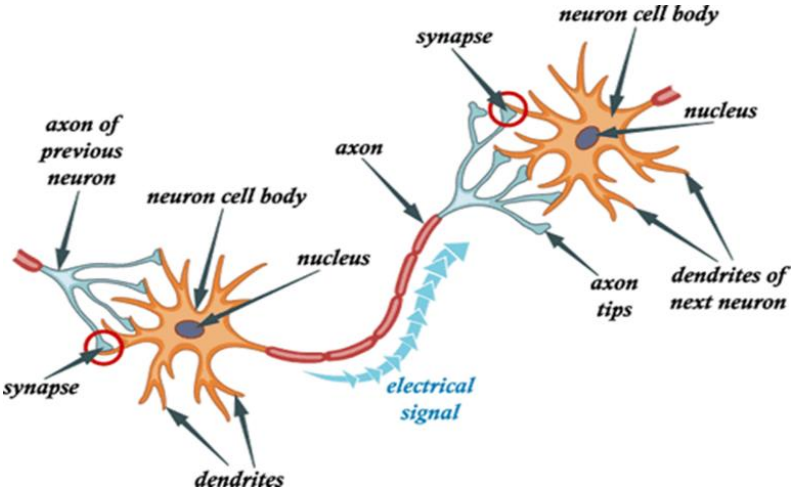
- The surface of the cerebrum comprises of folds of nerve tissue called the cerebral cortex, which is the outermost shell of the brain that takes care of complex thinking abilities including memory, language, spatial awareness and even personality traits.

- The cortex is divided into four lobes: frontal, parietal, occipital, temporal. Each lobe has a particular role in learning, although the brain as a whole is multisensory.

- Beneath the cortex there are also subcortical structures that are also very important for learning. These are essential for our experience of emotions and operate a type of 'reward system', which determines how we experience the world and respond to or approach learning situations and which influences our motivation.

- Key parts of the subcortical structures are the hippocampus, which is crucial for laying down memory in the cortex and the amygdala, which is involved with our emotional response. Subcortical structures interact and communicate with the cortex in a number of complex ways which helps explain why emotion plays such an interconnected role in our learning.

- Information is transmitted through the senses to neurons within the brain stimulating response as neurons relay information to each other through a complex electrochemical process, making connections that affect the way we think, learn, move, and behave. The information is received through the dendrites, is processed within the nucleus (the cell body) and then moves along the axon, which functions like an electric cable transmitting the signal. Once the electrical reaches the end of the axon, at the synapses, a special molecule called a neurotransmitter is released by the neuron. This neurotransmitter will then stimulate the second neuron, triggering a new wave of electrical impulse, repeating the process.



https://biology.stackexchange.com/questions/25967/nerves-neurons-axons-and-dendrites-by-example

- Areas of the brain work in neural networks which direct signals through the brain along a linear pathway. Different types of information can be analysed and organised within milliseconds during this process.

- Neural pathways can be strengthened through repetition and rehearsal. Practice increases myelination, whereby the fatty substance *myelin* improves the strength and speed of electrical signals.

- The brain undergoes sensitive (rather than critical) periods in its development, particularly during the early years and adolescence, during which there is significant 'pruning' of unused neural connections.

- An understanding of the differences between working, long-term and short-term memory and how they work can help improve memory and retrieval. Cognitive overload can result in ineffective encoding of information in long-term memory, potentially slowing learning down or causing misinterpretation or confusion.

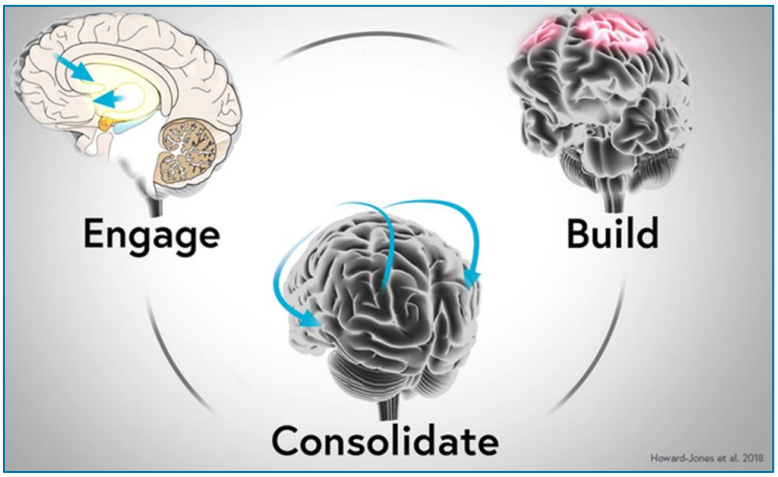
- Sleep, diet, exercise and other environmental and lifestyle factors all play a major role in healthy brain function and development.

- The brain operates in both focused mode, in which concentration and absolute attention is given to something specific, and in diffuse mode, in which the mind is not engaged with something specific. The potential of the whole brain can be exploited when operating intentionally in both thinking modes.

nb. Further detail of aspects of the Science of Learning will be examined (Appendix E) under the headings of *Neuroplasticity; Memory*, *Brain Operating Modes*; *The Emotive Brain; Deliberate Practice and Motivation.*

Applying the Science of Learning in the Classroom

Professor Paul Howard-Jones[16] has categorised learning into three processes: *engagement, building knowledge* and *consolidation*.



[16] https://impact.chartered.college/article/howard-jones-applying-science-learning-classroom/

Howard-Jones defines the processes as:

Engagement involves subcortical structures and production of neuromodulators particularly in the amygdala, which control the emotional processes that encourage us to attend and learn. This inherently includes an understanding of motivation and the impact of the use of praise. To avoid disengagement, it is also important to reduce anxiety or negative emotional response in the learning situation.

Building new knowledge demands activity in the frontal working memory regions of the brain. Once a student is engaged, to build on this new knowledge, the effective Cognitive Coach should:

- communicate clearly and concisely, with efforts to minimise distraction.
- connect the new content with prior knowledge, which requires two-way communication, e.g. the teacher should
    - reflect on student questions asked and responses given, as well as on student performance in classroom tests and homework;
    - prompt students to 'reactivate' prior knowledge (e.g. revision question-and-answer) prior to introducing new information, and
    - encourage students to make connections between the new information and their existing knowledge.
- support students in applying new information by using their prior knowledge to 'transform, organise and elaborate the new input' which activates working memory within the brain.

Consolidation will shift and distribute that activity to other parts of the cortex to free up the limited capacity of the working memory.

This can be facilitated by:

- practising the recall and application of the new knowledge in different ways by providing opportunities that challenge students to apply and test their knowledge in tasks that are considered low-risk and will not induce anxiety, (e.g. games/quizzes) and by -

- questioning, which can enhance the capacity for learning to be consolidated by providing opportunity for retrieval practice. This enables the new information to be represented in the brain in a variety of ways, therefore making a range of connections which have different meanings, which can aid future retrieval.

Whilst each of these processes of engage, build, consolidate uses a different part of the brain, they should not be considered as discrete stages and could actually all be occurring simultaneously, as learning involves all of the brain.

What We Do Already

Limbic brain → Neo-cortex

We help to develop the limbic brain by encouraging students to:

- Make learning memorable with strong emotional connections through enriching activity.
- Receive feedback, specific to the task, which improves self-esteem and confidence.
- Understand what motivates them.
- Have and use strategies that help embed learning into the long-term memory.

We help to develop the neo-cortex by encouraging students to:

- Know how their brains develop and that neural pathways can be built and strengthened.
- Use all the senses when learning.
- Connect new to previous learning and understanding.
- 'Stretch' themselves beyond their comfort zones.

TASK: *Think about a recent learning activity that you have completed with a class. Identify ways in which you sought to engage the limbic system and the neo-cortex.*

How did this reflect the 'Engage, Build, Consolidate' process?

To what extent do you feel this lesson effectively developed student metacognition?

PART FIVE:

Next Steps

What will inform your transformative design?

All of the thinking from today is available to you as your school develops a transformative design in order to facilitate becoming a Thinking School.

While it may seem obvious at this point, the process of developing into a Thinking School engages a vision for whole school cultural change over time. Change, as we know, needs to be thought through carefully in order to be sustained. Thinking Schools are not just about improving questioning, or focusing on certain skills, or implementing a single strategy. Neither is it just about students, or teachers or senior management. It is the bringing about of a community that understands, believes in and is committed to the co-development and interdependence of thinkers and learners of all ages. Once a vision has been created it will only be realised in small steps and stages. But we have to start somewhere. Each potential Thinking School begins in its own unique way. It is important then that the Senior Leadership Team, together with the Drive Team (DT), develops a plan that is not reactive, but that is adaptive and has built into it reflection and research opportunities.

The role of the Drive Team will be crucial in providing leadership, sustaining momentum, providing guidance and clarity, minimising bureaucracy, setting goals and providing ways for the whole staff to share ownership of change.

So, as we invite you to consider your first thoughts about priorities and plans, look back at today and consider some of the elements that will help you. Take a walk back over the day.

- What difference does the school need to make?
- What outcomes would be desirable?
- What good practice already exists that we can capitalise on?
- How can we make the 'Science of Learning' explicit?
- Who teaches about the brain and learning? Is it made explicit to students?
- What do we each need to do differently?
- Which tools and strategies could support our students?
- What further training might we need?

The following suggested activities may provide a useful context for the staff to continue to deepen a shared understanding of becoming a Thinking School. The activities may be completed by the whole staff, the DT, or individual departments or key stage teams within the staff.

Suggestions for Shared Thinking

a) Revisit the TM Big Picture and Science of Learning Jigsaw

TASK: Staff may find it useful to spend further time with colleagues interrogating the information provided in the Big Picture and in Appendix E and particularly to consider what implications it raises for pedagogy and practice.

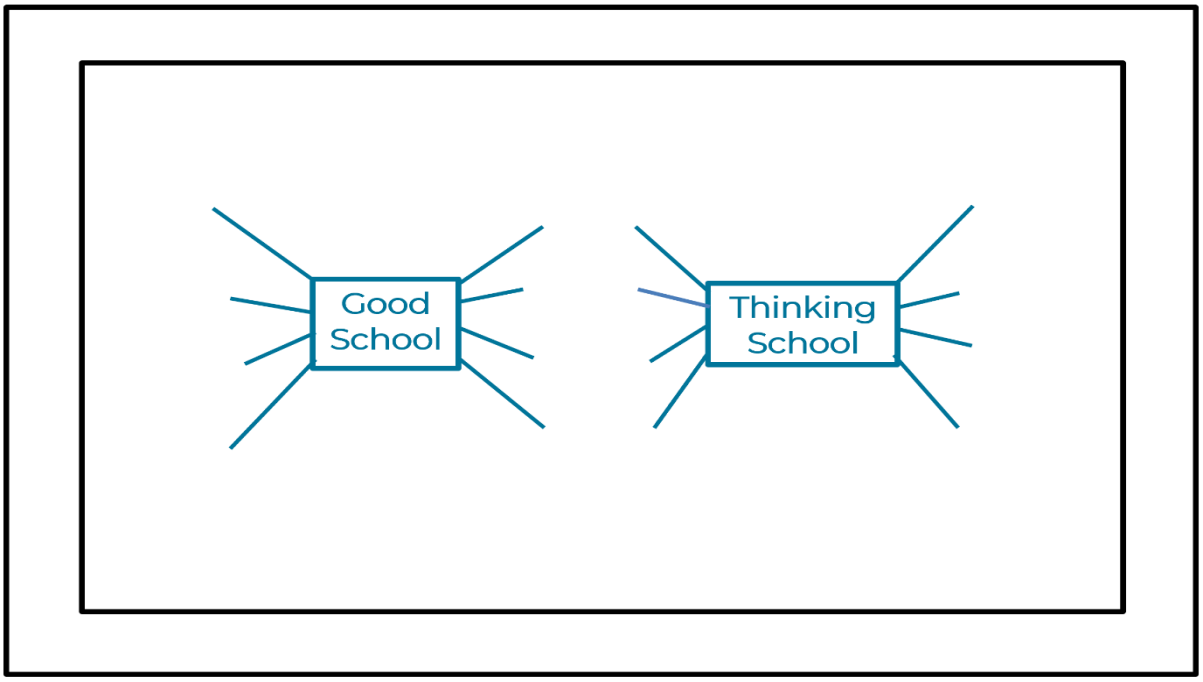
In a Thinking School, it is important that students share an understanding of the Science of Learning. Thinking Matters provides information and links to other sources within its membership material which include advice and exemplification of such classroom practice. Likewise, schools may also wish to consider the potential benefits of sharing some of this information with parents.

b) Revisit the Needs/Skills of 22nd Century Learner

TASK: Thinking Schools seek to ensure that their students develop the skills and dispositions that will equip them for the uncertainties and potential challenges they may face in the future. Staff may therefore benefit from spending further time considering some of the issues raised during this workshop and the extent to which they may also engage with students, parents and their wider school community in considering such issues.

c) Compare/Contrast a 'Good' School with a Thinking School

TASK: Staff may discuss and record thoughts on the similarities and differences between a good school and a Thinking School using the Compare Contrast Frame below:



d) School Survey

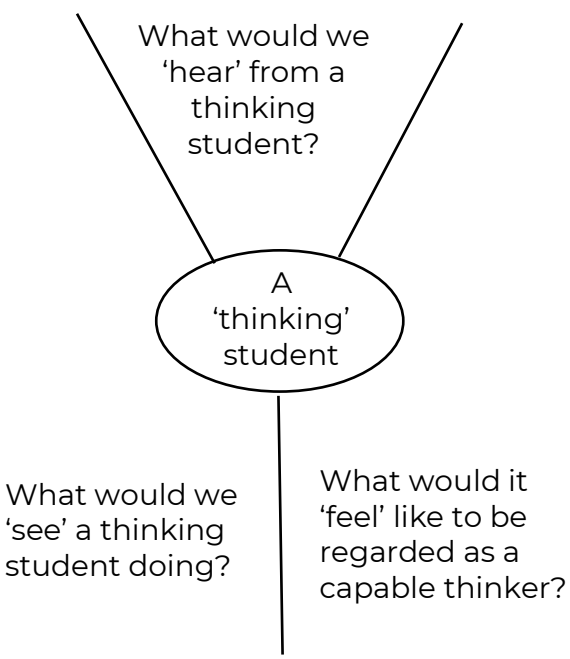
TASK: On the continuum below, place 'X' where you think your school mostly operates. Place 'Z' where you think your school might aspire to.
Discuss these differences.

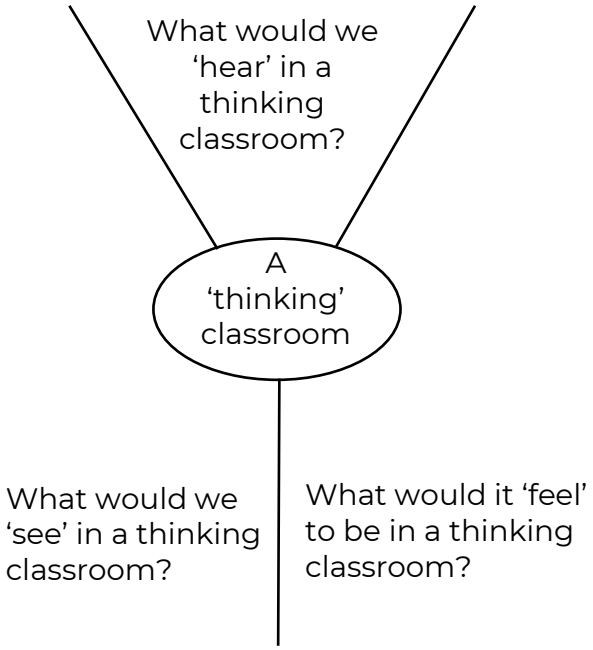
nb. The continuum does not signify 'good' and 'bad', or 'past' and 'future'. This task helps a school to identify the 'shifts' it may wish to make.

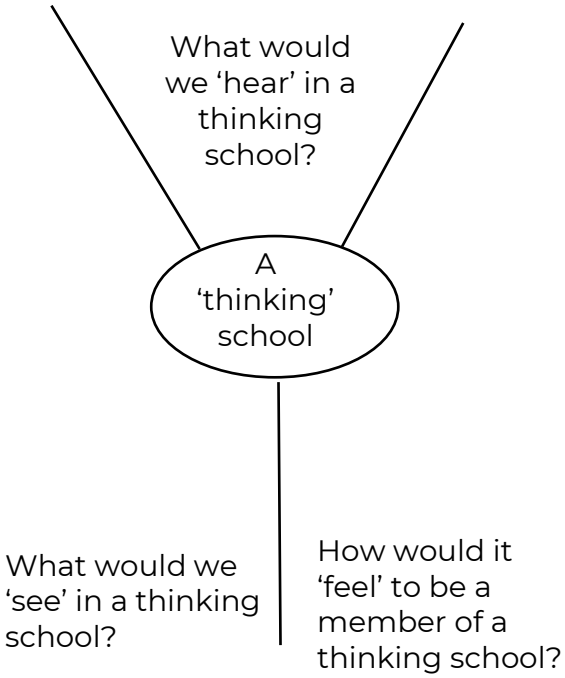
Knowledge is expressed in linear speech and writing	⟷	Students use a range of learning methods such as visual mapping
Focus is on passing closed-ended exams for selection purposes	⟷	Students learn how to accept feedback and become self-assessing and metacognitive
A belief in static intelligence is fostered	⟷	Students are aware of a range of multiple, dynamic intelligences and have a growth mindset
Questions asked by teachers are factual and closed-ended	⟷	Students independently ask a variety of questions which include open-ended, generative and higher order questions
Teachers tell students about how well they are learning	⟷	Students record and reflect on their own thinking processes and how it leads to more effective learning
Emphasis is on student recall of prescribed content information	⟷	Students apply core thinking skills to constructing knowledge
Different ways of thinking remain personal and private	⟷	Students use a wide vocabulary to discuss and describe different ways of thinking

e) Complete Y Chart Outcomes for Students

TASK: Staff may use Y-charts to consider what might a thinking student, a thinking classroom and a Thinking School look and feel like.



