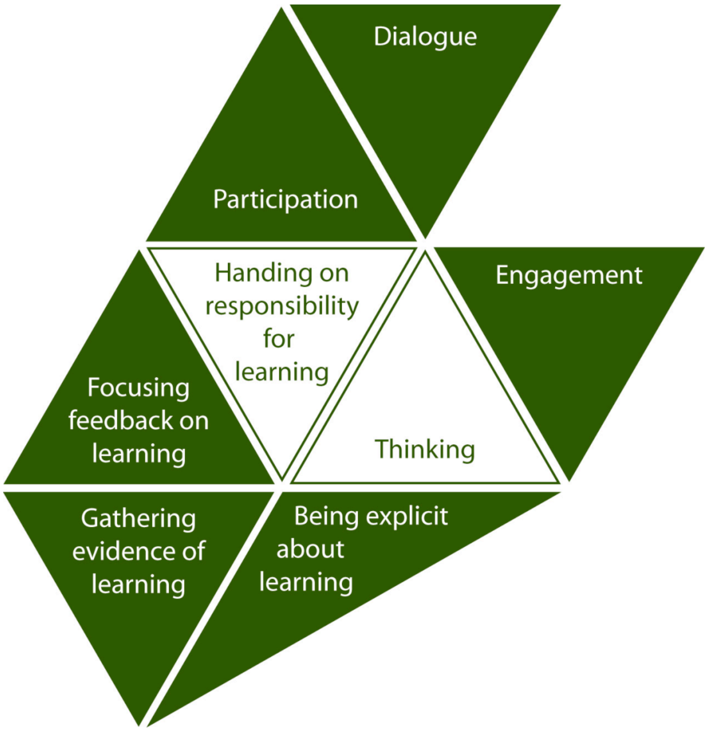
Tools for Thinking

Helping pupils take greater responsibility for their own learning

Support material by
Prof Robert Fisher



Embedding Curriculum for Excellence in the classroom

Reflective Professionals and Thinking Children

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TOOLS FOR THINKING

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INTRODUCTION

The aim of this booklet on strategies, or tools for thinking is to support students in personal learning planning and peer and self-assessment, so that they can take greater responsibility for their own learning. This process is not simply about teaching pupils a new set of techniques to help them improve their critical and creative thinking. It is also about fostering among them a belief that, with more active involvement in their own learning, everyone can make real progress.

We use tools and strategies for thinking all the time without thinking about them. The aim of teaching for thinking is to make these strategies explicit so that they can be used, practised and developed consciously. They encourage awareness about what we do and why and help us to internalise the habits of intelligent behaviour and successful learning.

This booklet offers 30 strategies under the three headings: critical thinking, creative thinking an information processing. They are cross-curricular in the sense that they can be applied to any content and have all been found useful in developing 'thinking classrooms'.

We want students to be critical rather than uncritical, creative rather than uncreative and to be able to process information in relevant and productive ways. They need help if they are to take control of their own thinking and develop metacognitive control of it. To develop intellectual independence, they need to be shown different ways of thinking and the way skilled thinkers use tools for thinking to develop understanding through learning conversations with teachers and others. The aim is not to produce a set of fragmentary and disjointed skills but an integrated and able thinking person. These global thinking abilities include helping students to learn how to learn through:

- creative thinking
- critical thinking
- information processing

Creative thinking

We become creative when we are able to look at things from a new perspective. Einstein, who believed that the key to learning was flexible thinking, said 'To raise new questions, new problems, to regard old problems from a new angle requires creative imagination, and makes real advances'. According to Piaget,' To understand is to invent'. We make knowledge our own 'by reconstructing it through some creative operation of the mind. The mind once stretched by a new idea' said Oliver Wendell Holmes 'never regains its original dimensions'. Creative thinking skills enable us to:

- generate and extend ideas, both verbally and visually
- suggest possibilities and hypotheses
- apply imagination, including seeing other viewpoints
- experiment with ideas
- create analogies, metaphors and new connections

Any learning that is not routine that takes account of new knowledge, develop new ideas, or design solutions to new problems requires creative thinking. needs creativity. Unless the learner has complete knowledge of an area of learning then creativity will be needed to help develop, adapt and apply understanding that is at present partial or incomplete. Creative or divergent thinking opens possibilities, the chance to see more in any situation

Critical thinking

Children often absorb the attitudes and opinions of the significant adults in their lives and can become dependent on the thinking of others. They need to learn to question their own ideas and the ideas of others, to value and exercise their own reasoning capacities. If children are to become open-minded and critical, their thinking cannot be left to chance. They should be

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taught how to think critically. Learning to think critically means learning how to:

- ask and analyse questions
- give reasons for opinions and actions
- draw inferences and make deductions
- use precise language to explain concepts and ideas
- make judgements based on criteria, reasons and evidence

The word `reason' is derived from the word `ratio' which means balance. A child can only think critically or reasonably to the extent that he is able carefully to examine experience, assess knowledge and ideas, and to weigh arguments before reaching a balanced judgement. Being a critical thinker also consists in developing certain attitudes, such as a desire to reason, a willingness to challenge and a passion for truth. A corollary of this is that the critical thinker should also be willing to submit their ideas to scrutiny, to the challenge of reason and be open to self-correction.

Information processing

The brain is an information-processing capacity that enables us to store, organise and use the information received by the senses. To deal with the huge amounts of information they are presented with children need the tools that will help them process information if they are not to become victims of information rather than controllers of information. Intelligence is the ability to adapt to new situations and new information. To process information successfully children need to develop a number of research skills including how to:

- identifying purposes of research
- locate, collect and store relevant information
- sort, classify and sequence information
- identify concepts and relationships
- understand vocabulary of thinking and learning
- develop self awareness and control over their learning
- clarify, summarise and evaluate what they have learnt

How to use 'Tools for Thinking'

Each strategy is explained and a rationale given. Having familiarised yourself with this/ these, choose one strategy to focus on in a lesson or interaction with students. Make the thinking visible by discussing the strategy, the reasons and purposes for it and showing how it can be applied in this and other contexts. Examples of how to use the strategy are given but they are presented for you to develop and personalise in your own way – or to devise strategies better suited to your students' needs. They are not recipes but suggestions for research through your own teaching.

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CREATIVE THINKING

1. Generate ideas: use idea generating questions

Ask questions to stimulate curiosity and creativity. Try to generate many responses, encourage thinking of alternatives and greater fluency of ideas.
Question cues include:

- How many kinds of … can you think of?
- List all … that could be used for …?
- What might be the arguments for … (and against …)?

A written list of mind-stimulating questions is useful because it reminds us of approaches and possibilities that we might not otherwise think of.

Journalists' Questions
These are the six key questions that journalism students are taught to answer somewhere in their news articles to make sure that they have covered the whole story. These questions encourage critical thinking about a topic from different angles.

1 Who? (Agent)	Who is involved? What are the people aspects of the problem?
2 What? (Event)	What happened? What was done and not done?
3 When? (Time)	When will, did, should this happen?
4 Where? (Scene)	Where did, will, should this occur or happen? Where else is a possibility?
5 Why? (Purpose)	Why was or is this done, avoided, permitted? Why should it be done, avoided, permitted?
6 How? (Method)	How did it, could it, should it happen/ be changed/prevented? How did beginning lead to conclusion?

Osborn's Questions
Alex Osborn's is a classic list of idea generating questions (adapted below). Not all the questions apply to all topics, but some will stimulate thinking whatever the topic.

Other uses?	New ways to use it? Other uses if modified?
Adapt?	How to adapt? What is it like? What does it suggest?
Modify?	How to change - meaning, colour, motion, sound, form, shape?
Magnify?	What to add – time, shape, ingredient? Multiply? Exaggerate?
Minify?	What to subtract – smaller, shorter, omit, split up?
Substitute?	What to substitute? Who/what else instead? Try other approach?
Rearrange?	Change components? Try other pattern, layout, sequence?
Reverse?	Try opposites? Turn it backward, upside down, reverse?
Combine?	Try to blend, combine units, purposes, ideas?