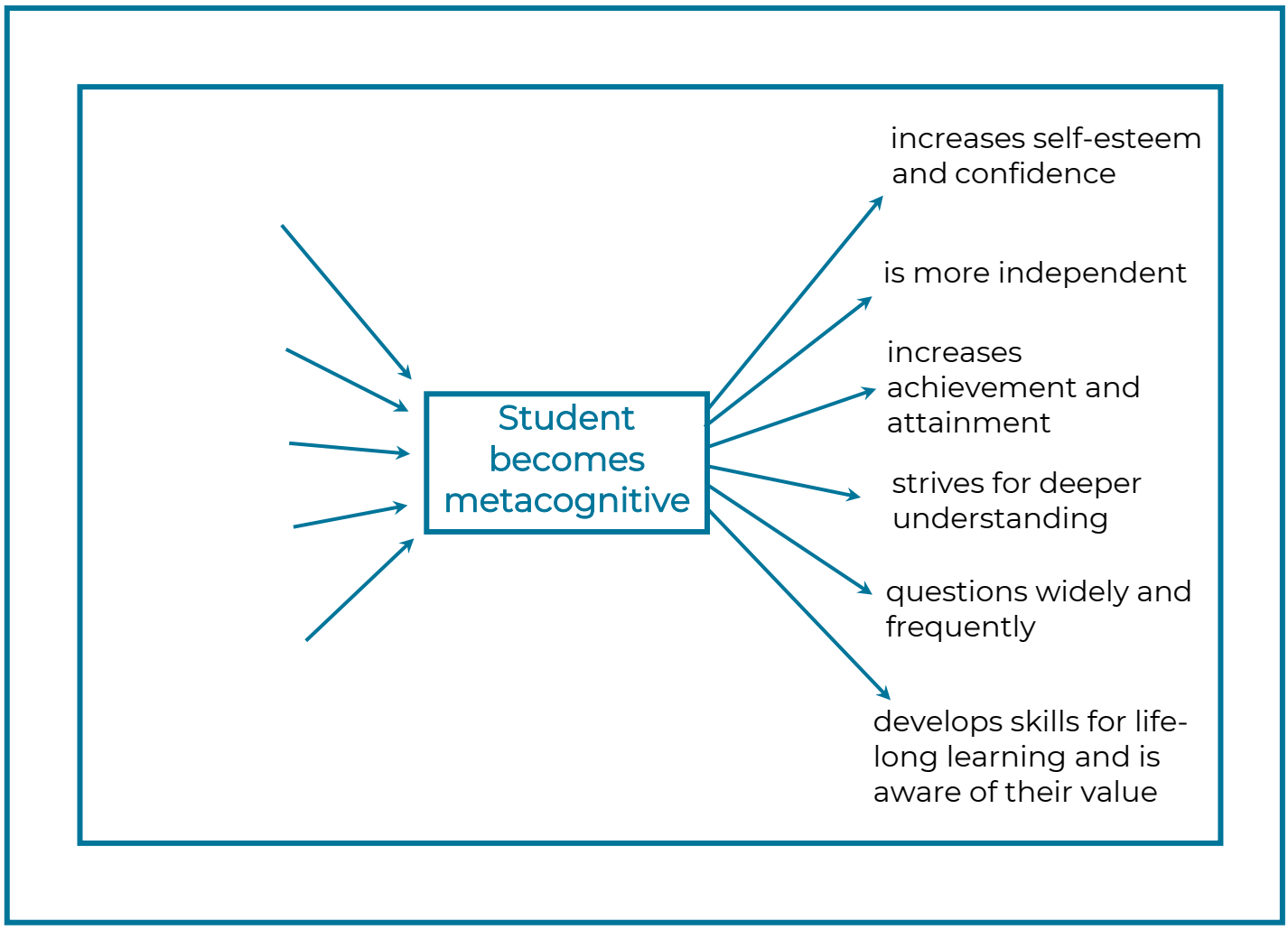




f) Consider what the different members of the school need to do to create a Thinking School

TASK: Staff may use the Cause Effect Frames below to record ideas on what might the student, the teacher and the school leaders have to do differently in order to create a Thinking School.

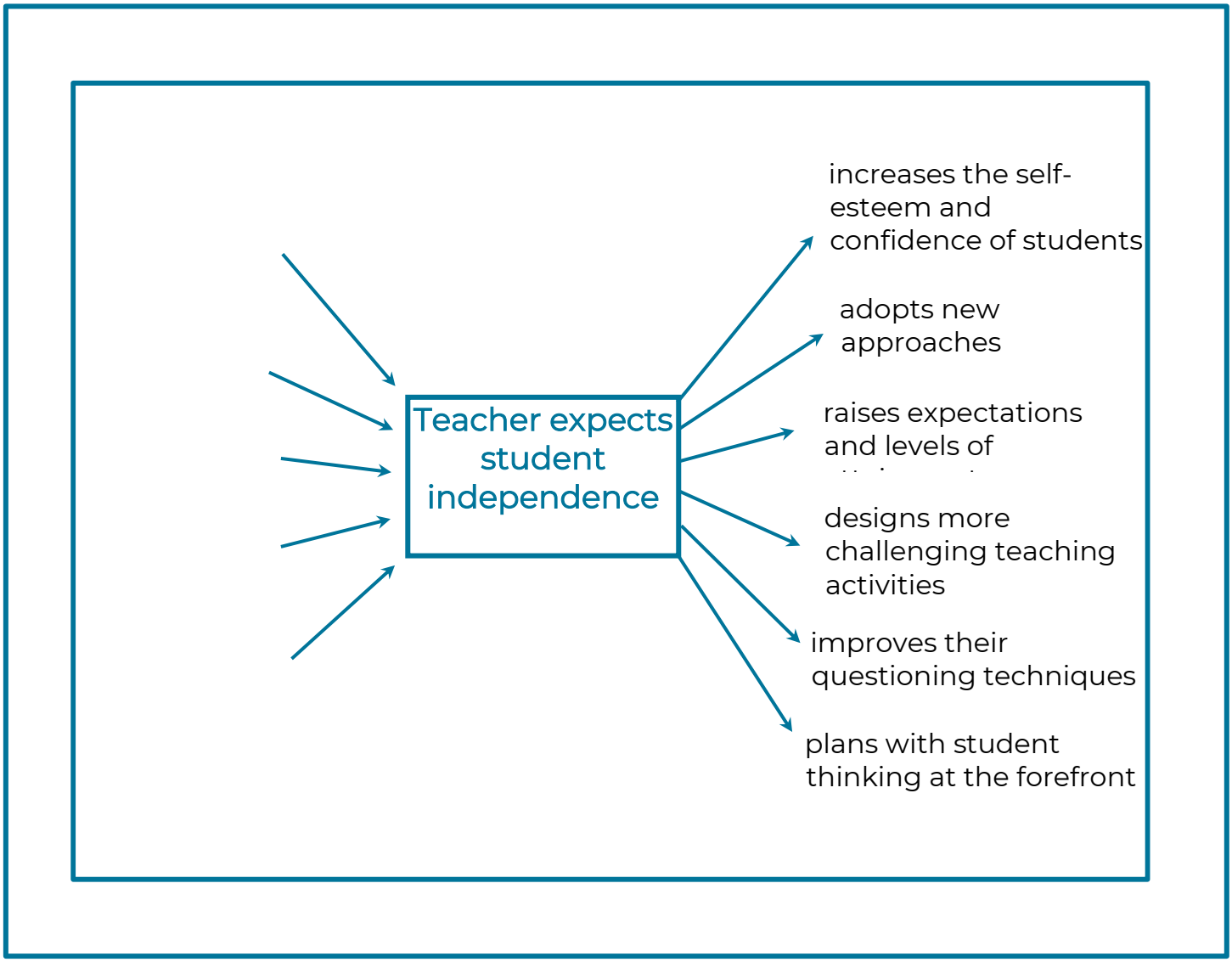
TASK: What would an individual student have to do for herself/himself in order to achieve these outcomes?



Reflective Lens Question

How does this portrait correspond with what the students currently do in your school?

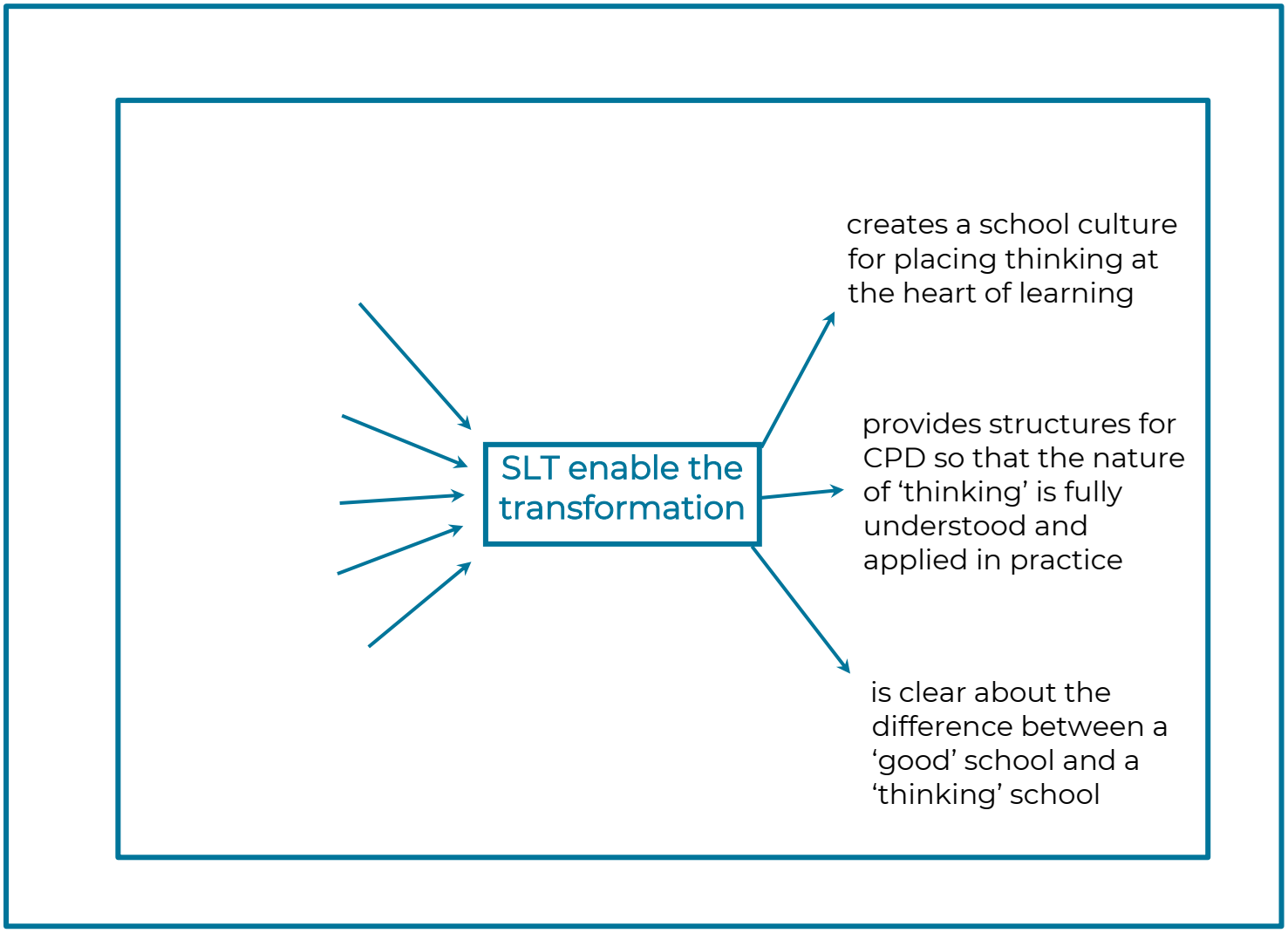
TASK: What would an individual teacher have to do to achieve these outcomes?



Reflective Lens Question

How does this portrait correspond with what the teachers currently do in your school?

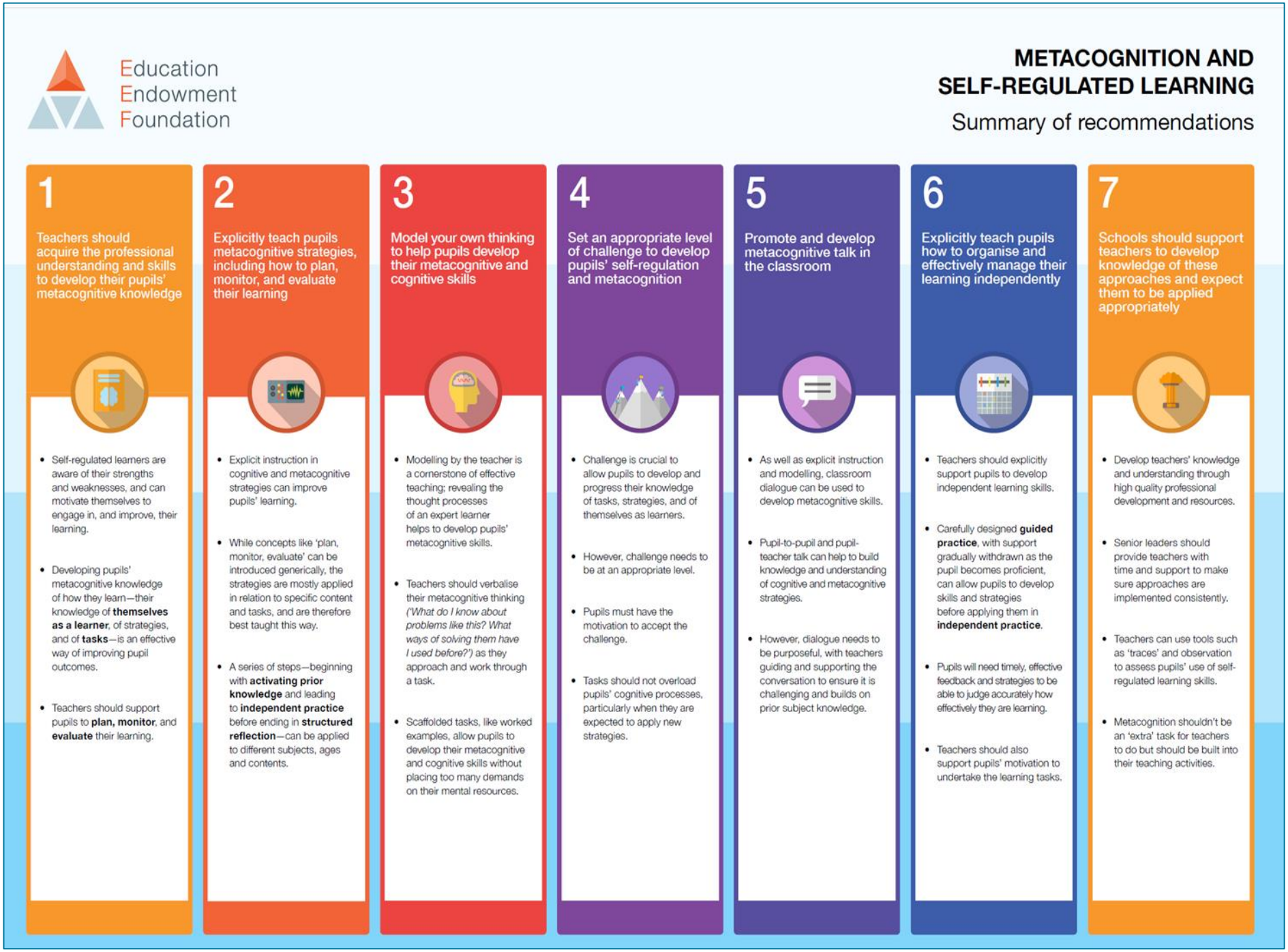
TASK: What would the school leadership team have to do to achieve these outcomes?



Reflective Lens Question

How does this portrait correspond with what the school leaders currently do in your school?

g) Consider the extent to which the recommendations made by the EEF in their Guidance for Metacognition and Self-Regulated Learning might inform the school's journey in becoming a Thinking School.



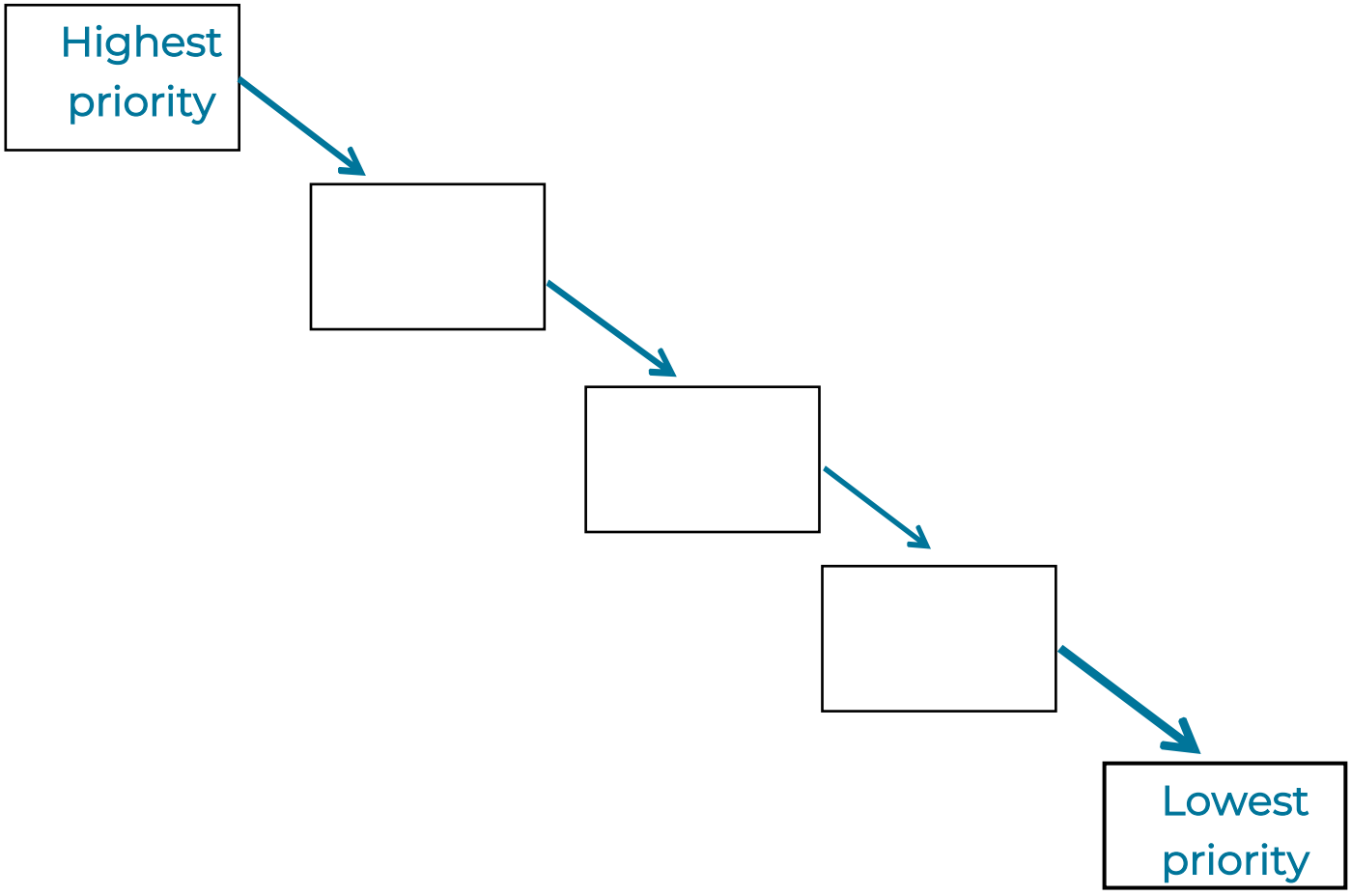
https://educationendowmentfoundation.org.uk/tools/guidance-reports/metacognition-and-self-regulated-learning/

At this stage, what are your priorities?

TASK: Look back over the day and consider the thinking and discussion that took place in each part.

In small groups, devise priorities by creating a sequencing frame from top to bottom showing what you and your colleagues believe the priorities should be. Compare the work of each group.

Write the highest priority at the top followed all the way down to your fourth priority. Each of these priorities is important as it will inform your next actions.



Becoming a Thinking School involves a journey. In our experience schools take several years (on average three) to make a significant difference.

The journey that you may undertake has started today. Thinking Schools that have brought about profound change, to the advantage of their students, give due consideration to the elements that have been covered in this workshop. That is, in summary:

- Why become a Thinking School?
- How to define a Thinking School
- How to approach thinking and learning
- What further and on-going research would benefit the school?

Thinking Matters would advise that this initiative becomes central to school improvement. It will involve a change in both teacher and student practice and behaviour. The DT also avails of specific guidance on how to bring about sustainable change.

Thinking Matters provides on-going support to schools over time. We provide further training to follow on from today, which will be delivered to all staff in the school either by our Consultant or by the Drive Team. The next phase has an explicit focus on whole school strategies and approaches that seek to develop student metacognition. This includes the introduction to fundamental tools that have been proven to make a significant difference to the cognitive capacities and then, after an interval, strategies that seek to deepen and strengthen intelligent learning behaviours and the social and emotional aspects of learning.

Thinking Matters also offers a series of 'Deep Dive Days' that explain more fully aspects of a thinking approach and a thinking curriculum. These are for whole staff or groups of teachers.

For further information, contact Thinking Matters or visit our website www.thinkingmatters.com

APPENDICES:

A. Bloom's Taxonomy

B. Thinking Frames

C. Habits of Mind

D. Thinking Routines

E. The Science of Learning Jigsaw Activity

F. The Drive Team as Agents of Change

G. Reflection

APPENDIX A: Bloom's Taxonomy[17][18]

Benjamin Bloom developed the taxonomy in the 1950s in the United States. It is a hierarchy of six types of thinking, which he believed become progressively more complex and demanding.

Though the 'levels' have increasing complexity, at any age level or at any time within a classroom context a teacher or student may move between different levels. There is no linear sequence required for use of this taxonomy.

In 2001 Lorin Anderson et al made some significant changes to the original taxonomy. Here is the original model with the revised model by Anderson. Notice that the nouns were changed into verbs to reflect the fact that thinking is an active process.

ORIGINAL BLOOM	REVISED BY ANDERSON
EVALUATION	CREATING
SYNTHESIS	EVALUATING
ANALYSIS	ANALYSING
APPLICATION	APPLYING
COMPREHENSION	UNDERSTANDING
KNOWLEDGE	REMEMBERING

There is no intention that the levels move from 'simple' to 'complex'. Indeed, understanding or remembering may involve sophisticated processing skills.

Each of the levels may depend on some or all of the other levels. The taxonomy is, however, accessible to all ages and abilities and draws attention to the kind of thinking that is needed.

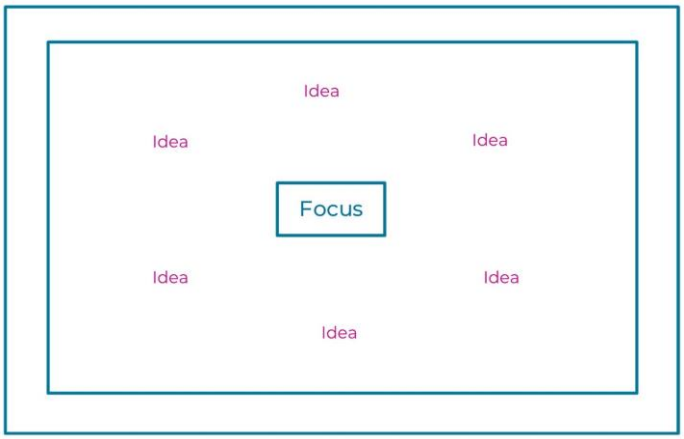
[17] Bloom, B. S. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*. New York: David McKay Co Inc.

[18] Anderson, L. W., and Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

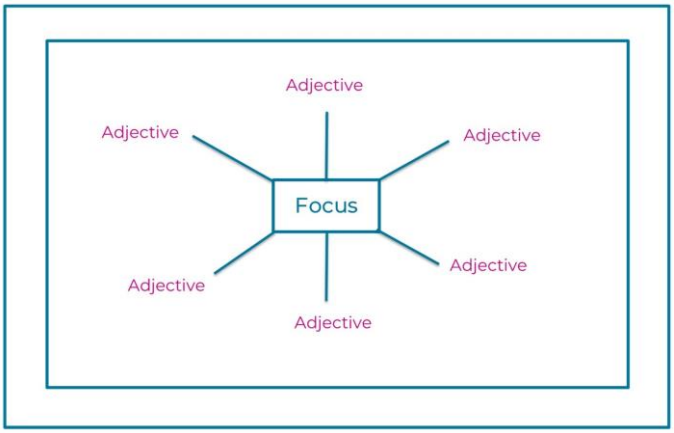
APPENDIX B: Thinking Frames

The eight Thinking Frames are metacognitive visual tools, each of which supports a specific thinking process. They can be used to support student's thinking across all age groups and all subject domains. A Reflective Lens encourages reflective thinking and the asking of higher order, generative and developmental questions.

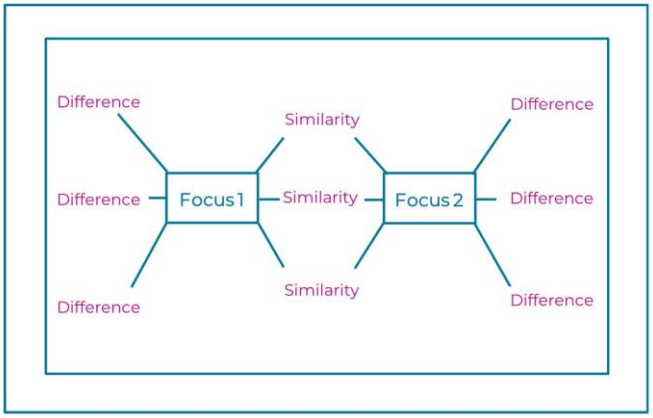
DEFINING



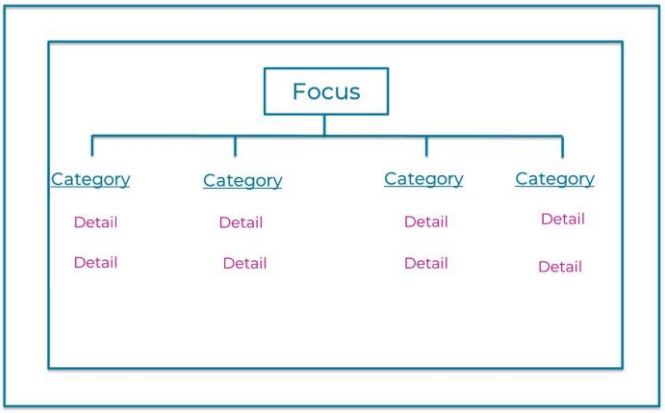
DESCRIBING



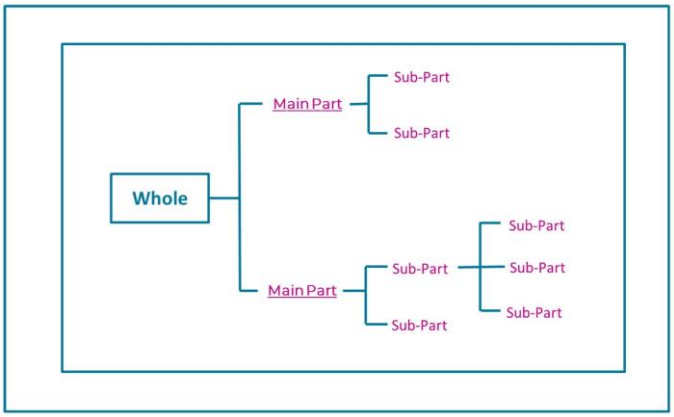
COMPARING CONTRASTING



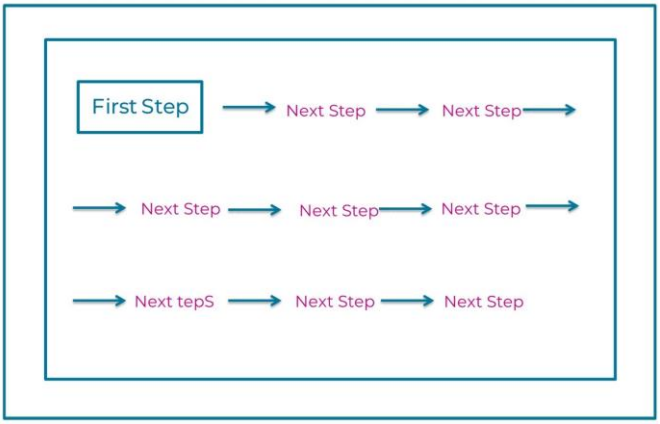
CATEGORISING



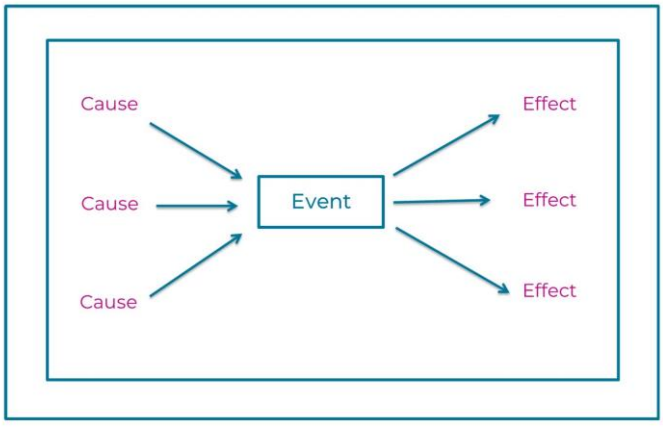
WHOLE PART



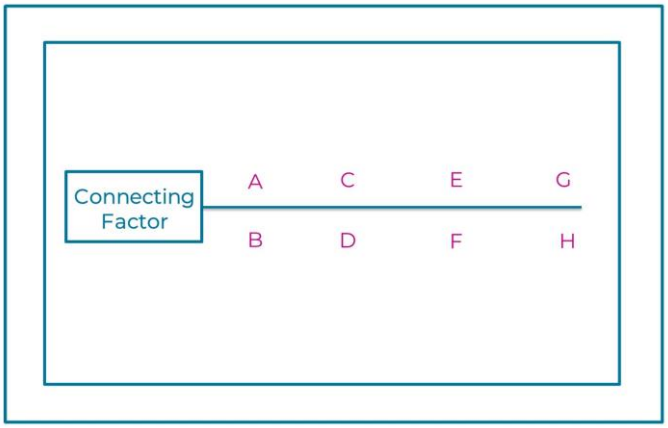
SEQUENCING



CAUSE EFFECT



CONNECTING



APPENDIX C: Habits of Mind[19]

"*Habits of Mind are the characteristics of what intelligent people do when they are confronted with problems, the resolutions of which are not immediately apparent (...) A Habit of Mind is a pattern of intellectual behaviours that leads to productive actions ... It is a composite of many skills, attitudes, cues, past experiences and proclivities ... These Habits of Mind are often used together in clusters of behaviours and used in various situations.*"

(Costa, A. and Kallick, B. (2008) *Learning and Leading with Habits of Mind*.)

Art Costa and Bena Kallick developed this model of 16 'Habits' or 'intelligent behaviours' based on observations of what differentiates more successful from less successful students.

1. Persisting – *Stick to it!*
Persevering in task through to completion; remaining focused.

2. Managing impulsivity – *Take your Time!*
Thinking before acting; remaining calm, thoughtful and deliberative.

3. Listening with understanding and empathy – *Understand Others!*
Devoting mental energy to another person's thoughts and ideas. Make an effort to perceive another's point of view and emotions.

4. Thinking flexibly – *Look at it Another Way!*
Being able to change perspectives, generate alternatives, consider options.

5. Thinking about your thinking (Metacognition) – *Know your knowing!*
Being aware of your own thoughts, strategies, feelings and actions and their effects on others.

6. Striving for accuracy – *Check it again!*
A desire for exactness, fidelity and craftsmanship.

7. Questioning and problem posing – *How do you know?*
Having a questioning attitude; knowing what data are needed and developing questioning strategies to produce those data. Finding problems to solve.

8. Applying past knowledge to new situations – *Use what you Learn!*
Accessing prior knowledge; transferring knowledge beyond the situation in which it was learned.

9. Thinking and communicating with clarity and precision – *Be clear!*
Striving for accurate communication in both written and oral form; avoiding over-generalisations, distortions and deletions.

[19] https://www.habitsofmindinstitute.org

10. Gather data through all senses – *Use your natural pathways!*
Using all the senses – taste, touch, smell, hearing and sight – to garner information.

11. Creating, imagining and innovating –*Try a different way!*
Generating new and novel ideas, fluency, originality.

12. Responding with wonderment and awe – *Have fun figuring it out!*
Finding the world awesome, mysterious and being intrigued with phenomena and beauty.

13. Taking responsible risks – *Venture out!*
Being adventurous; living on the edge of one's competence.

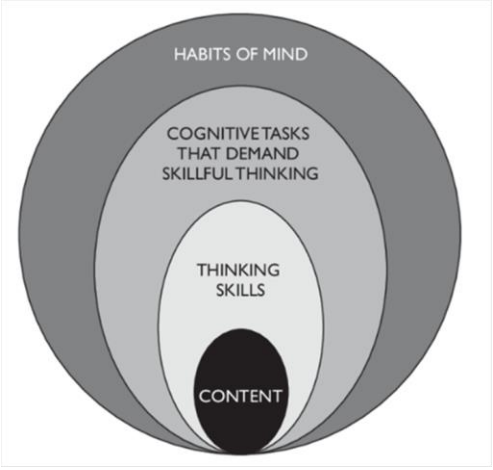
14. Finding humour – *Laugh a little!*
Finding the whimsical, incongruous and unexpected; being able to laugh at oneself.

15. Thinking interdependently – *Work together!*
Being able to work in and learn from others in reciprocal situations.

16. Remaining open to continuous learning – *I have so much more to learn!*
Having humility and pride when admitting we don't know; resisting complacency.

www.habitsofmindinstitute.org

Costa and Kallick's Nested Model



"When educators make decisions about curriculum, instructional methodologies, and assessment strategies, they hold in their minds at least four nested levels of outcomes. Each one is broader and more encompassing than the levels within, and each represents greater authenticity. We might consider these levels to be working like a digital camera in which we can zoom in to any one level or zoom out to get a panoramic view of the whole. Skilful teachers learn to maintain the vision of the whole, or zoom out, as they work in each level simultaneously."