2. Visualise: use visual thinking

Visual prompts can stimulate curiosity and creativity, and encourage the generation of ideas. Visual thinking is the ability to represent the visual-spatial world internally in your mind, to perceive it accurately and to use these perceptions to solve problems or be creative. It involves sensitivity to line, shape, form, space, and the way they are related. It includes the capacity to internally represent visual or spatial ideas, and to orient oneself appropriately in a spatial context. It is a form of non-verbal reasoning that enables us to see visual patterns and to generate, retain, and transform visual shapes. Such visual/spatial abilities are important for higher-order thinking in science, technology and maths. Successful sailors, engineers, packers, surgeons and taxi-drivers have a highly developed visual/spatial intelligence.

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One simple way to be creative with shapes is to draw a simple shape, symbol or diagram and ask: ‘What could it be?’ ‘How many different things could it be?’ ‘What is the most interesting thing it could be?’ This calls for creative thinking but also challenges spatial intelligence.

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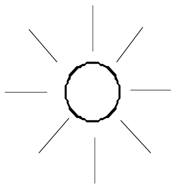
Task: What might this be?
The following is an example of a visualisation test.
Look at the shape below and list as many things as you can think of that the shape might represent



(Note: groups of children often make more than 40 suggestions)

Guided imagery can be a powerful stimulus to imagination as a form of meditation using 'the inner eye' to create and explore special places in the mind through guided images. A focus such as a picture or word stimulus can be used to practice focusing the mind and stimulate visual thinking and imagination. Such experiences can help still the mind and focus it on positive images and emotions.

Task: Can you visualise it?

- Describe a picture without showing it to your partner. Can they visualise it? Can they draw it from your description?
- hut your eyes and listen to a new piece of music. What pictures/words come into your mind? What does it make you feel or think?
- Discuss a geometric shape(s). Ask students to visualise the shape(s) in their mind's eye. Ask them to try to add to or turn the shapes in their mind to see different angles and combinations.

Are there more ways you could use visual prompts and questions in your own teaching?

3. Find a use: What could this be used for?

Creative thinking is about generating ideas and increasing the breadth of perception. A common complaint of students engaged in effortful learning tasks is: What is the point? We need to help students see the point of things, even better if students themselves can identify possible purposes or uses for what they do. They also easily get into fixed mindsets and stop thinking about the potential of things. This simple technique can be used for mental stimulation or practical application, and is a useful tool for breaking students out of a functionally fixed mindset. The question to be asked of any product, outcome or item of knowledge is What could this be used for? The question is also used in tests of divergent thinking.

To use this technique, think of an item or object, usually a common one like a brick, pencil, or bucket, and set the task of thinking of all the possible uses for that object, not how the object is normally used or thought of.

For example: What are the possible uses for a brick?
Ideas: doorstop, boat anchor, build a wall, build a path, sanding block, nut cracker, red chalk, step, heating block, leaf press, paper weight, target for shooting, children's toys, weight , distance ruler, model of cuboid etc.

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Task: What could this be used for?
How many alternative uses as you can for a familiar object such as a blanket, barrel, brick, sock, paper clip, a shoebox, an elastic band, a human hair, toothbrush, compact disc, milk bottle, sock?

Verbal challenges like these provide a useful stimulus for creative thinking and for discussing the possible uses of any product, outcome or item of knowledge.

4. Possibility Thinking: think of alternatives, possibilities and choices
The world is full of alternatives, possibilities and choices. But we don't always see them. This is especially true of children who often comes to believe there is only one answer, only one right way to do things. We need to alert them to alternatives, to possible new directions, and to encourage them sometimes to choose 'the road less travelled by'. We talk of being 'blinkered', and of 'tunnel vision'. As learners we talk of 'getting stuck', and of not knowing what to do, where to turn, which way to go. If children value the practice of seeking alternatives they will be better placed to think of alternative solutions when they need them.

There are many sorts of alternatives, including:
- viewpoints
- actions
- solutions
- ways of working
- explanations
- plans
- designs

Encourage children to look for alternatives, to be alert to multiple possibilities. Support the belief that they always have a choice and can always look for alternatives. You may not find an alternative, but your approach is intelligent. As one child commented, 'There is always a different way, even if you can't find it'.

The most difficult thing to do is to check look for alternatives when you don't have to. We do things out of habit, we work mindlessly. What can help us to be more flexible in our thinking, and more alert to possibilities? Questions to ask include:
- Is there another way?
- Can we come up with an alternative suggestion?
- Is there a possibility we have not thought of?
- What other choices have we got?
- Have we considered all the options?

When we begin to look for alternatives we should be clear about the purpose of the alternative. The following tasks provide sample ways to encourage looking for alternatives:

Task: Possibility thinking
Make a list of options, alternatives and possibilities to help in making a decision about the following problems or situations:
1. You discover your best friend is a thief. What alternatives do you have?
2. As you walk along the street you see a woman collapse to the ground. Why could this have happened? What could you do?
3. A car is found crashed in a ditch. There is no driver. What happened?
4. Some places are dirty because people drop litter and cans everywhere. What could you do to solve this problem?
5. You and your friends decide to raise money for charity. Which charity? What could you do?

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5. Futures Thinking: focus on creative futures

All our actions and decisions have consequences, often these consequences go unconsidered for we did not 'think forward' to what might happen. We need to feed forward (by thinking might be) as well as feed back (thinking of what has been). Critical thinking about a course of action means trying to predict the consequences. Children tend to be egocentric (not only children!), live in the present and find it difficult to project themselves into the future. Forward thinking invites students to think along a time scale into the future.

Forward thinking occurs along a time scale which can be:

- immediate
- short-term
- medium-term
- long-term

Important concepts of possibility, probability and certainty are involved in considering questions such as -

What outcome are you sure about?
Will it always turn out like this?
What else could it be like?
Do we know what will happen?
What do you think will happen? Why?

Part of assessing possible consequences is working out not only what will happen, but also the risks involved - what might upset our prediction and alter the consequences.

What are the opportunities? What is the ideal (best) outcome?
What are the dangers? What might go wrong? What is the worst thing that could go wrong?
What is the most likely outcome?

The following are some activities to encourage a focus on Futures Thinking:

Task: Forward Thinking
Do some forward thinking about the topics below. Specify a time scale for your forward thinking eg less than a year, 1-5 years, 5-15 years, or 25+ years.

- Schools of the future.
- The development of computers.
- The world runs out of oil.
- The greenhouse effect continues to make the earth's atmosphere much warmer than at present.
- Scientists discover a cure for every known illness.

Forward thinking provide good starting points for divergent thinking. A question like: What do you think will happen next? could refer to the next page, episode, book, picture, design, action or idea. Begin a thought and invite the student to continue it. What might the sequel be? Assessment for learning should help children to think more widely in time, past (prequel), present and future (sequel), and more deeply at the causes and consequences of things. An understanding of these concepts is a gradual process but they can powerful tools for understanding about how and why things change and how they can change too.

6. See other points of view

One way to broaden perception of self and others is to try to see things from another person's point of view. For the learner, and perhaps for us all, this is a difficult challenge. It requires an ability to listen to the views expressed by other people, and to make an imaginative leap to

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understand their feelings and ideas. This leap of imagination is fundamental to moral development, and to an understanding of others (part of social and emotional intelligence).