Costa, A. and Kallick, B. (2008).
Learning and Leading with Habits of Mind, p.47.

APPENDIX D: Thinking Routines

Visible Thinking Routines[20] were developed by 'Project Zero', an educational research group at Harvard Graduate School of Education as part of a five-year 'Visible Thinking' project, which sought to explore how to cultivate thinking dispositions in school settings. The routines consist of a few short steps, which scaffold and guide students' thinking and are designed to be woven into a teacher's ongoing classroom practice.

Routines for Introducing and Exploring Ideas

See-Think-Wonder - used for description, interpretation and wondering. Good with ambitious or complex visual stimuli.

Zoom-In - used for description, inference, interpretation. Variation of STW using only portions of an image.

Think-Puzzle-Explore - used for activating prior knowledge, wondering, planning. Good at the beginning of a unit to direct personal or group inquiry and uncover current understandings as well as misconceptions.

Chalk Talk - used for uncovering prior knowledge and ideas, questioning. Open-ended discussion on paper; ensures all voices are heard, gives thinking time.

3-2-1 Bridge - used for activating prior knowledge, questioning, distilling, and connection making through metaphors. Works well when students have prior knowledge but instruction will move it in a new direction. Can be done over extended time like the course of a unit.

Compass Points - used for decision-making and planning, uncovers personal reactions. Solicits the group's ideas and reactions to a proposal, plan or possible decision.

Explanation Game - used for observing details and building explanations. Variations of STW that focus on identifying parts and explaining them in order to build up an understanding of the whole from its parts and their purposes.

Routines for Synthesising and Organising Ideas

Headlines - used for summarising, capturing the heart. Quick summaries of the big ideas or what stands out.

CSI: Colour, Symbol, Image - used for capturing the heart through metaphors. Non-verbal routine that forces visual connections.

---

[20] *Information adapted from:*
Ritchhart, R., Church, M. and Morrison, K. (2011). *Making Thinking Visible: How to Promote Engagement, Understanding, and Independence for All Learners.*
Further information on Visible Thinking and Thinking Routines is available at:
http://www.pz.harvard.edu/projects/visible-thinking
http://www.visiblethinkingpz.org/

Generate-Sort-Connect-Elaborate: Concept Maps - used for uncovering and organising prior knowledge to identify connections. Highlights the thinking steps of making an effective concept map that both organises and reveals one's thinking.

Connect-Extend-Challenge - used for connection making, identifying new ideas, raising questions. Key synthesis moves for dealing with new information in whatever form it might be presented: books, lecture, movie, etc.

The 4 Cs - used for connection making, identifying key concept, raising questions, and considering implications. A text-based routine that helps identifies key points of complex text for discussion. Demands a rich text or book.

Micro-Lab - a protocol used for focused discussion. Can be combined with other routines and used to prompt reflection/discussion.

I Used to Think - used for reflection and metacognition. Used to help learners reflect on how their thinking has shifted and changed over time.

Routines for Digging Deeper into Ideas

What Makes You Say That? - used for reasoning with evidence. Used to help learners reflect on how their thinking has shifted and changed over time.

Circle Viewpoints - used for perspective taking. Identification of perspectives around an issue or problem.

Step Inside - used for perspective taking. Stepping into a position and talking or writing from that perspective to gain a deeper understanding of it.

Red Light, Yellow Light - used for monitoring, identification of bias, raising questions. Used to identify possible errors in reasoning, over-reaching by authors, or areas that need to be questioned.

Claim-Support-Question - used for identifying generalisations and theories, reasoning with evidence, counter arguments. Can be used with text or as a basic structure for mathematical/scientific thinking.

Tug-of-War - used for perspective taking, reasoning, identifying complexities. Identifying and building both sides of an argument or tension/dilemma.

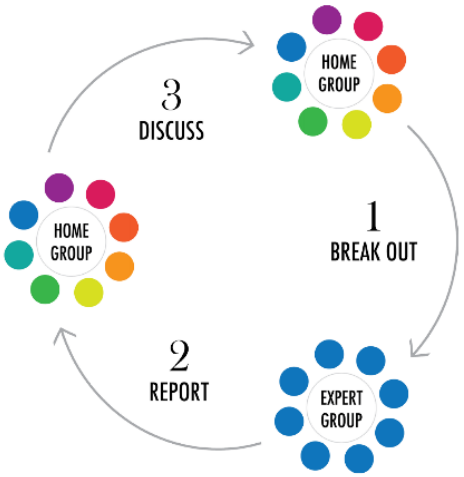
Sentence-Phrase-Word - used for summarising and distilling. Text-based protocol aimed at eliciting what a reader found important or worthwhile. Used with discussion to look at themes and implications.

APPENDIX E: Science of Learning Jigsaw

The Jigsaw Grouping Strategy

The jigsaw technique is designed to promote collaborative learning where students can become 'experts' in a certain area and share that knowledge with their peers. It promotes both self and peer teaching.

The Jigsaw method was designed as a three-step process, invented by Elliot Aronson, an award-winning psychologist, and his graduate students in 1971 in Austin, Texas[21].



When facilitated accurately, it has been identified as a teaching strategy that works effectively for acquiring and consolidating surface and deep learning, e.g. John Hattie's recent update to his list of influences on student learning indicates that the jigsaw approach has an effect size of 1.20.[22]

How to organise the jigsaw activity:

Getting organised
Work out how to divide the class into even-sized 'home" groups. Within each group, allocate each student a number – which they must remember.

Step One
The students then move to be seated with others who have the same number as them – this creates their 'expert' group. Assign each expert group a separate concept, theory or task to master – in the case of this workshop, allocate one of the sections of the Science of Learning content. As a group, they agree the best way each of them will explain their piece of the /puzzle' to their respective home groups.

Step Two
All students return to sit with their home group and appoint a timekeeper who ensures that each student is kept within the agreed time when reporting back. Each student takes turn explaining their part of the jigsaw to their home group.

Step Three
Students return to their expert group to discuss how their section connects with the various pieces of the whole jigsaw and how each part fits in the big picture.

[21] Aronson, E. (2000). *Nobody left to hate: Teaching compassion after Columbine.* New York.
[22] https://visible-learning.org/hattie-ranking-influences-effect-sizes-learning-achievement/

APPENDIX E1: Neuroplasticity

Neuroplasticity, Neurons and Good Neural Conditions

Developments in neuroscience in the last 15 years have demonstrated that the brain is 'plastic'[23] and that it has the ability to change, at any age and can develop in order to be used more effectively[24]. Our experiences cause the modification and creation of new neural networks. Whilst scientists admit there is still a huge amount to discover about the human brain, it is important for an aspiring Cognitive Coach to know, at least at a basic level, how neuroplasticity occurs. Knowing this enables the Cognitive Coach to identify the best ways to deliver information to help ourselves and those we teach, learn and think more effectively.

Neurons are specialised cells that receive, process and transmit information from our senses through our central nervous system to the various parts of our brain. Neurons receive and transmit chemical and electrical signals (messages) from and to other adjacent neurons.

When a message to the brain is new, the electrical signal is weak. If the message repeats – i.e. the information is the same or similar – then the signal strength increases and the ease with which the signal will be passed to the next neuron in the chain improves. Every time the same information comes down that 'neural pathway' the quality of the path along which the signal travels also improves. Through regular use (repetition of the information) the link becomes stronger. Without use, the signal weakens. Imagine a footpath in a jungle that, with increased traffic, becomes a road and then a superhighway. Then imagine it without traffic when the jungle reclaims the ground and the pathway is lost[25].

Repetition or rehearsal strengthens neural pathways most effectively where experiences utilise multi-sensory or different modes of learning, or stimulate using a variety of the senses, enabling students to construct a more flexible understanding of the idea or concept that is being taught. The more a particular pathway is used the more easily the information it carries can be accessed by other parts of the pathway network. Strong, well-used pathways improve the likelihood of the information they carry being accessed by different areas of the brain network and enable 'whole brain' connections.[26]

How Information can be Reinforced

With our understanding of neurons and the creation of strong neural pathways it is no surprise to discover that, if one seeks to embed new information in the memory, a core element of the learning approach should be to reinforce the information regularly over a period of time. If, for example, we learn new

[23] Costandi, M. (2016). *Neuroplasticity.* Massachusetts Institute of Technology.
[24] Helmstetter, S. (2014). *The Power of Neuroplasticity.* Park Avenue Press..
[25] Oakley, B. Sejnowski, T. and McConville, A. (2018). *Learning How to Learn*. New York.
[26] Siegel, D. and Payne Bryson, T. (2011). *The Whole Brain Child*. New York.

information on Monday then we should reinforce it on Tuesday, then again on say Thursday, then again on Saturday. By the following Monday, the information will be far more embedded in the memory than if it had been received just once.

To ensure information stays fixed over time we should continue to recall it periodically, preferably in different contexts and ways, in order to maintain a particular neural pathway. You will hear about this from your colleagues studying the *Jigsaw* piece on memory. Using regular repetition in practice is called *Spaced or Distributed Practice*.[27] Using Spaced Recall is proven[28] to be more effective for retaining information than the massed practice of trying to 'cram' information in one sitting – especially at the expense of sleep.[29] Knowledge and the use of Distributed Practice is, therefore, a core element of the effective Cognitive Coach's toolbox.

Good Neural Conditions

If we want our neurons and neural pathways to function optimally (i.e. to promote positive neuroplasticity), we need to ensure that we provide the best conditions for them to do so.

- *Sleep*

  Sleep is arguably the most important element in allowing our cognitive capability to develop[30].

  At one end of a neuron is a set of 'legs' known as dendrites. Along each dendrite are nodules known as dendritic spines. These are an important part of the connective circuitry of the neural pathway, as it is through these spines that a signal from a neighbouring neuron is accepted and a connection is made. When a new piece of information is absorbed during the day it causes a dendritic spine to emerge on the dendrite.

  When we sleep, the brain rehearses what we have learnt during the day. So, during sleep, electrical signals continue to travel the same neural routes they did during the day. Sleep enables the repetition of electrical signals through the newly formed dendritic bud, allowing it to strengthen and grow into a fully-fledged spine[31]. An absence of sleep ensures the spine, and with it the messaging it carries, withers and dies. To allow learning that has taken place during the day to be reinforced, we need sleep and plenty of it. The amount of sleep we need varies with individuals but a minimum of eight hours for adults and twelve hours in young children is a good rule of thumb. The sleep, however, needs to be of the right type. Stimulants like caffeine or alcohol do

[27] Baddeley, A. and Longman, D. J. A. (1978). *The influence of length and frequency on training sessions on the rate of learning to type*. Ergonomics, 21:8, 627-635, DOI: 10.1080/00140137808931764
[28] Schutte, G. et al. (2015). 'A Comparative Analysis of Massed vs. Distributed Practice on Basic Math Fact Fluency Growth Rates'. Journal of School Psychology Volume 53, Issue 2, April 2015, https://www.sciencedirect.com/science/article/pii/S0022440514001034
[29] Bloom, K.C. and Shuell, T.J. (2014). 'Effects of Massed and Distributed Practice on the Learning and Retention of Second-Language Vocabulary'. The Journal of Educational Research, Dec 2014 https://www.tandfonline.com/doi/abs/10.1080/00220671.1981.10885317
[30] Walker, M. (2017). *Why We Sleep. The New Science of Sleep and Dreams*. Penguin Random House UK.
[31] Yang, G. et al. (2014). 'Sleep branch specific formation of dendritic spines after learning'. Science, 2014 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4447313/

not allow for the deep sleep required to enable signal rehearsals, which in turn allow dendritic buds to grow and form spines.

Sleep also allows information learned during the day to be transferred from the neurons of the hippocampus, which is strongly linked to working memory, to the cerebral cortex – the outer layer of the brain and the home of long-term memory. So, sleep not only helps build new synaptic connections – the dendritic spines – it also clears out the hippocampus and makes room for new learning.

- ***Exercise***

  There are well-established benefits of physical fitness and exercise on brain health and cognitive function, including even almost immediate effects[32], e.g. two 3-minute sprints improve subsequent memory in short-, medium- and long-term. New neurons associated with memory are created in the hippocampus every day.

  The benefits of exercise on attention have been indicated through changes in human brain structure and function, where studies[33] have found that fit individuals show better attention control and more efficient use of the *anterior cingulate cortex*, a primitive brain region which is involved in staying on task, focusing attention and ignoring distracting information.

  Exercise helps these new neurons to grow strong and healthy.[34] When one exercises, the brain makes a chemical called *Brain Derived Neurotrophic Factor* (BDNF) and this acts as a 'fertilizer' to young hippocampal neurons. BDNF allows young neuron synapses and dendritic spines to grow larger and makes them more likely to connect to other neurons. By exercising (120 minutes a week of regular aerobic[35]) we provide better conditions for our neuron growth, neuroplasticity and, therefore, our cognitive capability.

  The aspect of cognition most regularly shown to be influenced by exercise is 'executive function', which includes things like focused attention and switching between tasks.[36] Difficult executive function tasks have been shown to improve in sedentary school children who engage in a programme of exercise, with more improvement the more exercise done[37].

- ***Diet***

  Increasingly, science shows that diet has an impact on children's learning and that certain foods are of specific benefit to brain development and others are

[32] Colcombe, S. J., Kramer, A. F., Erikson, K. I., Scalf, P., McAuley, E. Cohen, N. J., Webb, A., Jerome, G. J., Marquez, D. X., and Elavsky, S. (2004). 'Cardiovascular fitness, cortical plasticity, and aging'. Proceedings of the National Academy of Sciences Mar 2004, 101 (9) 3316-3321; DOI: 10.1073/pnas.0400266101
[33]. Colcombe, S.J. et al. (2004) as above
[34] Van Praag, H. et al. (1999). *Running Enhances Neurogenesis, Learning and Long-term Potential in Mice*. PNAS 1999.
[35] Ten Brinke, L. (2015). *Aerobic exercise increases hippocampal volume in older women with probable mild cognitive impairment*. BMJ Volume 9 Issue 40, 2015.
[36]Diamond, A., and Lee, K. (2011). 'Interventions shown to aid executive function development in children'. Science 333,959-964. doi:10.1126/science.1204529. p.259..
[37]Diamond, A., and Lee, K. (2011). 'Interventions shown to aid executive function development in children'. Science 333,959-964. doi:10.1126/science.1204529. p.259..

equally detrimental to neuroplasticity[38]. The good brain 'foods' such as Omega 3 fatty acids (found in oily fish) help signal transduction at the neural synapse (the tiny gap across which signals are passed between neurons) and are shown to have a positive impact on the health of the myelin sheath – an insulator that covers the body of a neuron and influences the speed at which signals can travel along it.

Adolescence

During the critical stage of adolescence, at the commencement of puberty, young people generally experience significant changes which may impact on their learning and behaviour.

Whilst the brain continues to develop beyond puberty, MRI scans have indicated an increase in white matter and decrease in grey matter on the brain during puberty. This is the result of extensive 'pruning' of weaker neural pathways coupled with an increase in 'myelination', which insulates neurons to make signals travel faster, especially in the brain's frontal lobes, reflecting potential for increased capacity to learn.

The limbic system typically reaches adult levels of development by adolescence, however, parts of the prefrontal and parietal cortices, which deal with reasoning, decision-making and empathy are generally the last area to mature at approximately 25-30 years old. This remodelling of the brain, along with hormonal changes experienced during adolescence, contribute to common changes in behaviour observed such as changes to sleep patterns, peer influence, levels of motivation and attitudes to risk taking[39].

[38] Mosconi, L. (2018). *Brain Food, The Surprising Science of Eating for Cognitive Power*. New York.
[39] Blakemore, S-J. (2018). Inventing Ourselves: The Secret Life of the Teenage Brain. New York.

Prompts for Practice

- ✓ Opportunities for students to learn about relevant and age-appropriate aspects of the Science of Learning can be embedded within the curriculum as discrete lessons, e.g. as part of Personal, Social Emotional Development or Science areas of learning, and can usefully be infused within study skills/exam preparation programmes at the post-primary phase. An effective Cognitive Coach will also use the language of the Science of Learning as part of normal classroom discourse.

- ✓ Classroom routines and lessons may be adapted to explicitly reflect an understanding of relevant aspects of the Science for Learning, such as building on prior knowledge, regular review opportunities, providing effective feedback, timetabling and lesson structure.

- ✓ Schools may reinforce the importance of a healthy diet and exercise in supporting healthy brain functioning by, for example, involving the school meals staff and students in menu design and/or involving parents in consideration of suitable snack and packed lunch provision. Home Economics and PE specialists within the school staff may also contribute to ideas to promote healthy eating, exercise and movement within the school day and in extra-curricular activities as well as raising awareness of the contribution of diet and physical activity to brain health.

- ✓ Post-primary schools may consider the potential for changing timing of the school day to facilitate the need for different sleep periods of young people at the adolescent phase. Consideration may be given to how young people might be better informed about the impact of neural changes during adolescence and how the school culture and routines may offer sensitive support during this phase.

- ✓ An appreciation of many aspects of the Science of Learning may also be helpful for parents/carers. Relevant information and advice can be included within ongoing parental communication and schools may facilitate bespoke workshops for parents.

APPENDIX E2: Memory

We have three basic types of memory[40]:

1. Sensory
2. Working (of which Short-Term Memory is a part)
3. Long-Term

1. Sensory Memory stores inputs from our various senses for incredibly short periods of time. Depending on the modality through which information comes, our sensory memory will last anything from milliseconds if it is iconic (visual) to 5 seconds if it is echoic (auditory), once the original stimulus has ceased. Information taken in via sensory memory is immediately, without being manipulated, transferred into our short-term (working) memory. There is often a significant loss of information during this transfer due to the limited storage capacity within short-term memory. Once in short-term memory sensory information can be further encoded and stored in our long-term memory.

2. Working Memory (WM) is where information from our sensory memory is stored but it is also to where information retrieved from long-term memory is moved in order to be used. WM and short-term memory are terms that are often used interchangeably, but there is a distinction. Short-term memory can be seen as purely a short-term store of information (only for up to 30 seconds) whereas WM, whilst also part of that short-term store, actually utilises the information. WM can therefore be thought of as the information upon which we are concentrating and actively working on at a particular time. Trying to fit too many chunks (pieces of information, instructions, new concepts, etc.) into working memory, causes some of those things to 'fall away' (see *'Cognitive Overload'*).

The number of chunks that can be stored in WM is dependent on their complexity (see 'Schema'), the age of the person involved and the research you read! For a typical adult the number of items that can be stored in WM is between 4 and 9[41]. In young children this number can be much smaller (3 is not unusual) but the range in both adults and children can be wide[42]. WM improves with age in young children and then plateaus during adolescence. WM capability is shown to have strong correlation to Maths and English attainment in primary and secondary age children.[43]

3. Long-Term Memory (LTM) As far as we currently understand the capacity of LTM is unlimited so the constraint on our recall of distant events is about accessibility not availability. The information stored in our LTM can last as long as

[40] Baddely, A. (2007). *Working memory, thought & action.* Oxford. Oxford University Press.
[41] Miller, G.A. (1956). *The magical number seven plus or minus two: some limits on our capacity for processing information".* Psychol Rev. 63 (2): 81–97.
[42] Cowan, N. (2001). *The magical number 4 in short-term memory: a reconsideration of mental storage capacity*. Behav Brain Sci. 24 (1): 87–114, discussion 114–85.
[43] Gatherole et al. (2004). *Working memory skills and educational attainment: evidence from national curriculum assessments at 7 and 14 years of age.* Journal of Applied Cognitive Psychology.

a lifetime. It is typically broken down by psychologists and scientists into two sub-categories – *Implicit* and *Explicit* memory.

1. Implicit memory includes unconscious memories such as skills. Implicit memory is largely considered 'procedural' because the skills and tasks it contains are carried out without having to be re-learnt each time e.g. changing gear whilst driving a car.

2. Explicit memory involves the conscious, intentional recollection of factual information, experiences and concepts, e.g. that a gear stick is called a 'gear stick' or the recollection of a particular driving lesson or the moment a driving test was passed.

Explicit memory can be divided into three sub-categories (although there is also much debate as to whether each of these merits their own sub-categories):

- Episodic memory, which can last up to several days and relates to details of particular experiences, e.g. where in the street a car was parked.
- Semantic memory, which can last a lifetime if used frequently, i.e. with regular recall and reinforcement, and which relates to facts and knowledge, e.g. London is the capital of England.
- Autobiographical memory, which can also last a lifetime and relates to significant events and facts of importance, e.g. a birthday or wedding.

Cognitive Load Theory[44] suggests information is stored in long-term memory in the form of 'schemas'; and that processing new information results in 'cognitive load' on working memory which can affect learning outcomes.

Schemas – a schema organises elements of information according to how they will be used. According to schema theory, skilled performance is developed through building ever greater numbers of increasingly complex schemas by combining elements of lower level schemas into higher level schemas. There is no limit to how complex schemas can become.

An important process in schema construction is automation, whereby information can be processed automatically with minimal conscious effort. Automaticity occurs after extensive practice.

Schemas provide a number of important functions that are relevant to learning. First, they provide a system for organising and storing knowledge in long-term memory. Second, and crucially for cognitive load theory, they reduce working memory load. This is because, although there are a limited number of 'chunks' that can be held in working memory at one time, a schema constitutes only a single chunk. In this way, a high-level schema – with potentially infinite informational complexity – can effectively bypass the limits of working memory.

[44] Cognitive load theory: Research that teachers really need to understand. New South Wales Centre for Education Statistics and Evaluation. September 2017. https://www.cese.nsw.gov.au/images/stories/PDF/cognitive-load-theory-VR_AA3.pdf

Learning to read is a good example of schema construction and automation. Children begin to learn to read by constructing schemas for squiggles on a page – letters. These simple schemas for letters are used to construct higher order schemas when they are combined into words. The schemas for words, in turn, are combined into higher order schemas for phrases and sentences. This process of ever more complex schema construction eventually allows readers to scan a page filled with squiggles and deduce meaning from it. With extensive practice, readers can derive meaning from print with minimal conscious effort

Cognitive Overload

If working memory is overloaded, there is a greater risk that the content being taught will not be understood by the learner, will be misinterpreted or confused, will not be effectively encoded in long-term memory and that learning will be slowed down[45]. There may be additional consequences such as inattentive behaviour and learner confidence being diminished.

Encoding Information for Easier Retrieval [46]

It is important when providing information to understand that:

1. We all have different working memory capability;
2. That young learners have lower working memory capacity than teenagers or adults;
3. That young learners have not yet had time to develop complex schema and as a consequence even simple information, because it is new, is taking up valuable and extremely limited working memory.

Some of the limitations of working memory can be overcome by schema construction and automation. By way of example, try to remember the following combination of letters: y-m-r-e-o-m. In this case each letter constitutes one item, so you are being required to remember six items at once. Now try to remember the following combination of letters: m-e-m-o-r-y. In this case you are still required to remember the very same six items. However, because you have a schema in your long-term memory for the word 'memory', you are able to chunk the letters into just one item. Now your working memory is freed up to remember other items.

So far, methods of improving working memory capacity are not proving conclusive. Fortunately, methods by which we can encode information into and retrieve from long-term memory have shown positive results.

Some other effective ways of enabling students to remember information by both encoding into and retrieving from long-term memory follow.

[45] Martin, A. (2016). *Using Load Reduction Instruction (LRI) to boost motivation and engagement*. British Psychological Society, Leicester UK.
[46] Gathercole S.E. and Alloway T.P. (2008). *Working memory and learning: A practical guide for teachers*. Sage Publishing.

Prompts for Practice

Strategies for Improving Imprinting and Recall from Long Term Memory[47]

When trying to imprint and recall content:

- ✓ **Spaced**
  If we want to absorb new learning, we should embed it into our long-term memory by reinforcing it regularly over a period of time not by trying to cram it in at one go. This should be interspaced with quality sleep.
- ✓ **Make it Personal**
  Content and ideas need to be tailored to the learner(s) and their collective experiences, interests or 'worlds'. Learners can be encouraged to make material as personal as possible, thereby engaging with their autobiographical memory. When personalising learning, the autobiographical memory is engaged, and creativity is encouraged. In some schools this is known as 'self-referencing'.
- ✓ **Pictures and Dual Coding**
  Whilst contested, there is evidence that backs up The Picture Superiority Effect[48] that is closely linked to Dual Coding Theory[49] i.e. that images are more likely to be remembered than words because they generate a verbal and image code rather than just a verbal one. Looking at and particularly enabling learners to make their own images of information that they are seeking to remember helps them to better capture key ideas. The more fantastical, and the brighter the picture, the better. Movement in an image is also said to help encode and recall information.
- ✓ **Metaphors and Analogies**
  These are ways of creating pictures or words with which learners will already be familiar. When new concepts are linked to the already familiar, existing neural pathways are used over again and benefit from the strength already existing in those pathways.
- ✓ **Active Recall**
  Active recall requires a learner to recall information and re-use neural pathways thus reinforcing those links within the brain. By reaching into memory and recalling information the pathway is strengthened significantly. Active Recall can also be divided into different sub-categories:
  - **Teaching Others the Material one wants to Learn or Understand oneself**
    Evidence suggests there are fewer more powerful ways to embed understanding than teaching a concept or topic to someone else. This is prime active recall. Not only does the teacher have to recall the

[47] Abrams, H.N. (2018). *Remember It.*, Nelson Dellis.
[48] Hockley, W. E. (2008). 'The picture superiority effect in associative recognition'. Memory and Cognition. 36 (7): 1351–1359. doi:10.3758/MC.36.7.1351. PMID 18927048..
[49] Paivio, A. (1986). *Mental Representations: a Dual Coding Approach*. Oxford. England: Oxford University Press.

information they wish to teach but in order to deliver it they have to draw on multiple parts of the brain.

- **Testing** (e.g. self- testing, spot testing, class testing)
  Any of these are ways to recall information, thus strengthening a neural pathway. Encouraging independent learners to test themselves frequently helps embed information.
- **Questioning**
  Effective questions can require us to do more than recall and start processing and using information. This helps us to move what is in our working memory to our long-term memory.

✓ **The 'Worked Example'**

A worked example is a problem that has already been solved for the learner, with every step fully explained and clearly shown. It has been found that giving worked examples to novice learners to study perform better on subsequent tests than learners who are required to solve the equivalent problems themselves[50]. According to Cognitive Load Theory, this "unguided problem-solving places a heavy burden on working memory, inhibiting the ability of the learner to transfer the information into their long-term memory. The learner may effectively solve the problem, but because their working memory was overloaded, they may not recognise and remember the rule that would allow them to quickly solve the same problem again in the future."[51]

✓ **The 'Expertise Reversal Effect'**

The is an important exception to the worked example effect in which the heavy use of worked examples becomes less effective as learners' expertise increases, eventually becoming redundant or counter-productive to learning outcomes[52]. Cognitive load theory supports fully guided instruction such as worked examples for novice learners, whereas expert learners require incorporation of more independent problem-solving tasks.

✓ **The 'Redundancy Effect'**

Providing students with unnecessary information that is not directly relevant to learning, or with the same information in multiple forms, can overload working memory and inhibit learning. The effective Cognitive Coach therefore is likely to avoid needlessly repeating information, e.g. using a PowerPoint presentation in which the presenter reads the text on the screen.[53]

---

[50] Carroll, W. M., (1994). 'Using worked examples as an instructional support in the algebra classroom'. *J. Educ. Psychol.*, 86, 360–367; Cooper, G., and Sweller, J. (1987). 'The effects of schema acquisition and rule automation on mathematical problem solving transfer'. *Journal of Educational Psychology, 79*, 347–362; Sweller, J., and Cooper, G. A. (1985). 'The use of worked examples as a substitute for problem solving in learning algebra'. *Cognition and Instruction, 2*, 59–89.

[51] https://www.cese.nsw.gov.au/images/stories/PDF/cognitive-load-theory-VR_AA3.pdf

[52] Leslie, K.C., Low, R., Jin, P. *et al.* (2012). 'Redundancy and expertise reversal effects when using educational technology to learn primary school science'. *Education Tech Research Dev* 60, 1–13 (2012); Pachman, M., Sweller, J., and Kalyuga, S. (2013). 'Levels of knowledge and deliberate practice'. *Journal of Experimental Psychology: Applied*, 19, 108-119. (2013); Yeung, A., Jin, P., and Sweller, J. (1998). 'Cognitive load and learner expertise: Split-attention and redundancy effects in reading with explanatory notes'. *Contemporary Educational Psychology*, 23, 1–21.

[53] Sweller, J. (2016), 'Story of a Research Program', *Education Review Summary Article.pdf* p. 8.

APPENDIX E3: Brain Operating Modes

Research[54] has shown that the brain has two basic modes of operating:

1. Focused – in which concentration and absolute attention is given to something specific.

2. Diffuse – in which the mind is not engaged with something specific.

Let us use the analogy of a torch in which the bezel can be twisted to concentrate light into a small bright dot on a wall or twisted the other way to create a less focused, wider light.

When the brain is in focus mode it is similar to the small bright dot. One is in a highly attentive state where the brain is using 'task positive networks' predominantly constrained in the pre-frontal cortex to concentrate on the details of the specific task in hand and exclude all other influences.

In diffuse mode the brain is like the wider, less focused light. It happens when a person's mind is wandering freely and they are doodling, daydreaming, not thinking about anything in particular or are about to nod off. Neuroscientists describe the brain as operating in its 'Default Mode Network' (DMN) when a person is in diffuse mode. In this mode we use a large number of well-spaced out parts of the brain. The relaxed state of the brain allows for a wider neural network to be utilised and, therefore, for more random, bigger picture, 'out of the box' creative thoughts to occur.

It is worth noting that for younger brains still developing, tired brains and those with ADHD the spotlight bezel can be a bit loose. When we try to tighten it into focus mode the bezel can slip more easily into diffuse mode. Focus time is shorter and different teaching strategies are needed to move these brain states back into focused mode.

Barbara Oakley[55] has offered another way of thinking about focused and diffuse modes and uses the analogy of a pinball machine. According to Oakley the pinball (an idea) is pinged into the pinball machine (the brain). In focused mode, the pinball bumpers are tightly packed together, and the idea can only move around in a small area (the pre-frontal cortex). In diffuse mode the bumpers are much wider apart allowing thoughts to travel more freely and draw from other areas of the brain.

Oakley takes the analogy a step further, suggesting that, as the two modes are using two different areas of the brain, it is better to see the two thinking systems as a two-level pinball machine: the focused mode level (with its tightly spaced bumpers) on the top level and the diffuse level (wider spacings) below. The ball starts in the top-level focused zone and stays there for as long as it can be kept

[54] Golland, Y. et al. (2008). 'Data-driven clustering reveals a fundamental subdivision of the human cortex into two global systems'. *Neuropsychologia*. 2008 Jan 31; 46(2):540-53.
[55] Oakley, B. Sejnowski, T. and McConville, A. (2018). *Learning How to Learn*. New York.

there by using the flippers, i.e. concentrating. As soon as the flippers stop – fatigue, distraction, cognitive overload or conscious decision – the ball drops into the diffuse mode zone. This is not a bad thing per se, as in the diffuse mode the idea is being worked on behind the scenes by different parts of the brain. Indeed, Oakley et al suggest regular, conscious use of the diffuse level as it increases the likelihood of making connections and allows for better imagination and creativity.

Whichever analogy (torch or pinball) is preferred, as Cognitive Coaches and independent learners it is important to understand how best to use our knowledge of focused and diffuse thinking so we may think, learn, and coach more effectively.

The Pomodoro Technique

This is a method designed to help make the most of the two thinking modes and exploit the potential of the whole brain. (It is named after a tomato shaped kitchen timer that Francesco Cirillo, inventor of the method, used in his kitchen as a student). The Pomodoro Technique is this.

1. Set the timer for 25 minutes (a time for which we should all be able to focus – though see the comment on reduced timings for those with young, developing brains).
2. Remove all distractions (including electronic devices).
3. Focus for 25 minutes.
4. Stop when the alarm goes.
5. Reward yourself with 5-10 minutes of diffuse time (e.g. napping, daydreaming, exercise).
6. Repeat as necessary.

The technique not only allows us to use the whole brain for thinking, it also allows time for the task positive and default networks to rest and recharge.

There are factors we need to consider with the Pomodoro technique:

- For younger children, 25 minutes focus time may be too long.
- For the diffuse time in Pomodoro to be effective it should be used to do something different from the task of the focus period. Taking the mind off the original task is key.
- There could be a temptation to use an understanding of brain modality to justify spending the whole time napping, daydreaming, exercising etc. rather than arriving at a 'Eureka' moment. Not recommended if you want to get things done!

It is, of course, no surprise that Archimedes developed his volume displacement theory, his *Eureka!* moment, in the bath. Showers and bath times provide excellent prime diffuse thinking opportunities as do exercises such as jogging and dancing. It is also little wonder that Salvador Dali and Thomas Edison used to seek creative moments by taking regular naps. They would do so with keys or

ball-bearings in their hands. When the objects fell out of their grasp they would wake, knowing that they had given themselves the best opportunity to create an idea. We now understand this strategy was allowing them to draw upon the wider range of neural pathways available to their brains in diffuse mode.

It is worth noting that the diffuse mode can also be operating when we are in focused mode. If we cannot solve a difficult task immediately or deal with a question in an exam, we can leave it and revisit it later, knowing that our diffuse brain will continue working on it in the background and may provide the solution when we come back to it later. The Pomodoro technique facilitates the brain's utilisation of our two modes of thinking.

An understanding of memory and modes of thinking reminds Cognitive Coaches that learning opportunities are most productive when they combine short, focused periods of activity with a small number of tasks, thus avoiding cognitive overload and providing for a variety of ways of thinking.

You will hear more about Cognitive Overload, Distributed Practice and the benefits of exercise and sleep on Neuroplasticity from your colleagues who have been looking at these elements in the *Jigsaw* exercise.

Prompts for Practice

- ✓ It is important for the metacognitive student to have knowledge of focused and diffuse modes of thinking. Information on modes of thinking might usefully be included within study skills or exam preparation programmes.
- ✓ Consider how the use of the Pomodoro technique, or the use of timers as prompts, may be utilised to support student's capacity to build attention and maximise study time.
- ✓ An effective Cognitive Coach will recognise opportunities for diffuse thinking through, e.g. infusing brief 'brain breaks' - periods of physical movement or creative activities within lessons.
- ✓ It may also be useful for parents/carers to be aware of focused and diffuse modes of thinking.

APPENDIX E4: The Emotive Brain

In order for metacognitive learners to self-regulate and assess how they might better understand and cope with their emotions, including pressure, it is useful for them to understand the core emotive components of their brain. Cognitive Coaches may recognise the benefits of taking cognisance of this in creating a conducive learning environment and providing appropriate pedagogical support.

In the subcortical structures of the brain, the limbic system (the seat of our emotions) plays a key role in how we respond to incoming information. This part of the brain evolved before the prefrontal cortex (PFC) and many of its functions relate to primitive survival requirements. It primarily controls what might be described as 'basic' human emotions and behaviours: our flight or fight instinctual responses, arousal levels as well as components of memory. The amygdala is particularly relevant to understanding our motivation, as it identifies social rewards and how to attain them, and can associate a stimulus with reward or punishment.