Role play, such as Mantle of the Expert (see www.mantleoftheexpert.com) is an excellent way to challenge children to think as another person. Another obvious way into thinking about other points of view is to consider different views (peer reviews) of a piece of one's work, or consider both sides of an existing argument or conflict. It can be fruitful to encourage different views when assessing a piece of work. Stories and drama, historical and geographical settings, art, design and IT also provide good opportunities to look at different viewpoints:

Does everyone think the same thing?
What do you think? What does s/he think?
What do the others think?
What are they feeling? Why?
What do you think is going through his/her/their mind?

The following are some tasks which aim to encourage seeing things from another's point of view:

Task: Seeing other viewpoints
List what you think the views are of different people in these examples:

1. A father and mother forbid their son and daughter to stay up past 10 o'clock to watch a TV programme they want to see. What are the different views of the parents, and children?
2. Someone wants to sell you a second-hand bicycle. What are their views, and your views?
3. You lend a friend some money to buy a lottery ticket. Your friend wins a prize with the ticket. Who does the prize belong to? What might be the different points of view of you and your friend
4. A burglar breaks into your house and steals everything of value that can be found. Your parents call the police, who say they will try their best to catch the thief. What are the views of your parents, the burglar and the police?
5. Choose a book, picture or video programme and list the different thoughts, feelings and points of view of the characters.

7. Provocation: try though experiments

One way is through provocation, what creative thinking guru Roger von Oech calls 'a whack on the side of the head'. He argues that we need to be whacked out of habitual thought patterns and provoked to look at what you are doing in anew way (de Bono has coined the word 'po' to describe a similar kind of 'provocative operation'). One technique is what Victor Quinn calls 'provocation in role', which entails the teacher or other 'agent provocateur' playing the devil's advocate in discussion with children by challenging all or any received moral and scientific assumptions with a view to building up a child's confidence and resilience in argument. A provocative statement is any that will stimulate creative thought, response or discussion.

Examples of provocative statements might include:
There is no point in going to school.
Nothing is true.
I can do whatever I want.
A triangle can have four sides.
Adults know more than children so what they say is never wrong.

What provocative statements can you create to get your children thinking and responding?

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Thought experiments: What if....?
You see things and say 'Why?'. But I dream things and say 'Why not?' (G.B. Shaw)
What if animals could speak? What if we could live forever? What if the earth stopprd revolving and the sun did not arise? 'What ifs' provide a wishful thinking kind of provocation by adding some impossible feature or picking out some feature of an item and imagine it was missing. This kind of playful imagination is a kind of conceptual exploration. By examining what can or cannot be imagined or conceived students are exploring the possibilities and limits of their thinking.

For example:

1. What essential features of the following could you imagine leaving out of a house, school, bicycle, library, birthday? (eg 'What if your house had no ...?').
2. What features could you imagine adding to school, parents, clothes, sleep, sports (eg 'Wouldn't it be nice if...')

Can you or your children create ten 'What if ..' impossibilities. Choose, draw and discuss your most interesting idea.

8. Metaphorical thinking : create analogies

Combination thinking. An important element in creative problem solving is making the familiar strange - looking at the same problem in different ways through combining different elements to make unfamiliar connections. The following are three methods of creating metaphor for helping to see the familiar in new ways. They are:

1. Direct analogy - making a simple comparison, for example:
   'How is a teacher like a tuna sandwich?

2. Personal analogy - imagining being the thing, for example:
   A candle is not alive, but it looks alive when it burns.
   How would you feel if you were a candle burning in a camping tent?

3. Symbolic analogy - creating a compressed conflict (oxymoron), for example:
   What is an example of a careful collision?

Carl Sandburg the American poet once said: 'Poetry is the synthesis of hyacinths and biscuits' (taking two unrelated words or images and putting them together to make the familiar strange). Take two unrelated words or ideas and try to join them with a linking thought. If we say that one thing is also true of another in some way we are reasoning by analogy. Children can be encouraged to create an analogy by asking questions such as: What is similar to this object? How are they similar? What do you know about one object that might be true of the other?

The following are examples of students creating metaphors about themselves:

I am undiscovered gold lying in the hills, waiting to be discovered.
I am like a grape, just one of a bunch, but I am full of juicy goodness
I am like a pawn in a game of chess, but without me the game would not work

Task: Create a metaphor
Think of as many answers as you like for these questions. There are no right or wrong answers:
1. What answers can you find for these riddles:
   Why is summer like a bridge?
   Which animal is like a rubber band?
   Which colour is quickest?

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2. Create more metaphorical riddles of your own by linking two seemingly unrelated ideas.
3. Make up some metaphors (or analogies) about yourself:
   What kind of food are you?
   What kind of furniture are you?
   What kind of animal are you?
4. Think of some more categories, and make up some more metaphors.
5. Create some more metaphors about yourself:
   What is your mind/brain like?
   What is your life like?

Metaphor and analogies are also used as forms of reasoning, see Thinking Tool 14 for more on Analogical reasoning.

9. Elaborate: make new connections

Creativity involves expanding existing knowledge. This is done through building on existing ideas or thinking of new ideas. In these activities children are asked to build on what is given, to expand an idea to make it more complex. This will involve both visual and verbal thinking, working by themselves and with others.

Task: What could we add?

- Read a text, stop halfway through, and ask students to try to complete it. For example: 'After the war, Earth was dead; nothing grew, nothing lived. The last man sat alone in a room. There was a knock on the door…' Can you continue and complete the story?
- Write lines or fragments from different poems on slips of paper. Students select at random some of these fragments of poetry and try to compose a poem (or prose) inspired by the fragments in their own words.

Piaget argued that concepts are organised into 'schemas' or 'models' which are mental representations of things or ideas, and it is through these that we process information. For Piaget cognitive development was very much to do with conceptual development, and this was often best achieved through cognitive conflict when our existing concepts or 'schemas' are challenged, and our existing ideas disturbed. To learn is to change. Cognitive development must entail some change, some re-arrangement or enlargement of the conceptual structure. It is these conceptual structures that underlie skills and understanding.

Task: What connections can you make?

- Choose any word - a simple concept like 'tree' or 'wet', or something more complex like 'anger' or 'democracy'. Ask students to think about it and write words they associated with it. Individually or in pairs they continue to add words, building up a sequence of associations. A more challenging version is to try to reach in a chain of association a very different word from the first word.
- Make connections with key concepts in a unit of study by giving them a number of concept words from a unit of study, ask them to think and try to pair up any two or more words with a connecting idea or ideas. Discuss or display these in visual form..

10. Discuss Creativity: make an audit

The following are some questions to reflect on and discuss.

- What are my/our views on creativity?
  What does it mean to me?
  How important is it to me and to my pupils?
  Can creativity be fostered? How is it fostered?
- How important is creativity in my classroom?
  How do I show that creativity is worthwhile?
  How do I show that it applies to everything that pupils do?
  Do I have high expectations in this area?

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- How do I foster creativity in my classroom?
  What kind of atmosphere do I create in my classroom?
  What learning and teaching methods do I use to promote creativity?
  What opportunities do I provide for creativity?
- What is the evidence is there that my pupils are creative?
  What does creativity look like in each subject area?
  What is the evidence of the creativity of my pupils?
  Where is evidence of pupils taking responsibility for their own learning?
- Do I feel free to be creative in my own teaching?
  Do I feel free to diverge from the plan on occasions?
  Do I improvise or follow pupils' interests?
  What stops me from being/would help me be more creative in teaching?
- Do I ensure assessment supports learning and creativity?
  Do I assess my pupils' creativity in appropriate ways?
  Are my pupils engaged in self assessment?
  Do the demands of assessment stifle creativity? What can I do about this?
- How do I maintain and develop my own creativity?