A useful mnemonic for remembering the limbic system's functions relates to the idea that it is the 'CAVE man' part of our brain:

- **C**o-operating with other humans – for optimal hunting and protection.
- **A**ctivity – to only do as much as is needed to preserve precious calories.
- **V**iolence – fight or flight when encountering predators or rivals.
- **E**fficiency – sourcing food, water and warmth.

A metacognitive learner should be aware that their CAVE brain, for sound evolutionary reasons, would have us:

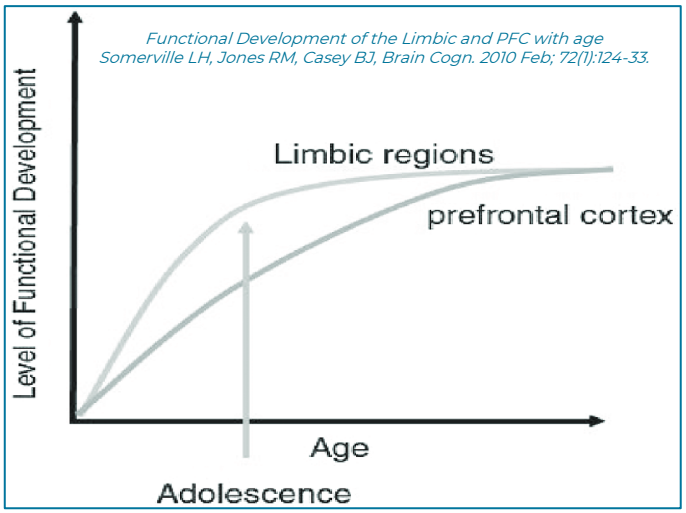
- use physical force if we want something, or to run from it if it looks threatening;
- take the path of least resistance – never doing more than the minimum;
- constantly worry about what others in our group think of us.

Whilst good fundamental *survival* instincts, these may not be particularly helpful habits for the modern, competitive world in which increased complexities (such as communal living and language) are seen as the evolutionary driver of the prefrontal cortex in the great apes, and specifically, *Homo sapiens*[56].

[56] Jeroen B. Smaers, Aida Gómez-Robles, Ashley N. Parks, Chet C. Sherwood *Exceptional Evolutionary Expansion of Prefrontal Cortex in Great Apes and Humans* Current Biology, Volume 27, Issue 10, 22 May 2017, Pages 1549.

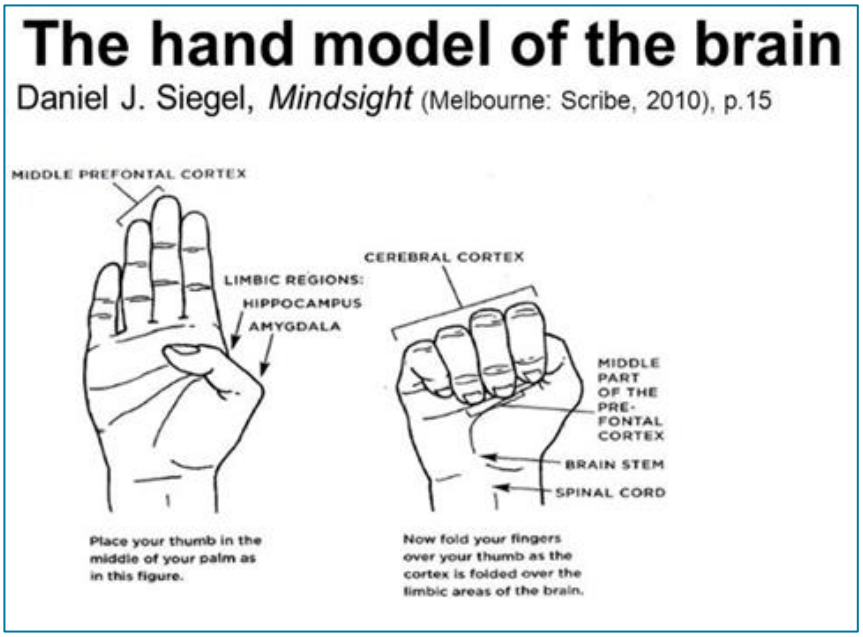
The PFC thus manages more rational analysis, decision-making and action in response to new information. In humans, it develops far later than the limbic system, typically reaching full maturity only when we are in our mid-20s.

Knowing the age profile at which the PFC matures shouldn't offer an excuse for poor behaviour or a lack of self-control, but it should be taken into account by both learner and coach when setting goals, assessing progress and providing feedback. The Cognitive Coach should note the development gap between PFC and limbic region development is at its widest at adolescence.



Research shows that both executive function skills and metacognition (considered the behavioural output of executive functions) can be taught and both have a high, positive impact on both academic results and behaviour regulation[57] [58]. Explicitly developing metacognitive strategies and learner agency is central to the Thinking Matters approach and is covered in more detail in subsequent workshops. Metacognitive learners may benefit from being introduced to some simple analogies to help them visualise how to manage their emotions in learning situations.

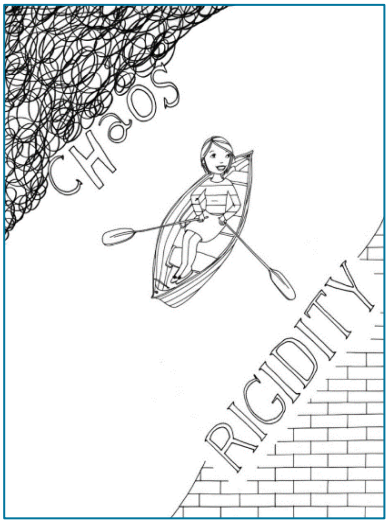
The hand model developed by Dan Siegel[59] in which the two key areas of the prefrontal cortex (PFC) and the limbic system are highlighted provides a simple illustration of this process. In this model, the thumb is a crude representation of the limbic regions, the little finger the PFC. The model can be used to demonstrate how a learner might 'flip their lid[60]' when the fingers of the cortex are blown off by the limbic thumb in the brain fist analogy.



[57] Roebers C.M. Executive Function and Metacognition: Towards a unifying framework of cognitive self-regulation, *Developmental Review*, Volume 45, September 2017, Pages 31-51.
[58] Hattie, J. visiblelearningplus.com (accessed Dec 2017).
[59] https://www.drdansiegel.com/
[60] Siegel, D. https://www.youtube.com/watch?v=G0T_2NNoC68

Continuing the 'cave man' analogy, the PFC could be thought of as representing sophisticated, modern man and the limbic system his ancestral 'cave man' past[61].

Siegel and Bryson's imagery of a canoeist paddling down a river may also be useful here[62]. In the canoeist analogy the learner (canoeist) should be aware that there are sirens constantly beckoning from the CAVE bank (chaos). They should therefore look to keep close to the right, prefrontal bank (rigidity) without getting so close that they run aground by being too rigid!



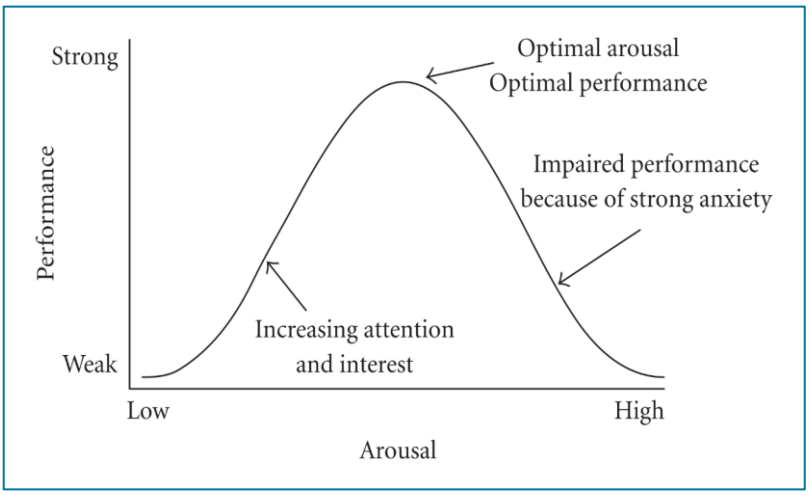
The effective Cognitive Coach seeks to create an environment where making progress on controlling emotions is an explicit goal and where appropriate verbalisation and discussion of emotions is encouraged (rather than suppressed) without fear of reprimand or mockery.

The Mirror Neuron System

This is a group of specialised neurons that 'mirrors' the actions and behaviour of others. Observing an emotion in someone else (e.g. through their expression) activates the brain mechanisms involved with experiencing that emotion ourselves. In other words, when we see someone else express an emotion, our own brains activate the same regions involved with experiencing that emotion[63] [64]. The unconscious workings of our brains can, therefore, help explain how easily negative emotions, such as anxiety about mathematics[65], can be transmitted from teacher to student and how positive teacher attitudes can be linked to higher student achievement[66]

The effects of anxiety, stress and pressure

It may be helpful for the Cognitive Coach to be aware that there is an optimum level of performance and that too much pressure has detrimental consequences on outcomes. The Yerkes-Dodson[67] inverted U model is a useful image to portray this.



[61] Prof Peters, S. (2012). *The Chimp Paradox*, Vermilion.
[62] Siegel, T. and Bryson, D. (2012). *The Whole Brain Child*. Penguin Random House.
[63] Gallese (2003). Psychopathology. 2003 Jul-Aug;36(4):171-80.
[64] Gallesse et al (2007). Journal of the American Psychoanalytic Association 55(1):131-76 · February 2007.
[65] Beilock et al (2010). PNAS February 2, 2010 107 (5) 1860-1863; https://doi.org/10.1073/pnas.0910967107.
[66] Ker (2016). An International Journal of Experimental Educational Psychology', Volume 36, 2016 Issue 2.
[67] Yerkes, R.M. and Dodson, J.D. (1908). "The relation of strength of stimulus to rapidity of habit-formation". *Journal of Comparative Neurology and Psychology*. 18 (5): 459–482. doi:10.1002/cne.920180503.

More specific to those seeking to impart or absorb knowledge and to solve problems is the research that shows the consequences of anxiety on memory and our ability to learn. The area of the brain involved with conscious attention is often referred to as the working memory network (predominantly positioned in the prefrontal cortex). When students become anxious, studies have shown they become less able to sustain activity and access our working memory network, which in turn limits our cognitive ability to solve the problem we are working on and remember the knowledge we are being presented with.[68] [69] [70]

If students are stressed, they won't perform at their best. Lots of things can induce a stress response in the classroom; teacher or parent expectations, an overload of information, the complexity of the task, timed testing (where the time given may be appropriate for one student but not for another), self-consciousness about speaking out in class, fear that reading or writing ability will prevent a task from being completed, noise levels, etc. The skill of a Cognitive Coach is to understand the types of stresses that may be causing a student to underperform and then to address those they can influence. With Deliberate Practice, skill levels can be improved and coping mechanisms for specific stresses can be offered so the task seems less complex to the learner and pressure is therefore lowered.

Pressure often comes from the belief that winning is the target. Those that understand the negative performance effects of pressure should seek to create a common language and culture used by elite performers: The winning, or doing well in an exam or test, is the outcome of being the best that you can be. It is NOT the target.

Elite performers practise in a way that enables them to control what they can control – and not to worry about what they can't[71]. This should be true of any learner faced with any task. The mindset is never to fear a match/exam/test or performance as whatever the result the learner cannot lose. If the result isn't as expected (or the opponent is better) then the learner has still won because they have gained by putting themselves into a position to analyse their performance (and their opponent's in a sporting context) and to use that information to improve for next time. The end result of progress and improvement will be better scores and ultimately the 'win'.

[68] Robinso, O et al. (2013). Published online 2013 May 17. Doi: 10.3389/fnhum.2013.00203
[69] de Quervain et al., Stress and glucocorticoids impair retrieval of long-term spatial memory. Nature, 394, 787-790 (1998).
[70] Kuhlmann, S.; Piel, M.; Wolf, O.T. (2005). "Impaired Memory Retrieval after Psychosocial Stress in Healthy Young Men". *Journal of Neuroscience*. 25(11): 2977–2982.
[71] Wesisinger, H. and Pawliw-Fry, J. (2015). *How to Perform Under Pressure. The science of doing your best when it matters most.* Crown Publishing.

Prompts for Practice

- ✓ For Cognitive Coaches working with young learners and for learners themselves, understanding the interplay between emotion and cognitive processing is crucial knowledge. Th PFC is associated with executive function – the cognitive processes that enable us to respond positively under pressure, to plan, focus, pay attention, choose appropriate behaviour and control our CAVE emotions. This knowledge is likely to be reflected in the culture and in classroom climate and dialogue within a Thinking School.

- ✓ Given the importance of observation and mimicry, how the Cognitive Coach and the whole school culturally deal with emotive situations will have an important bearing on how students believe they should handle their own emotions. Role-modelling, self-regulation and emotional intelligence behaviours are crucial features of the Cognitive Coach's toolbox.

- ✓ Schools may find it helpful to review their positive behaviour policies in light of their understanding of the integration of emotion and cognition, particularly in relation to the use of rewards.

- ✓ Thinking schools seek to create a 'growth mindset' environment where mistakes are welcomed and understood as part of the learning process towards mastery. Common language is important here where failure, if used at all, is reframed with concepts like *FAIL* being the '*First Attempt in Learning*'.

- ✓ Reframing situations, i.e. seeking to see the positives in a situation rather than catastrophising, is one of a multitude of other strategies for managing emotions. Many Thinking Schools explicitly teach students strategies for managing their emotional responses and stress (such as breathing, stretching, mindfulness) and build these into their Personal, Social, Emotional Development curriculum offer.

APPENDIX E5: Deliberate Practice

Deliberate Practice is one of the most powerful performance behaviour methodologies yet evidenced. This concept is more widely known as the 10,000 hours rule, popularised by the writings of Gladwell[72] and Syed[73]. The basic tenet is that:

a) 10,000 hours of practice is all (!) it takes for anyone to become expert.
b) Anyone can become 'expert' whatever their genetic level of innate 'talent'.

Anders Ericsson, the originator of the *Deliberate Practice* concept, qualifies his theory to avoid its over-simplification.[74] He attaches nuance to the *10,000 Hours* so that the number varies considerably depending on the complexity of the skill being developed. Ericsson's main point, however, is that *Deliberate Practice* does not merely comprise 10,000 hours' effort but that the practice itself has to be of the right kind.

The Key Elements of Deliberate Practice

The six key elements of the right type of practice are identified and explained in further detail below:

1. Purposeful

Deliberate Practice is not for those who are happy with 'good enough'. Deliberate Practice is structured, with well-defined, specific goals for self-improvement above and beyond what might be believed possible.

2. Focused Micro-mastery

Deliberate Practice requires connecting well thought-through 'baby steps' to reach a clear long-term goal. The concept of micro-mastery[75] – a self-contained unit of doing, complete in itself but connected to a greater field – is key here. Micro-mastery is a 'small challenge' that can be perfected reasonably easily and allows for a quick win. If repeated it provides a stepping-stone, towards the wider goal and once perfected the learner is more motivated to move on to the next micro step.

The small 'quick win' provided by *micro-mastery* is important from the brain's perspective because the anticipation of the win produces the neurotransmitter chemical dopamine and dopamine increases the learner's desire to continue the learning process. Part of micro-mastery is the concept of using Distributed or Spaced Practice (short, well-spaced time periods of practice) over massed (long, large blocks) practice.

[72] Gladwell, M. (2008). *Outliers. The Story of Success*. Little, Brown and Company.
[73] Syed, M. (2010). *Bounce. The Myth of talent and the Power of Practice.* Harper Collins.
[74] Ericsson, A. and Pool, R. (2016). *Peak. How all of us can achieve extraordinary things*. Vintage.
[75] Twigger, R. (2017). *Micromastery.* Penguin.

3. Feedback

In Deliberate Practice the learner and the coach have to know whether or not the approach they are taking is working and the learner is moving closer towards achieving the goal. John Hattie's[76] work in this field demonstrates how feedback is one of the most significant influences on attainment. Ericsson stated that feedback should be specific to the micro-mastery level and should be analytical, criteria-based and welcomed by the learner.

4. Expert Input

Feedback requires expert input. Ericsson's true definition of Deliberate Practice is that it can only take place in a field where there is already defined expertise. Getting input from an expert, either through them having achieved expertise themselves in that field or through their expertise in coaching is crucial. Both the coaching skill and subject knowledge of the Cognitive Coach are therefore key in nurturing student metacognition.[77]

5. Being Stretched

The human body is designed for homeostasis or stability. It is constantly seeking equilibrium, monitoring and re-adjusting itself continuously so, for example, its heart rate and temperature are as they should be. This happens not only in the major organs but also in single cells which similarly balance and rebalance themselves in order to remain in stasis.

Research shows that if people gradually move themselves out of their comfort zones, after a while their bodies will see the *stretch* position as the 'new normal' and adjust to it by switching on elements of DNA that have been lying dormant.[78] Think of the jogger whose body encounters low levels of oxygen in the capillaries that supply tiring leg muscles. The body registers that the legs need more oxygen and responds by creating new capillaries. More oxygen is therefore supplied to the leg muscles so returning them to the comfort zone. Homeostasis achieved, body happy and now better equipped for running.

What is true of the body is also largely true of the brain. Under challenge, in its stretch zone the brain will reshape and grow to meet that challenge. It does this by strengthening the connections between neurons related to the specific task being challenged.