A CREATIVITY AUDIT

Could there be less	Could there be more	Evidence
copying	inventing	
being told	finding out	
describing	applying imagination	
teacher talk	class discussion	
limiting focus	developing ideas	
individual work	interaction with others	
using worksheets	real-life challenges	
giving of answers	hypothesising	
working in groups	working as teams	
seeking one solution	seeking innovative alternatives	
use of closed questions	use of open questions	
teacher posing questions	pupils posing questions	

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CRITICAL THINKING

11. Foster student questions

If we want pupils to be capable of engaging in their own research we need to encourage them to ask good questions. As they grow older children often grow out of the questioning habit. We need to fight the tendency and find strategies to foster curiosity and encourage the questioning child.

Discuss with children the nature of questions (see Question Quadrant below) and sort them for example into:

- questions we can answer
- questions we can find the answer for
- questions that cannot be answered

Give them a list of questions and ask they think is the best or most interesting question. Discuss good and bad questions. Find out what questions they would like to have answered. Can they think of a question that can never be answered? Question a text or topic. Ask, for example: What do you not know or understand about it? What do you want to find out? What questions can you ask about it?

Devise, write and display questions to stimulate thinking and discussion about objects, pictures or texts of interest in your classroom. Display a question or problem of the day. Use the 'think/pair/share' strategy. Give children time to think about the question (or draft responses), discuss with a partner then share and discuss as a whole group. Collect any interesting or puzzling questions that arise in the classroom, Create a place to write, store or display your questions, such as in a box, on a board (or Wonder Wall) or in a special book. Set aside some time, such as at the end of the week to choose and discuss a question or share out the questions for children to work on at home or swap with another class or group. Use computers, including use of email and website pages to extend the opportunities for questioning, interaction and dialogue. Use the interactive whiteboard to allow children to engage with a focal question or to develop questions within a lesson.

Task: Generating questions

In this task children generate and discuss questions on a chosen topic. The teacher also brainstorms /devises some back-up questions.

1. Ask children generate questions on a chosen topic in twos or threes.
2. Share and analyse questions together. How many different questions were created?
3. Discuss the kinds of questions that were asked.
4. What were the most interesting questions? What made them interesting?

12. Analyse questions: the question quadrant

The questions students ask can be analysed into different types. A useful distinction is that between closed questions that only require one answer and open questions that have many possible answers. These can also be called factual (closed) or enquiry (open) questions. When applied to a text a closed question is a comprehension question where the answer is in the text. An open question may require the use of imagination to read 'beyond the lines' and make an inference, speculation or hypothesis requiring the use of imagination
Many teachers have found Professor Phil Cam's 'Question Quadrant' a useful tool in analysing questions with children. This tool is particularly effective in the context of philosophy for children when the children are asked to raise questions from a stimulus which could be a text, object or picture. Having listed their questions these can then be analysed using the Question Quadrant. Teachers report that the use of this tool improves the quality of children's enquiry questions. Philosophy for Children is a valuable pedagogy to improve the quality of critical thinking in your classroom (see Fisher R. Teaching Thinking)

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TEXTUAL QUESTIONS

Reading Comprehension The answer is in the text	Literary Speculation Using your imagination
CLOSED QUESTIONS	**OPEN QUESTIONS**
Factual knowledge One right answer	Enquiry questions Many possible answers

INTELLECTUAL QUESTIONS

Source: Adapted from Cam P. (2006) 20 Thinking Tools, ACER, p34

Task: What kind of question is this?
Ask students to think about what is strange, interesting or puzzling about a particular text, to generate and share questions. List their questions then ask them to analyse the questions eg using the Question Quadrant. Could they turn any of the closed questions into more interesting open enquiry questions?

13. Positive, negative, interesting points (PNI)

We need to aims to force students to think about any situation before assessing or coming to a judgement about it. The process should involve the teacher helping the student to listing all the good points about a piece of work, the weak points and the points of interest or potential development about a given idea, object or event. It is one of the most effective tools in helping students engage in self-assessment for learning, for directing attention at particular features and generating thinking about different aspects of a topic.

'Positive' relates to the positive elements of the topic, 'negative' to the elements that need improving, and 'interesting' to those points are neither good or bad, but are regarded as neutral observations, comments or points of interest. These three elements help to model the 'praise sandwich' approach to assessment, that is we should begin any self, peer or student assessment with what is successful in the work in hand, then applying critical thinking to what is unsuccessful or lacking in some way and ending with a positive review of what was or might be interesting to do next. Or to put it another way to ask for example:

> 'What do you think worked in what you did?'
> 'What would you say did not work?'
> 'What might help it work better next time?'

PNI is a useful critical thinking and evaluation tool that can be used to generate thinking about any situation or piece of work. Pictures, objects or texts can be subjected to creative analysis using the PMI method. The following are examples of activities with which to practice divergent thinking using PMI.

Task: Assessing - positive, negative and interesting points
Make a list of of good points under Positive, Negative and Interesting points about a given topic, for example:

1. Homework should not be compulsory for any child.
2. If school uniform was/was not compulsory.
3. Students should choose which classes they attend.
4. Think about what you have done today, yesterday or during the last week. What were the positive, negative and interesting points in your life during this time?
5. Choose a book, picture or TV film and do a PNI on it.

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14. Use inference: reason from evidence

Reasoning is the mental process of looking for reasons to support beliefs, conclusions, actions or feelings. This process of supporting belief in the truth of conclusions is also called inference. Different forms of reasoning may be used to support or justify conclusions. The main division between forms of reasoning or inference is between informal or inductive reasoning and deductive or logical reasoning. inductive reasoning, the truth of the premises does not guarantee the truth of the conclusion. Instead, the conclusion of an inductive argument follows with some degree of probability. The conclusion of an inductive argument gives more information than is already contained in the premises. Thus this method of reasoning is explanatory. A classical example of inductive reasoning comes from the 18th century philosopher David Hume:

Premise: The sun has risen in the east every morning up until now.
Conclusion: The sun will also rise in the east tomorrow.

Critical thinking is about students giving reasons to support any claim to belief or knowledge. The key word for young children to use is ‘because’. In comparing one thing to another they are enging in analogical reasoning In making inferences from evidence they are also engaging in hypothetical reasoning.

Analogical Reasoning
Analogical reasoning infers that if two or more things are similar in some respects they are probably also similar in some further respect We use such comparisons to explain, illustrate or argue what we mean. Suppose, for example, that I am thinking about buying a new car. If I discover that three of my friends have recently bought a certain car and have been delighted with their purchases, then I will conclude by analogy that if I buy this type of car I will be delighted, too. Of course, this argument is not deductively valid; it is always possible that my new car may turn out to be an exception. I need to weigh the evidence to determining the relative strength or weakness of my inference. For more on analogies see Thinking Tool 8: Metaphorical Thinking above.

We need to help students to critically assess the evidence that support their conclusions. Factors to consider include: Number of instances, variety of and relevance of reasons

Task: Reasoning from evidence; making inferences
Give the students a picture, text or object and a sheet of paper with three headings: Questions, Knowledge, Inferences.
Ask them to think about what they can see and to record under ‘Questions’ what they do not know and want to find out; under ‘Knowledge’ what they know for certain about it and under ‘Inferences’ what they do not know for certain but can infer through reasons or evidence. These inferences are of course hypotheses.

15. Make deductions: be logical

A deductive inference uses logic or reasoning by deduction. Pure logic is based on a mathematical approach to knowledge, it relies on lines of reasoning that can be set in symbolic form. Deductive arguments aim to be valid. An argument is valid if the conclusion must be true when the premises (the reasons given to support that conclusion) are true.

One traditional form of logical reasoning is the syllogism, which takes the form of two statements (assumed to be true), followed by a conclusion which is drawn from them. For example,

All children love sweets
Mary is a child
Therefore Mary loves sweets

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Give students practice in making similar deductions by supplying conclusions to given premises, for example,

All fish can swim
The trout is a fish
Therefore ...

Discuss examples of faulty reasoning, for example:

All children love sweets
Peter loves sweets
Therefore, Peter is a child

The drawing of circles or sets can help to show whether the relationship of one part to another is clear or whether it is ambiguous (and might be contained in another set, for example Peter may be an adult or a horse). Ask whether the evidence or information given is sufficient to reach definite conclusions. What else do we need to know?

Ask students to write, analyse (draw in sets) and discuss their own examples, for example.

All teachers are …
David is …
Therefore David is …

Encourage children to distinguish 'some' from 'all' in analysing arguments, for example if most road accidents are caused by fast cars, what can we say about fast cars or any particular fast car?

Exercises in deductive logic do not easily transfer to talk about the real world unless there is a process which links the two, such as the scientific methods to establish 'proof'. Everyday reasoning depends on the ways we use language to create meaning. But even when meanings are clear everyday reasoning is prone to error (to being invalid). That is why we need the tools of deductive reasoning.

Task: Deductive reasoning
Which of the following arguments are valid and which are not?

1 If you eat an apple a day you will keep the doctor away. You do not eat an apple a day. You will not keep the doctor away.
2 If there is a red sky tonight tomorrow will be shepherd's delight. There is a red sky tonight. Tomorrow will be shepherd's delight.
3 If peolple were meant to fly they would be born with wings. People were not born with wings. They were not meant to fly.
4 Of it is good for the goose it is good for the gander. It is good for the gander. Therefore it is good for the goose.

Now make up some of your own examples of valid and invalid arguments

16. Ask critical questions: use Socratic questioning

Questions become Socratic when they are genuine invitations to enquiry, for example, 'What do you think?' Socratic questions provide a stimulus for thinking and responding. They differ from random open-ended questioning in that they follow a pattern, a progression of questions that probe reasons and assumptions and take the enquiry further. Socratic questions urge students to probe or 'dig deep', and to think clearly about the concepts they use to explain the world.

Socratic questions are the kind that can add rigour to any lesson. They help move discussion from unstructured talk and unsupported opinion to dialogue with purpose and direction.

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Research suggests that teachers should in general ask fewer but better questions. What are these 'better questions'? There is no fixed set of questions that are Socratic, but the following is a summary of questions that are open, Socratic and act as structured, progressive invitations to critical thinking.

Socratic questions

1. Questions that seek clarification:	
Can you explain that?	Asking for an explanation
What do you mean by...?	Seeking a definition
Can you give me an example of ...?	Seeking examples
How does that help?	Seeking support
Does anyone have a question to ask?	Sustaining enquiring
2. Questions that probe reasons and evidence	
Why do you think that?	Forming an argument
How do we know that...?	Probing assumptions
What are your reasons...?	Seeking reasons
Do you have evidence...?	Asking for evidence
Can you give me an example/counter-example?	Requesting counter examples
3. Questions that explore alternative views	
Can you put it another way...?	Re-stating a view
Is there another point of view?	Inviting speculation
What if someone were to suggest that?	Alternative views
What would someone who disagreed with you say?	Counter argument
What is the difference between those views/ideas?	Distinctions
4. Questions that test implications and consequences	
What follows (or can we work out from) what you say?	Implications
Does it agree with what was said earlier?	Consistency
What would be the consequences of that?	Consequences
Is there a general rule for that?	Generalising rules
How could you test to see if it was true?	Testing for truth
5. Questions about the question/discussion	
Do you have a question about that?	Questioning
What kind of question is it?	Analysing
How does what was said/the question help us?	Connecting
Where have we got to/who can summarise so far?	Summarising
Are we any closer to answering the question/problem?	Coming to conclusions

Thinking time

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Allow sufficient time for students to reflect on the questions asked or problems posed. Critical thinking seldom involves snap judgments; therefore, posing questions and allowing adequate time before soliciting responses helps students understand that they are expected to deliberate and to ponder, and that the immediate response is not always the best response.

17. Create categories: draw distinctions, discuss borderline cases

Critical thinking depends on the meanings of words and also on the strength of evidence that supports a particular statement. The question `Do spiders have eight legs?' requires different forms of reasoning – definition of terms, evidence (observing, collecting, classifying spiders) and a logical chain of reasoning. The ability to pattern experience into conceptual categories, classes or sets is the basis of thought and communication, of reasoning and the scientific method. We pattern our experience through concepts or category names like spiders, fire, fear, love, which provide the building blocks of thought. A concept is an abstraction or generalisation from experience. It can be used to interpret fresh phenomena and data, to ask for example' Is a spider an insect?' and enables us to perceive connections between items of knowledge, for example what links spiders, octopus and octagon?

In creating categories we usually draw distinctions between things that are the same and similar in some respects but that we need to keep apart because they do not fit into that category. To make a distinction is to identify the property or properties within a specified category or domain in which they differ. There are also borderline cases which can provide fruitful sources of debate and discussion.

Task: Drawing distinctions and discussing borderline cases
Take a contestable concept, like 'friendship' and discuss borderline cases, drawing distinctions between 'a friend' and 'not a friend'.

For example create some statements about friendship and asked students to sort the statements into two piles, one for those they agreed with and one for those they disagreed with. Each group then compares their decisions with another group, and then with the whole class. Which of these statements do you agree with and which do you disagree with?

- A friend is someone who is always there to help when things go wrong.
- A friend will always forgive you if you do something wrong.
- Friends are just the people you see every day.
- Friends are people who are the same race and religion as you.
- A friend is someone who does what you say.
- A friend is someone who will never lie to you.
- A friend is a special person you can share secrets with.
- A friend is someone who is loyal to you – no matter what.

Students can be given rules for classifying information for example whether a word is being used as a noun or as a verb. The Create Categories strategy, however, challenges students to categorize information by discovering the rules rather than merely memorizing them. For example students could be asked to distinguish phenomena into two categories such as animals and plants, then to research the categories and come up with proposed rules or criteria for each category. Such critical thinking approaches typically results in better understanding than more directive teaching methods.

18. Conceptualise subject knowledge

Critical thinking can contribute to children's thinking about the conceptual nature of any subject. We know from research that many students have hazy or confused notions about the nature of different subjects and methods of enquiry. Helping them to discuss and conceptualise subject knowledge will help their understanding of the nature of of subject

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matter and its relation to learning and to life. Subject knowledge should not be random bits of information and procedures but be part of the conceptual understanding of the nature of the academic discipline or domain. The following are the sorts of question that can be asked about any topic or concept related to subject knowledge or to the nature of the subject itself.

- reflection on the nature of the subjects, through discussing such questions as:
  - What is…? (eg history, geography, science etc.) Who studies …? Why do they study …?
  - Who are better at …, girls or boys?
  - Do you need a special talent to be good at …? Is … useful? Why study …?
- reflection on personal experience in the subject, developing self awareness through for example by:
  - keeping a learning diary or notebook to record ideas, feelings and problems,
  - discussing experiences in learning … like being stuck, explaining, problem solving, being tested etc.
  - having a help or question box where students can post any problems they have about … for later discussion
- reflection on concepts in …, developing a metalanguage for mathematics, through for example discussing:
  - problematical concepts
  - discussing stories or news items with a … content
  - discussing the lives and work of pioneers in the study of …
- reflection on processes of investigation in …, for example by discussion of:
  - ways of investigation and problem solving in …
  - ways of gathering and interpreting data in …
  - possible strategies for solving a problem in …

Every subject has its conundrums. For example in mathematics: are mathematical entities, as Plato believed, real, independent objects of study about which discoveries (and mistakes) can be made? Or as constructivists believe, is it we ourselves who construct what we talk about in maths?