To keep positive change happening it is necessary to keep 'upping the ante', but not too fast and not too far. The key in managing the upgrade is to find a perfect 'sweet spot' outside, but not too far outside, the comfort zone, or the Zone of Proximal Development (Vygotsky).

Deliberate Practice is about *not* being comfortable with 'good enough', about

[76] Hattie, J. and Clarke, S. (2018). *Visible Learning Feedback.* Corwin Press.
[77] Didau, D. and Rose, N.(2016). *What every teacher needs to know about psychology..* John Catt Publishing.
[78] Carson et al. (2002). *Differential gene expression in the rat soleus muscle during early work overload-induced hypertrophy.* FASEB Journal 6, no 2 (2002) 207-209.

resetting our understanding of our own capability, about pushing ourselves out of our comfort zone so that our bodies and brains have to rebalance at a higher level. The Cognitive Coach might consider how we best challenge homeostasis in order to develop full metacognitive capability of students.

Being stretched involves:

a. Actively seeking mistakes – Learners using Deliberate Practice recognise that the stretch zone is, by nature, not an easy or comfortable place within which to operate. They will want to optimise their potential by designing their practice routines to actively create mistakes, as this stretches them to move out of their comfort zones. The skill of the learner, and of their Cognitive Coach, is to identify those mistakes and to reflect on and analyse why they happened and how they can be overcome. Mistakes therefore provide opportunities to learn and improve. Cognitive Coaches seek to create environments and a 'mindset' in their classroom where mistakes and errors are viewed as learning opportunities and an integral aspect of an effective feedback culture.

b. Coping with pressure – In attempting to optimise performance, whether in the context of a Wimbledon final or a class test, pressure is generally regarded as an enemy[79]. Neither too little, nor too much pressure enables us to perform at our best. Part of what operating in the stretch zone enables us to deal with is to become used to dealing with higher levels of pressure. This is in part because stretch practice should be designed to introduce pressure situations as the regular practice we put in embeds skills into our procedural memories so those tasks that were once complex, and therefore more likely to break down under pressure, become 'second nature' and so more robust under pressure, e.g. changing gear in a car.

As learners experience success with different ways of coping with pressure, they deepen understanding that pressure can often come from the belief that winning is the target, and shift perspective toward an appreciation that winning is rather an outcome of being the best that you can be. Elite performers practise in a way that enables them to control what they can control, and not to worry about what they cannot.

Success for a Deliberate Practitioner is founded on having a mindset which does not fear a match/exam/test or performance as, whatever the result, they cannot lose. If the result goes against them, or the opponent is better than them, they will still believe they have 'won' because they have gained by putting themselves into a position to analyse a performance (their own and their opponents) and to utilise that information to inform future improvement.

c. Fresh Thinking Transfer – Another piece of the stretched practice jigsaw is the concept of introducing Fresh Thinking - a way to avoid what psychologists call 'Functional Fixedness'. A risk of Deliberate Practice is that with such a focus on becoming expert in a particular area, our thinking and skill set can become too

[79] Weisinger, H. and Pawliw-Fry, J.P. (2015). *How to Perform Under Pressure, The Science of Doing your best when it matters most.* New York..

narrow. This can result in sending too many signals down the same neural pathway and, as a consequence, rather than it becoming wide and flat and easy to travel on, it can become deep and rutted.

High quality Deliberate Practice should include working on something completely different. The idea behind this is that the shift of focus to a different skill or topic can stimulate fresh ideas which can be usefully transferred, providing the learner approaches the task with a mindset of seeking to learn from it and make connections.[80]

d. Interleaving – Doing big chunks of learning on a single topic before moving on is known as *blocked practice* and functional fixedness is sometimes a consequence of that. Similar to fresh thinking, the concept of interleaving is useful for the Cognitive Coach in order to prevent the blocks to creative thinking that can come from getting too deep into a thinking rut.
At the heart of the concept of interleaved practice is the avoidance of learning or practising a single topic or technique repeatedly. Alternatively, interleaving multiple subjects, topics or techniques forces the brain not only to be actively retrieving information but to be drawing on multiple links from different parts of the brain, so making connections and transferring that knowledge. There is evidence (Roherer et al, 2014) of this being more effective than blocked practice for developing problem solving skills. It is a proven way of imprinting knowledge into our long-term memory schema.

6. Visualisation and Mental Representations

Much of Deliberate Practice is about developing more efficient mental representations of what is perceived and understood. Images are important for input and recall from memory (as Dual Coding Theory highlighted). Indeed, good mental representations make it possible to process large amounts of information quickly, despite the limitations of short-term memory.

Pretend you are a human from another planet where there are no cats. If you visit planet earth and hear the word 'cat', it has no meaning – it is just the sound of the word 'cat'. To make the word meaningful you could look at the picture of a cat and at that point you would be able to store the image in your long-term memory. It might also be possible to link it with something already in there, such as a lion.

Better still, however, if you saw a real cat you could see it walk and marvel at its subtle movements, you could touch it, feel its warm, soft fur and hear it purr. As you would have received information on the cat through multiple senses your mental representation of it would have improved hugely and you would have a much richer understanding of the cat than either the word or picture alone could give. Indeed, you might by now have hundreds of cat representations in your head as you would have seen it lie down, sit up, walk, yawn, sleep, etc. You may also have an emotional response to a cat, positive or negative, depending on whether it came up to you and rubbed against you or scratched you.

[80] Epstein. D. (2019). *Range, How Generalists triumph in a specialised world*. New York.

Such is the power of mental representation. For Cognitive Coaches, understanding this power is important. In *Deliberate Practice* coaches use mental representations wherever possible. At the start of a session they will often use visualisation to depict how the endgame or micro-mastery should look when carried out by experts.

Video footage of where the learner is at a precise moment in time is also a common tool of *Deliberate Practice*. It allows both learner and coach to visualise, compare and design an action plan to close the gap between the present and the desired end game.

Prompts for Practice

- ✓ Deliberate Practice is a highly effective metacognitive strategy for use by individual students; it is thus important that they understand the six key elements at an age-appropriate level.
- ✓ The Cognitive Coach may describe application of Deliberate Practice in appropriate contexts for students, as well as reminding them to apply it as part of their independent study and learning. They also have a vital role in providing feedback and expert input to individual learners and/or groups of learners.
- ✓ Deliberate Practice can be embedded in school study guides and visual posters displayed in prominent locations across the school. Thinking Matters offers student guides which seek to support student understanding of the process involved and serve as a useful reference resource.

APPENDIX E6: Motivation

The Iceberg Model

Motive is defined as the need or desire that causes someone to act[81]. Motive, therefore, is at the root of a person's behaviour. To understand this behaviour it is important to understand the motive(s) that has caused it – no easy task because whilst behaviour is visible to the naked eye, motive is not. Picture an iceberg where behaviour sits above the water for all to see. Far beneath the waves sits the motive. Helping students to think about and appreciate what motivates them (their key drivers) is vital in terms of student self-awareness and well-being. Understanding what is deeply satisfying or intrinsically rewarding helps us to find ways of managing our own lives better and approaching new learning with confidence.

Optimising Potential through Motivation

Research on elite performance[82] shows that potential is not fixed solely by the genetic cards one has been dealt. Genes do have some influence, particularly when considering traditional measures such as IQ[83]. However, other perspectives, such as that put forward by Oliver James in 'Not in Your Genes',[84] argue that they are only a starting point and after that, one's ability to fulfil potential is governed by three key controllable factors – Opportunity, Support and Motivation.

Let us imagine you want to become a top-class tennis player. First thoughts are that you would need to be of a certain height – there are not too many world number ones under 5'5" (165cm) and genes clearly have some influence. Let us assume, however, that you have the ideal genetic make-up. If you have never had an opportunity to play tennis, then your potential will never be realised. You will need to have had access to a tennis racket and court before your potential can be realised.

Now let us say you have had an opportunity to get on court. Combine this opportunity with your genetic makeup and you start to optimise your potential. To continue, however, you will need support. You will need someone to drive you to tournaments and a coach to give you lessons. So, you now have the genetic makeup, the opportunity and you have been offered support. Undoubtedly you will be playing well, going up the rankings, starting to optimise your potential but you cannot really be bothered to put in the hours of practice necessary to truly succeed (there is more information on *Deliberate and Distributed Practice* in Appendix E5). A crucial part of the jigsaw is missing, the desire and need to act are not there. You do not have the motivation.

---

[81] https://www.merriam-webster.com/dictionary/motive
[82] Eyre, D. (2007). *Gifted & Talented; What Really Works* http://www.brightonline.org.uk/what_really_works_pdf
[83] Plomin, R. and Deary, I.J. Genetics and intelligence differences: five special findings in Mol Psychiatry. 2015 Feb; 20(1): 98–108. Published online 2014 Sep 16.
[84] James, O. (2016). *Not in Your Genes.* Vermilion.

Becoming a top tennis player is clearly not everyone's objective, nevertheless, this example offers an illustration of the importance of motivation whatever the field, whatever the goal, whatever the level. If a Cognitive Coach is truly helping a student optimise potential, then understanding motivation is key.

The Performance Equation

In drawing together research from the fields of genetics, psychology, neuro and sports science there is clearly a powerful truth that inherited psychological traits, typically, have a limited effect on a person's ability to fulfill their potential. We can look at the controlling factors in optimising talents (**opportunities**, **support** and level of **motivation**) another way – by exploring the basic equation for human performance:

Performance = Ability x Motivation

This equation, admittedly taken from research[85] on the performance of workers in industry, suggests performance to be a function of ability and motivation. It implies that motivation is of an equal weighting to ability (made up of innate 'talent' and environmental influences such as the opportunities and support they have received) in terms of impact on performance. Whilst quantifying all the inputs of ability would seem something of an oversimplification, none the less running numbers through the equation highlights the vital importance of motivation.

If a person's ability is 9/10 but if their motivation is only 5/10 then their performance level, if measured out of 100, will only be 45 (9x5). Increase that motivation to 9/10 and performance shifts to 81 (9x9). This raises the question of where the Cognitive Coach and learner should be focusing their efforts. It strongly suggests that seeking to understand and improve motivation should be at the very top of every parent, educator and indeed child's own agenda.

Intrinsic and Extrinsic Motivation

The concepts of *Intrinsic Motivation* (where something is done for personal pleasure or satisfaction) and *Extrinsic Motivation* (where something is done in response to an external influence such as reward or punishment) are at the heart of motivational theory. There is much debate as to whether *Intrinsic* or *Extrinsic* motivation is 'better'. Work by Ryan and Deci[86], the creators of Self Determination Theory, shows that *Intrinsic Motivation,* the need for **Autonomy**, **Mastery** and **Purpose**, is what allows us to perform well at heuristic (complex and creative) tasks[87]. *Extrinsic Motivation*, the use of carrot and/or stick, has its place but is only shown to have positive long-term effects when used with algorithmic (routine, rule-based) tasks[88]. Indeed, there is much evidence to show that seeking to use extrinsic motivators (rewards and penalties) inappropriately can

[85] Vroom V.H, (i964). *Work and Motivation*, New York, Wiley.
[86] Ryan, R.M. and Deci, E.L. (2017). *Self Determination Theory*. The Guilford Press.
[87] Glucksberg, S. (1962). *"The influence of strength of drive on functional fixedness and perceptual recognition". Journal of Experimental Psychology. 63: 36–41. doi:10.1037/h0044683. PMID 13899303.*.
[88] Amible, T.M. (1996). *Creativity in Context* Westview Press.

destroy intrinsic motivation for that activity in the long term as well as promote unethical behaviour, create addiction and promote short-term thinking at the expense of the long view[89].

Understanding Motivation

James Sale's work[90], drawing as it does on Maslow's *Hierarchy of Needs*[91], Edgar Schein's *Career Anchors*[92] and the *Personality Enneagram*, seems to have the most practical application in the classroom. Sale identifies nine different motivators, split into three different clusters, all of which permanently exist, at some level, within us all of the time.

Rather than concerning himself with whether being driven by *Intrinsic* or *Extrinsic* motives is better or worse, Sale suggests that our motives are what they are, constantly being shaped by our experiences. The bias we have towards any of these drivers is neither right nor wrong, but we cannot perform optimally or be truly happy unless we are seeking to satisfy the motive(s) that is driving us at that particular point in time. This raises an interesting discussion – if our motivation is always there then the way to tap into it and raise our level of motivation (with its corresponding effect on performance) is to offer learning activities that correspond to an individual's motives at that particular point in their lives.

Sale's nine motivators are:

Relationship Motivators

1. The **Defender** - seeks security, predictability and stability.
2. The **Friend** - seeks belonging, friendship and fulfilling relationships.
3. The **Star** - seeks recognition, respect and social esteem.

Growth Motivators

4. The **Creator** - seeks innovation, identification with new and expressing creative potential.
5. The **Spirit** - seeks freedom, independence and making own decisions.
6. The **Searcher** - seeks meaning, making a difference and providing worthwhile things.

---

[89] Pink, D. (2011). *Drive - The Surprising Truth About What Motivates Us*. Cannongate.
[90] Sale (2016). *as above*.
[91] Maslow, A. (1943). *A Theory of Human Motivation*, Midwest Journal Press.
[92] Nira, D. (2008). *The construct validity of Schein's career anchors orientation inventory.* Emerald Group Publishing Limited. Retrieved 2011-11-09.

Achievement Motivators

7. The **Director** - seeks power, influence and control of people/resources.
8. The **Builder** - seeks material satisfactions, money and above average living.
9. The **Expert** - seeks knowledge, expert and mastery.

Taking time to understand what it is that motivates an individual allows us not only to better understand their behaviour but also enables us to offer learning that will engage them. The result of this is an individual operating closer to his optimal potential and crucially, with this, comes higher performance and the benefits that affect confidence and well-being.

Informal discussion using Sale's nine motivators can be used to understand an individual's motivation. More formally, diagnostic tools such as Motivational Maps® exist which provide a motivational profile of an individual (or class) including the current level of motivation.

Prompts for Practice

- ✓ Enabling students to understand the importance of motivation in their learning and the nature of their own motivation can enhance their sense of well-being and can be deeply satisfying.
- ✓ Ask questions as a Cognitive Coach that help students direct their energy in ways that are motivationally aligned, i.e. motivationally satisfying rather than stress-inducing.
- ✓ Provide opportunities as a Cognitive Coach for students to engage in tasks autonomously so that they bring learning to life for themselves.
- ✓ Use the Motivational Mapping tool to devise ways of exploring motives so that students are able to reflect on their own motivational needs and to what extent they are being met. Could students make changes to the way in which they study independently or in a team? Could this impact on their capacity for emotional and social intelligence in your classroom?
- ✓ Make sure to question and reflect on the lowest motivators within the classroom. Is there a degree of polarity or compatibility that might be important for focus? Is this motivational need low across the class, or is it higher for some pupils? How could you support this through a variety of learning tasks?
- ✓ Create a peer-to-peer coaching environment, whereby there is an atmosphere of collaboration and leadership following the motivational needs of the classroom.

- ✓ In recognising and supporting the motivational needs of students, a skilled Cognitive Coach is able to allocate roles and tasks that create an environment for all to thrive, in which success is within a student's grasp.

- ✓ The skilled Cognitive Coach will use an understanding of an individual's motivators to bring learning to life for them. This is the subject of a separate Thinking Matters workshop that explores the nine areas of motivation that lie at the core of an individual. The workshop will reveal how a skilled Cognitive Coach can start to look at the way in which students are intrinsically motivated, and support them by creating the right growing conditions in a classroom for all children to thrive, whilst developing the emotional intelligence and empathy of a peer group.
  By way of example, imagine a student whose lead motivator is 'director' (who naturally seeks power, influence and control of people/resources). What impact could this be having on this student building fulfilling relationships in the classroom? How might you choose to shape a learning experience, knowing that this student is highly motivated by leadership opportunities, but has a tendency to isolate themselves from others? This particular student might have no interest in being recognised by others, but thrive on 1-1 feedback on how to perform better. Is this student more future-focused, or change resistant? This workshop explores the use of a motivational profiling tool to help find answers to these questions, whilst supporting teachers in saving time and raising the level of motivation in classrooms.

APPENDIX E7: Additional Information - Neuromyth Busting

The growing interest in brain science has led to an increase in publication of popular literature on this topic with the potential for misunderstanding or misrepresentation. It is possible that many teachers and parents who are enthused about the potential learning coming from neuroscience may too readily accept teaching practices or ideas that do not actually have a scientific basis in neuroscience, or which have not been rigorously tested within an educational context. This phenomenon of 'neuromyths' – mistaken ideas about the brain – has therefore become an increasing topic of discussion for researchers within this field in recent years[93].

For a Thinking School, in which practice should be evidence-informed, it is important to build staff awareness of how neuromyths are perpetuated and of the need to be more critical when new ideas are presented.

Neuromyths, by their nature, often contain a kernel of truth, which may have been either misinterpreted or become distorted over time[94]. Such myths can also gain momentum due to a lack of accessible evidence to contradict them, as most such research exists within the context of academic journals and take time to counter.

The following explanations address some of the most common circulating neuromyths:

- **We tend to be right or left brained and this dominance can help explain individual differences amongst learners.**

  It is a myth that we use the left side of our brain in one task and the other side of our brain for another task, and the classification of people as 'left-brained' or 'right-brained' is a further misunderstanding. In most learning situations and everyday tasks many regions of the brain in both hemispheres work together in a very sophisticated parallel fashion. The left and right hemispheres are connected by an 'information superhighway' called the corpus callosum that integrates processing across the left and right side of the brain.