Task: The following are some questions to promote critical thinking about the subject of mathematics.
Questions to encourage reflection about the nature of mathematics include

- Is mathematics useful?
- What does 'useful' mean? How is maths useful?
- Who uses mathematics?
- What is a mathematician?
- Are you a mathematician?
- What do you do to become good at maths?
- Can everyone succeed in maths?
- What does 'succeed' mean?
- Is success in maths the same for everyone?
- What makes maths a challenge (hard)?
- What is a 'challenge'?
- Is a challenge in maths the same as other challenges, such as in sports?
- What is mathematics? Is maths invented or discovered?
- What does 'invent'/'discover' mean?
- What have you invented or discovered in maths?
- Does maths have a purpose?
- Does all maths have a purpose?
- What is the purpose (or usefulness) of what you have been doing in maths?
- How important is maths compared to other subjects?

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- What questions do you have about maths?

Source: Fisher R. (2003) Teaching Thinking (Continuum) p211

For more discussion plans about the nature of subjects across the curriculum see Robert Fisher Teaching Thinking (Continuum) p202ff

19. Discuss criteria: reasons for making judgements

A criterion is a standard that we use to assess what we have thought/done, evaluate the process and judge the outcome. There are different kinds of criteria. There can be

- a single criterion that is a necessary or categorical condition, for example that to be a fact it must be true.
- one of a number of criteria, each of which may be sufficient, or some of which are sufficient or all of which must be fulfilled for a judgement or decision to be made, for example 'these are the criteria for a successful project'.
- aims that we aspire to, that are desirable but are a matter of degree, for example that a student must get 'a high mark' (a comparative standard that is open to interpretation).

In other words criteria can be single or plural, absolute or comparative standards by which we judge things.

Some common kinds of criteria in education are aims or learning objectives, rules that have been agreed or tests. According to the philosopher Popper a criterion is only scientific when it is testable. Criteria are implicit in all judgements and decisions made. What we need to do with students is to help make explicit the criteria by which they are assessed and by which they can assess others and themselves. With primary pupils we begin by involving students in discussing the word and by constructing with them criteria by which to judge things. We make clear the criteria by which things are judged and invite them to identify criteria for judgement themselves. With secondary pupils can we introduce the notions of necessary and sufficient conditions.

Task: Discuss criteria for judgement
Question cues: What criteria should we use to judge whether …?

Ask students to discuss one or two pieces of work and ask them which they prefer and why. Discuss what they think is good/not good about the chosen piece of work. Use their descriptions of what is good to identify the criteria by which they are using to judge it. Record the criteria and discuss whether they are necessary, sufficient or desirable conditions

20. Make critical self evaluations– assess for self learning

In personalising the curriculum and expecting children to take some responsibility for their own learning, we want them to relate to what they are learning, to try to involve their personal interests, thoughts and imagination. To do this they need to:

- critically evaluate outcomes, for example by discussing: Have I/you succeeded? What is good about what I/you have done? What could be improved?
- critically review the whole process, for example by discussing: Would I/you do this again? Would I/you do it this way ? What haveI/ you learnt from doing it?

One way that has proved effective is to ask 'you-questions' which aim to help the student identify with the subject matter. "You-questions' are addressed directly to the student. They should be relevant to personal experiences, interests and feelings and invite personal opinion, knowledge and experience. They can also be discussed and shared with others. Examples of 'you-questions' include:

Questions that can help in this process include:

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- What have you learnt? Assessing learning.
- What have you achieved? Assessing achievement.
- What do you feel good about/proud of? Assessing positive feelings.
- What do you like doing/learning? Assessing preferences.
- What do you do well? Assessing strengths.
- What do you find hard? Assessing difficulties and problems.
- What don't you know/understand? Assessing obstacles to learning.
- What do you wan to be able to do/improve/learn? Assessing targets and plans for the future.
- What support would help? Assessing the need for support.
- What do you think of yourself as a learner ? Assessing self esteem as a learner
- What are your targets for the future? What do you want to try to improve? How will you try to improve? Agreed targets
- What help will you need?

In carrying out a review with a child try to move from 'what' questions, such as 'What do you think your best piece of work was?' to the much harder why questions, such as; 'Why do you think your maths has improved?' The review should be more than a question-and-answer session, but should encourage children to speak freely and honestly about their learning experiences, and to discuss specific samples of work. As children begin to reflect on what they have done, and what has helped them this gives the opportunity to reflect on what they could or should do in the future and what will help them achieve these goals.

The process of review is an ideal means for developing these important metacognitive functions which are the tools of independent learning:

- Inner meaning having a sense of purpose about learning, knowing the reasons for, and the value and significance of learning activities
- Self regulation developing the need to think about and plan their work, encouraging self control and personal responsibility in learning
- Feelings of competence feeling confident about learning, knowing what you can do and how to get help
- Feelings of challenge being self aware, knowing how to deal with challenge and difficulty
- Communicating developing the ability to communicate, to share thoughts through discussion, writing and creative expression
- Setting targets setting your personal goals or objectives to aim for, having high but realistic expectations
- Being aware of self change knowing that you can change, gaining feedback on learning and identifying achievements

Task: Critical review of personal goals
In any learning task the students can be invited to review what they want to achieve. Choose a topic of study and ask students to identify the task and goals (aims) of learning. Ask them also to identify the goal, intended outcome(s) and to specify criteria foe success. The following chart is one way of recording a review of personal goals:

Topic:
Task:

Goal	What am I trying to achieve?
Outcome	What am I going to do?
Criteria	How will I know if I am successful?

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20. Discuss critical thinking

The following are some questions to reflect on and discuss.

- What are my/our views on critical thinking?
- How important is critical thinking in my classroom?
- How do I foster critical thinking in my classroom?
- Which of the skills or strategies for critical thinking are most important?
- What evidence is there that my pupils are engaged in critical thinking?
- Do I apply critical thinking to my own teaching?
- Do I ensure assessment for learning supports critical thinking?

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INFORMATION PROCESSING

21. Plan to learn

There are thinking skills that relate to all kinds of learning regardless of the subject matter. Some of these skills relate to planning and involve thinking ahead about the information and strategies needed to solve a problem - encapsulated by the question: What does one need to think about and do?

A plan is a set of steps or sequences that we believe will lead to success in a task. Personal learning planning may involve students defining the challenge and identifying which strategies to employ. At other times it means identifying the knowledge needed to tackle a specific learning task. The key to planning is sequencing ideas, in steps that follow each other. Finding the right order is often essential for any activity or investigation. Students who are struggling often need direct instruction in planning by being shown how to break down complex tasks into manageable stages, for example by:

1. defining the problem - what do we want to achieve?
2. gathering information - what do we need to know to tackle the problem?
3. forming a strategy - how can we tackle the problem?
4. implementing the strategy - how are we tackling the problem?
5. monitoring outcomes – what have we achieved or learnt?

A plan does not need to be a set order of steps, often plans need to be flexible to allow for the use of a range of possible strategies that may help in achieving our objective. As we move to a solution we may need to try out new ideas, to take account of new obstacles and changing circumstances. Planning in its simplest form means we have thought about what we are going to do. It is about having a prepared mind.

Teachers can model planning prompts as 'What do we need to think about first ..?', 'What are we trying to achieve ...?', 'What strategy could we use ...?' Such dialogic teaching helps develop metacognitive awareness when a teacher asks questions that probe the child's assumptions about their learning, developing awareness of:

- self (what must I remember?)
- task (what must I do)
- strategy (what plans do I have? (is this the best plan?))

Task: Planning research
On a chosen topic ask list , or ask students to list under 3 headings:
1. What do we know (about the topic)?
2. What do we need to know?
3. How can we find out? (Where? Who might help us?)

22. Consider all factors

Thinking requires input. As those who practice meditation find, it is very difficult to think of nothing. Most input is in the form of information of one kind or another. One weakness of human thinking is that it tends to be narrow, to use only the information it requires to fulfil a function. The brain tends to want to use the least energy possible to complete any given task. Hence the common experience of children saying 'Finished!' when more effort would produce a better outcome. Instead of a narrow focus we try to expand the focus of attention and review the whole field. What are all the factors should we consider in this situation? If we want students to have the ability to see things within a learning situation and beyond what seems obvious, things present and things that may happen they need to have experience in broadening their perception, to look beyond the given, and to consider all factors.

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'Have you considered all factors?' is important not simply for brainstorming ideas, but as an attention-directing tool that encourages thinking time. As with all tools skill in use requires practice and familiarisation (for example by having the acronym written on a chart or bookmark). The more the tool is used in a deliberate manner the more useful the tool becomes by being internalised through practice.

Task: List the characteristics
This is best begun as a group or class activity, and later as a paired or individual activity.
It presents that most basic of problem-solving strategies - consider all factors, list all characteristics, find out what you know/find out what others know, define the concept.

5 Choose a concept.
6 Write it on a board, large piece of paper or projector.
7 Ask group to give as many characteristics/definitions as possible of the concept word.
8 List all suggestions.
9 After listing discuss similarities/differences. Could they be grouped into an order?

Task: Consider all factors
Either on your own or with a partner make a list of factors for each of the following:

1. Your family have decided to move to a new home. What factors should they take into account in deciding on a new home?
2. You are choosing a summer holiday. What factors should you keep in mind?
3. What factors make for a good teacher?
4. What makes for a good story? List all the factors that might be included in writing a good story.
5. You are designing a chair. What factors should you take into account?

23 Define learning objectives and goals

Why are you doing this? is a question we can ask of ourselves or others. When children are asked this question in school they often find it difficult to give a clear answer. The most common answer is 'because my teacher told me'. Children do things without knowing why. They inhabit an environment whose purpose is activity but they do not know the reasons for this activity. They live in a moment-to-moment world where the pattern and purpose of their learning is not clear. They often do not know the focus of their learning or the aim of their learning activity. Help students define the purposes of the activity, for example by discussing: Why are you doing this? What do you hope to achieve? How will it help (eg to fulfill your needs/ambitions, or the needs of others)?

Creating goals
Questions to ask in seeking to create a powerful learning environment include:

- What goals or outcomes do you want for your students?
- How are they communicated?
- Who knows them?
- When are they reviewed?

Identify up to characteristics of the learning environment which you wish to create.
List these characteristics in order of importance.

By helping students define LOs we help them to identify the purpose of our thinking and learning. Trying to explain the distinctions between 'aims', 'goals' and 'objectives' may not be time well spent. What is important is knowing what one is trying to achieve, by asking for example:

What are we trying to do?
What do we want to end up with?
Why are we doing this?
What is the purpose?

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What objective are we trying to achieve?

The following are some activities that focus on defining aims or objectives:

Task: Defining Objectives
List what you think the following may be trying to achieve:
1. Your school.
2. Your teacher in assessing your work.
3. Your aims in going to school
4. Your parents or carers at home.
5. The students in your class.

24 Decide priorities
What were your priorities (in this piece of work?)

Some things are more important than others, some values are more important than others. Priorities are things that should be taken into account in planning and reviewing what has or should be done. Priorities provide a focus for effort and assessment of learning.

A lot of things are important, but which are most important?
'What are (or were) your priorities?'
'Are your priorities the same or different from mine or other people's?'

In reviewing a list of factors, for example in planning a piece of writing, we may think that all the factors are priorities – spelling, presentation, ideas, word length, topic etc. - and a case can be made for the importance or value of all these things. The role of 'Decide priorities' (or any prioritising strategy) is that it forces us to make choices and to decide what the really important things to consider should be.

In doing a prioritising exercise it is useful to set a limit on the number of priorities, for example three, four or five. The above CAF tasks can be extended to considering what are the most important priorities in each list.

Task: Deciding priorities
Make a list of factors and then prioritize three or four items in order of importance:

1. In choosing a friend what are your first most important priorities?
2. A sum of £1000 has been given to improve your school. what would be your priorites in spending the money?
3. What do you think are the most important factors in choosing to buy a new bicycle?
4. What rules should a school or class have? Which are the most important?
5. What should parents consider in choosing a school for their child? Which are the most imortant points to consider?

25. Map information
Researchers need to locate, extract and record relevant information. Concept mapping is one way to make visible a conceptual structure out of information, to record, process and build on it in any area of the school curriculum. The aims or purposes of information mapping (also called cognitive mapping, think-mapping, mind-mapping, concept mapping etc.) include to:
- explore what we know
- help planning
- aid evaluation

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A map visually consists of an arrangement of shapes such as boxes, circles, rectangles, triangles etc. connected by lines and/or arrows drawn between and among the figures. the map conceptually contains verbal information within and between the shapes to create a pattern or relationships of ideas. The whiteboard or computer is ideal for displaying networks of visual information. Software enables children to create their own visual diagrams, ready-made visual organisers that enable them to experiment with ways of presenting information and ideas. Mapping encourages children to:

- actively engage in thinking about, interpret and build on information and ideas.
- communicate information to, from and among pupils and teachers.
- organise information, to show understanding of relationships between ideas
- develop a visual strategy to aid to memory.
- understand the structure of any text or body of knowledge

The best way to begin introducing concept maps to children is to construct some of your own, first with general topics such as animals or vehicles, then with topics of study in school. The mapping of a subject should help you to think more clearly about it. When you have practised the process you may wish to introduce your pupils to the process.

Task: Concept mapping

1. After brainstorming/listing words connected to a concept write the concept word in the middle of the board or a page.
2. Link the connected words tothe central concept word w ith lines.
3. Write along the lines the relationship between the concept and connected words.

Mapping a text

1. Give each pair of children a page from a reading or text-book. (a text of 10/30 sentences) Ask them to list, or mark every concept word they can find.
2. How often does the same concept word appear? Which concept word appears most often? Which are the most important concept words (which words could you not leave out for the passage to still make sense?).
3. List or mark words that are not concepts, that don't mean anything by themselves.
4. Share and discuss.

26 Memorise

Do you help students try to improve their power to memorise information? Do you practise memory games with them?. Remember that it is the discussion of strategies that stimulates the thinking about learning. Just doing it is not enough

Think about the ways in which the mind can try to process into the memory such information. The mind tends to remember more when it can link units of meaning into patterns. A famous psychological study showed that the human mind can recall about 7 (plus or minus 2) unrelated items of knowledge[6]. Memory can of course be trained, for example by making patterns out of the information given, and repeating these patterns until they become internalised as long-term memories. These patterns can created in visual ways, for example through remembering how things looked, verbally through how things sound or physically through doing things such as writing things down to remember them. These patterns can be processed in different ways by the human brain. In what ways do you prefer to process information:

- verbally - through listening and saying or repeating the information
- visually - through seeing visual patterns, or pictures "in the mind's eye"
- logically - through seeing a pattern of logical or mathematical relations
- physically - through physical representation or bodily gesture
- musically - through melody, rhythm or musical association
- personally - through linking information to personal experiences or memories

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- socially - through learning with and from others, sharing a task

There is not one way of remembering or learning, but many ways. Some people call different ways of learning
learning styles (for more on learning styles see p00), others say they reflect different types of intelligence.
We know that staring at a textbook is one of the most inefficient ways of learning facts. It is when we are
actively processing the facts, doing something with them, that they are likely to stay in the memory.

Task: Memorising information

1. Look for about 10 seconds at this line of numbers, cover them and see how many you can remember by writing them down

1 0 1 0 0 1 0 0 1 1 0 1 0 0 1

2. How successful were you at remembering (processing the information)?
   What strategy did you use to try to remember the information?
   What helps us to remember and learn things by processing information?
3. Try this task with children. Discuss what helps them t remember.

27. Thinking words

What words would describe your thinking and learning?