- **Short periods of specific physical co-ordination exercises, such as Brain Gym can improve integration of left and right hemispheres of the brain.**

  There is no evidence to suggest that such exercises lead to improved integration across the left and right hemispheres, as they are already

[93] http://www.educationalneuroscience.org.uk/resources/neuromyth-or-neurofact/
[94] Howard-Jones, P. A. (2014). Neuroscience and education: myths and messages. *Nature Reviews Neuroscience, 15,* 817-824. doi:10.1038/nrn3817.

integrated via the corpus callosum.[95] At any moment, activity is occurring throughout the brain with both hemispheres working together in a complex parallel manner. You will hear from colleagues reading about *Neuroplasticity* in this activity however, that aerobic exercise is good for brain health and can improve cognitive functioning and our capacity to learn.

- **Learning problems associated with developmental differences in brain function cannot be remediated by education.**

  This is a myth, as the brain is 'plastic' or malleable and can change over time. Neuroimaging studies have shown that education can help remediate both the behaviours and the brain function differences associated with common developmental disorders (e.g. dyslexia, dyscalculia).

  Traditional views of 'intelligence' as being predetermined by genes have been challenged as our understanding of neuroplasticity grows. It is now accepted that an individual's educational outcomes are not biologically determined by their DNA but are the result of the interaction of genes with experience. As the brain remains plastic throughout our lives, the way our brain functions, and even the shape and size of its various parts, can change as a result of our environment, including our educational experiences.

  Learning can change our brains in terms of function, connectivity and structure and research has shown that simply knowing about brain plasticity can improve the self-concept and academic potential of learners. The Cognitive Coach therefore has an important role to play in actually constructing students' brains.

- **Teaching to an individual's preferred learning style will result in progress**

  Many schools have engaged with staff professional development in recent years which has highlighted the idea that students learn most effectively when they are taught using their preferred 'VAK' learning style – visual, auditory or kinaesthetic. The idea that it is educationally helpful to categorise students in this way and teach to their learning styles remains popular, despite the findings of research within the past decade or so which has consistently reinforced this belief to be a neuromyth. Teachers may be aware of other models of Learning Styles, as with VAK they have no proven impact on learning if used to differentiate students. They may however provide a vocabulary for deeper self-understanding, especially when approaching tasks.

  A review of the literature was conducted by the University of Bristol[96] in which 89% of recent educational papers implicitly or directly endorsed the use of learning styles in higher education, despite lack of scientific or educational

[95] Spaulding, L. S.; Mostert, M. P. and Beam, A. (2010). 'Is Brain Gym an Effective Educational Intervention?', *Faculty Publications and Presentations*, paper 148. http://digitalcommons.liberty.edu/educ_fac_pubs/148

[96] Howard-Jones, P. A. (2014). 'Neuroscience and education: myths and messages'. *Nature Reviews Neuroscience,* 15, 817-824. doi:10.1038/nrn3817.

evidence for their effectiveness. Examples of the counter-evidence includes an extensive review[97] which found that there were no clear implications for pedagogy arising from any existing models of learning styles and also research using controlled experiments which concluded that teaching students in their VAK learning styles is "wasted effort"[98].

There is, however, emerging evidence[99] that presenting material in multiple modalities may be beneficial for all learners as the brain is multi-sensory and highly interconnected. Whilst the four lobes within the cortex each have specific functions, neurons communicate and seek to make connections right across the brain. For example, a picture of a bell, will not just produce activity in the visual cortex, but also produce activity in the auditory cortex as well because of the association of a picture of a bell with the sound of a bell. Our learning therefore benefits from being able to represent information in a variety of different ways using different modalities, sight, sound, touch.

- ## Drinking less than 6 to 8 glasses of water a day can cause the brain to shrink

  There is no evidence of under-performance amongst school children who fail to drink this amount of water – 6 to 8 glasses is a contentious recommendation in itself.[100] The hypothalamus within the brain relays signals about the body's state, including the message that we feel thirsty when our bodies (and brains) need water. There is thus not normally a need to monitor water intake except in cases of unusual heat or after vigorous exercise. However, as approximately 80% of the brain is water, it is common sense that even mild dehydration may decrease cognitive functioning and staying hydrated also has wider health benefits.

[97] Coffield, F., Moseley, D., Hall, E. and Ecclestone, K. (2004). 'Is there a role for learning styles in personalised education and training?', *International Journal of Lifelong Education*: Vol 24, No 3.
[98] Krätzig, G. P., and Arbuthnott, K. D. (2006). 'Perceptual learning style and learning proficiency: A test of the hypothesis'. *Journal of Educational Psychology*, 98(1), 238–246. https://doi.org/10.1037/0022-0663.98.1.238.
[99] Shams, L., and Seitz, A. R. (2008). 'Benefits of multisensory learning'. *Trends in Cognitive Sciences*, 12 (11), 411-417.
[100] Howard-Jones, P. (2009) 'Introducing Neuroeducational Research: Neuroscience', *Education and the Brain from Contexts to Practice*.

Prompts for Practice

- ✓ Thinking Schools recognise the unique individuality of each learner and are underpinned by principles that reflect a fundamental belief that each child's brain is malleable and capable of growth and development. Schools may find it useful to reflect on the extent to which the dialogue and interactions of staff and students consistently represent a growth mindset.

- ✓ An effective Cognitive Coach will teach in a multi-sensory way using a variety of modes of learning, which supports students in making links between different forms of information and thus aiding understanding and learning. Concepts may be explained verbally with learners expected to listen or may be presented visually using a diagram or practical demonstration, or learners may be invited to enact a concept and feel it. The multisensory brain can then connect those different representations together, thus deepening learning.

- ✓ Understanding that some people instinctively tackle learning tasks in the same way and knowing the vocabulary and behaviours that are attached to those approaches may help the self-reflective learner to develop a repertoire and language for ways and alternative ways of learning.

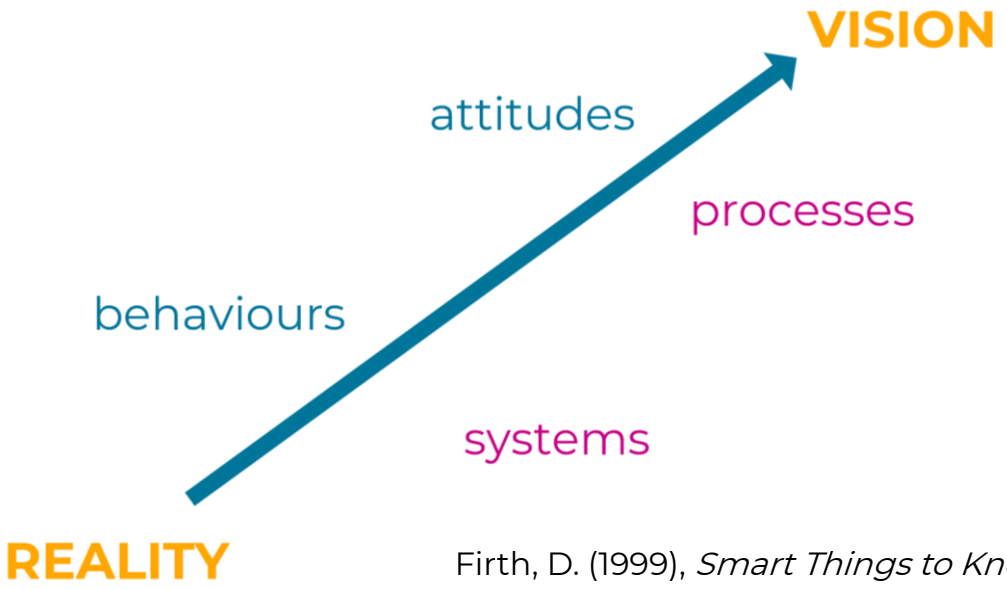
- ✓ The culture of Thinking Schools should promote a nurturing environment for children and young people in which healthy lifestyles, including access to a well-balanced diet and exercise are valued. Staff may also find it helpful to consider the autonomy afforded for individual students to have access to water and to be able to monitor their own levels of thirst and water consumption.

APPENDIX F:
The Drive Team as Change Agents

- Your roles as a Change Agent and Drive Team
- Kotter's 8-Step change model
- Managing emotional and behavioural responses to change
- Skills of Change Agent
- Creating a project plan to be successful

> *"Change management is about keeping minds open, about removing threat and insecurity in order to bring people into change. This requires facing truth, identifying people's real interests, making promises that you keep. To undertake these difficult tasks requires raising energy, building courage and confidence."*
>
> Page, T. (1996) *Diary of a Change Agent.*

The Dream Alignment



Firth, D. (1999), *Smart Things to Know About Change.*

John Kotter's Model of Change

Kotter's model [Kotter, J. (1996), *Leading Change*] is derived from extensive study of the change processes that proved effective in many different organisations.

Create a Climate for Change

1. CREATE A SENSE OF URGENCY

- Inspire people to move.
- Make objectives real and relevant.
- Articulate why there is an imperative.

2. FORM A POWERFUL COALITION

- Get the right people with the right skills in place.
- Provide leadership, give importance and define initial responsibilities.

3. CREATE A VISION FOR CHANGE

- Get the team to establish a simple vision and strategy.
- Focus on emotional and creative aspects necessary to drive service and efficiency.

Engage and Enable the Whole School

4. COMMUNICATE THE VISION

- Involve as many people as possible.
- Communicate the essentials.
- Appeal and respond to people's needs.
- Teach new behaviours by the example of the guiding coalition.

5. EMPOWER OTHERS TO ACT ON THE VISION

- Remove obstacles.
- Enable constructive feedback and lots of support from leaders.
- Change systems or structures that seriously undermine the vision.
- Encourage risk-taking and non-traditional ideas, activities and actions.

6. CREATE SHORT TERM WINS

- Set aims that are easy to achieve in bite-size chunks.
- Plan for visible performance improvements.
- Create those improvements.
- Recognise and reward improvements.

Implement and Sustain Change

7. BUILD ON THE CHANGE

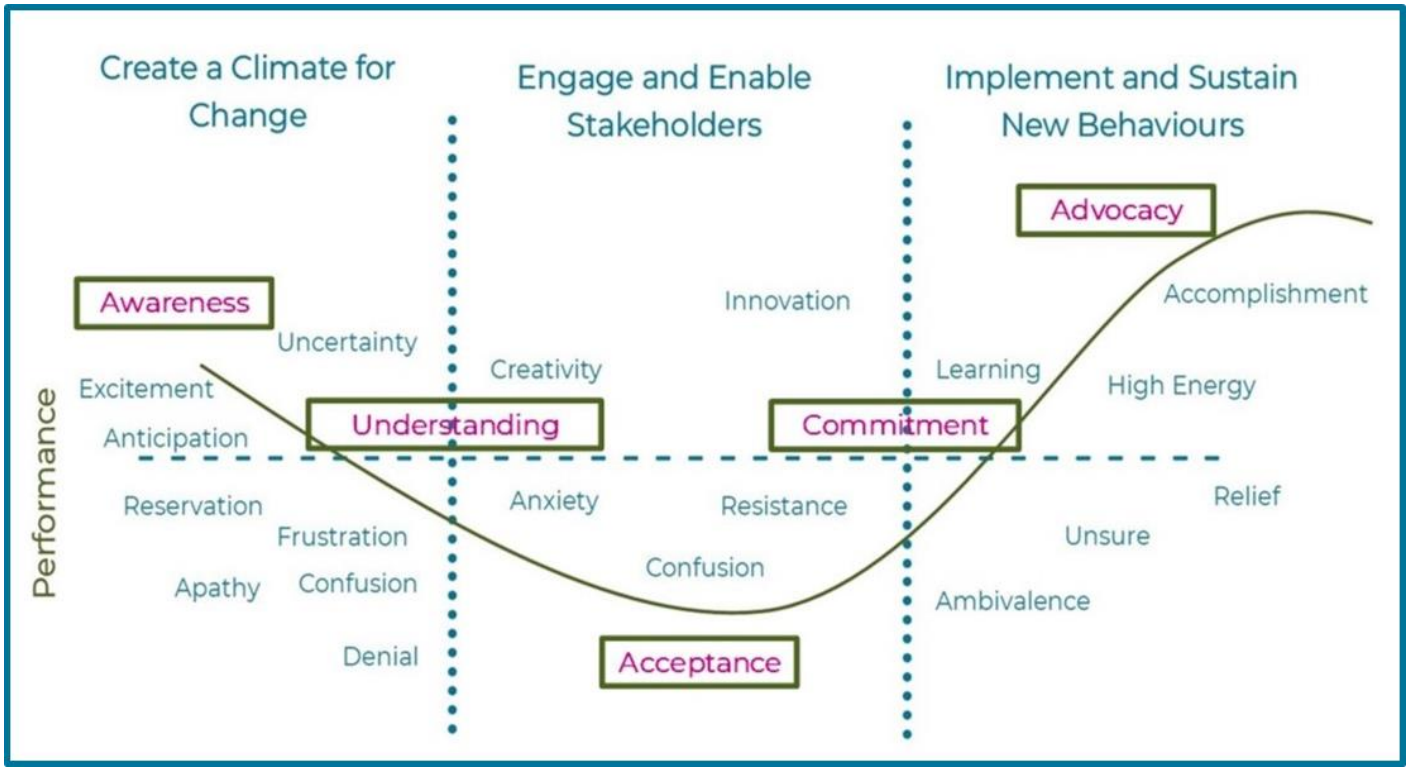
- Foster and encourage determination and persistence.
- Highlight achieved and future milestones.
- Set goals to continue building on the momentum you've achieved.

8. INSTITUTIONALISE NEW APPROACHES

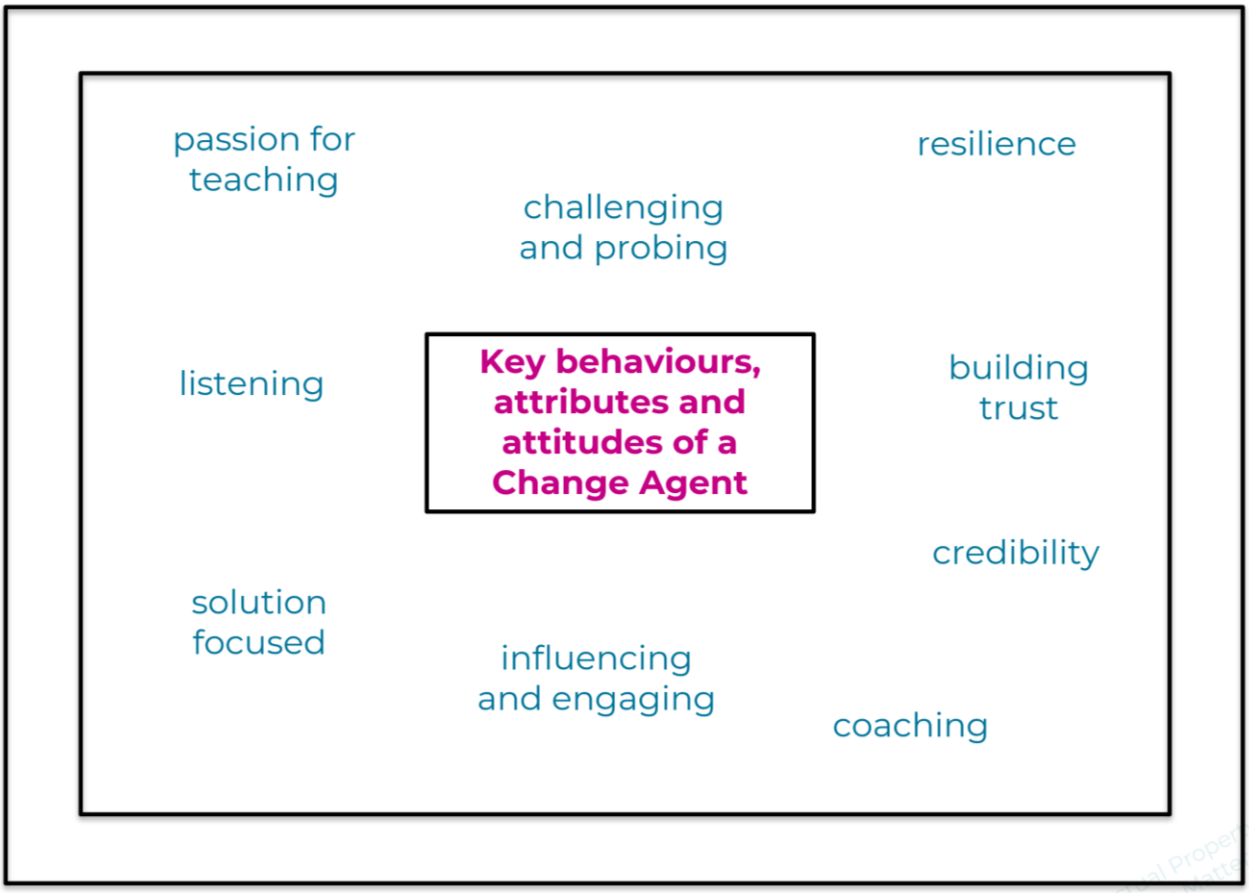
- Talk about progress every chance you get; tell success stories about the change process and repeat other stories you hear.
- Publicly recognise key members of your original change coalition and make sure the rest of the staff – new and old – remember their contribution.
- Articulate the connections between the new behaviours and success.
- Develop the means to ensure leadership development and succession.

TASK: What might need to happen in your school for each stage of this model?

Common Reactions to Change



Adapted by Zettler, J.P. & Hartling, P.C. (2010). from Bridges, W. (2003). *Managing Transitions: Making the Most of Change* and Kotter, J. (2002). *The Heart of Change.*



APPENDIX G: Reflection

How would you measure progress of new practice? How would you disseminate across the school? How might this feed into the implementation plan?

ADDITIONAL NOTES