We need to engage students in learning conversations about their thinking and learning. To do this well we need to discuss the key words that will give them the vocabulary to talk about thinking and learning. Once introduced these thinking words or concepts would be revisited in following years. The following are some thinking words to discuss with students from 5-14 years.

abstract - concrete accept - reject agree - disagree analogy - metaphor analysis - classification argue - persuade argument - quarrel assess - evaluate assumption (implicit)- assertion authority - plausibility of evidence brain - mind cause - effect cause/effect relationships clarify - confuse classify - category clear-ambiguous (vague/imprecise) compare - contrast concepts (clear/fuzzy) connote - suggest consistent - circular argument consistent - inconsistent content - context	explain - justify explicit - implicit fact - opinion fair - unfair fallacy - fallacious argument hypothesis - statement of fact identical - contradictory imagine - imagination implications - consequences infer - imply - entail inference - deduction interpretation - point of view justified - unjustified know - believe listening - speaking logic/logical - illogical logical certainty - logical impossibility meaning - definition mystery - philosophy necessary - sufficient conditions objective/subjective observation - interpretation paraphrase - summarize	qualifying - refuting prove (proof) - guess(work) question/s - answer/s questions (open and closed) rational - irrational real - not real reason - explain reason - faith - intuition reasons - supporting arguments relevant - irrelevant right - wrong rule - exceptions rule - rules relevant - irrelevant similar - different simplified - over-simplified talking - discussing thinking - thoughts - ideas true - untrue (truth/lies) view/s - opinion/s

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criteria (criterion)- judgement data - information dilemma - compromise distinctions - similarities empathy - emotional intelligence evidence -example example - counter example	plausibile - implausible possible - probable - certain predict - assess prejudice (bias)- balanced view premise - conclusion principle - grounds for belief problem - solution prove - disprove	weak/strong argument - criticism Add your own 'thinking words' to this list:

Task: Plan a teaching sequence for thinking words
If thinking skills are to be explicitly taught at the year level indicated, this should include teaching a vocabulary of thinking words and concepts. Try one of these tasks for planning a teaching sequence for thinking words

1. What words you would want to introduce to students in a year group each stage of schooling (5-7 years, 7-11 years, 11-14 years)?
2. What are the 3 most important concepts to introduce to students in each year or stage of schooling?
3. What are key learning words that relate to a current topic in your teaching? How will you ensure students understand these learning concepts?

28 Metacogitate

Metacognition (self awareness) is about the ability to understand and relate to oneself. It is probably the most important aspect of human intelligence, for it is linked to the processing of all other forms of intelligence. It is the 'me' in cognition. It is the access we have to our own thoughts and emotions, to what we think and feel, and why we do things. At the heart of metacognition is self awareness – summed up in the words carved over the Delphic oracle: 'Know Thyself'.

The following activities can help in developing metacognitive awareness:

- keeping a personal diary or journal
- planning how to use time
- predicting what you will be able to do well or have difficulty with
- discussing and understanding your feelings and moods
- recognising who you are like or unlike (see below)
- setting and achieving personal goals
- reviewing and evaluating what you have done

The following task can encourage metacognitive reflection:
Task: Metacogitate: assessing what we know
After a lesson. or period of study ask students to assess:
1. What they know (or understand),
2. What they think they know
3. What they do not know (or confuses them about the topic of study).

One way of recording this is in three columns or boxes to write what they:

Know or understand	Think they know or understand	Do not understand (are confused by)
√	?	x

Many teachers encourage their students to keep journals, learning logs or 'thinkbooks' as intellectual diaries in which to record their questions, observations and feelings about what has been taught, as a form of continuing review of the learning process. Students need help in

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keeping and learning from their journals, for example by making the journal interactive, with the teacher or a chosen response partner making a written response to journal entries. The journals may be private, so that children can feel free to record their true feelings and observations about what they have learnt and about themselves as learners.

Think write - about me
1. Think about yourself, or an area of your learning, and write under five headings:
    Who am I?
    What I am good at?
    What I am not good at ?
    What I find interesting?
    What I want to achieve?
    How will I achieve it?
    What do I need to do next?
2. You might want to show this to others, or keep it to yourself!
3. If this description was read to your friends, without naming you, would they recognise you?

Ask your students to try this exercise.

29 Summarise

Summarising means to check understanding of the whole of the topic, for example by asking: What was said? Can you say it in a few/your own words? Can you say what you think/know? This also involves helping students to clarify what they mean, for example by asking - What does that word/point/detail mean? Can you explain it? Are you saying that...?

'Reciprocal teaching' incorporates the key dialogic thinking tools of summarising, questioning, clarifying and predicting. It follows the principle that the best way to learn a process is to teach it, and uses the four strategies of successful learners:
- summarising
- questioning
- clarifying
- predicting

The teacher first models the process by summarising, asking a question, clarifying a point and predicting what will come next. Next time round the learner takes on one or more of these activities, and gradually expands this role. The aim is to gradually remove assistance to the learner, encouraging the learner to take more responsibility in the learning situation.

Summarising is useful as a means of synthesising the meaning of any complex message, in the process of assessing learning. The ability to provide a good summary is an advanced, higher order skill. It involves a number of important cognitive processes including:
- judging which ideas are important
- applying rules for condensing information
- practising in the communication of key ideas

Summarising can be done as spoken or written summary, and older children should gain experience of both. The practice of taking notes and concept mapping can help in this process. As these are advanced skills plenty of guided practice is needed. Students will need to be shown what to do and told the strategies that will help them, such as:
- deleting unnecessary material
- grouping parts into larger concepts
- picking out key terms, phrases or sentences
- creating new sentences which summarise the important points

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Children should be encouraged to 'look for the big ideas' in all that they learn. A good way to begin is for the teacher to model the process, and for the teacher to think aloud while searching for the main ideas. The following are some activities to help in develop the skills of summarising;

Task: Summarise what you have learnt
1. Ask students to summarise a text, lesson or learning experience in 100 words, then 50 words then in one sentence.
2. Try to summarise the key things that for you are most important in this booklet.

30 Help students become researchers

The aim of teaching students the tools of thinking and independent learning is to support personal learning planning and peer and self-assessment, so that students can take greater responsibility for their own learning. In help students to plan, define and decide priorities for their learning, to locate, classify and represent information; to memorise, think about and evaluate their learning we are helping them to become independent researchers.
The following are some of elements of research to consider in becoming a researcher:

- Design a research plan to show stages and possible timetable for your research
- Identify the key question(s) that your research will try to answer
- Decide on research methods for collecting information (data) eg reading, Internet, observation, interview, recording
- Systematically collect data about your research topic
- Analyse, summarise and present your data
- Critically discuss your conclusions/ answers to research question
- What further research is needed?

How could you make part of your teaching a joint research project with students?

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Further Reading
Fisher R. (2003) 2nd ed Teaching Thinking, London: Continuum (3rd edition due late 2007)
Fisher R. (2005) (2nd ed.) Teaching Children to Learn, Cheltenham: Nelson Thornes.
Fisher R. (2005) (2nd ed.) Teaching Children to Think, Cheltenham: Nelson Thornes
Fisher R. (2006), Starters for Thinking, Oxford: Nash Pollock.
The Question Quadrant is adapted from Cam, P. (2006) '20 Thinking Tools' ACER Press

Appendix: An audit of Tools for Thinking

Creative thinking

- What is your definition of creativity?
- How important is creative thinking in your classroom?
- How do you foster creative thinking in the classroom?
- What is evidence of your pupils being creative thinkers?
- What is evidence of your own creative thinking in teaching?
- Do you ensure assessment supports learning and creative thinking? If so, how?

Critical thinking
The following are some questions to reflect on and discuss.

- How would you define critical thinking?
- How do you foster critical thinking in your classroom?
- Which of the skills or strategies for critical thinking are most important?
- What evidence is there that your pupils are engaged in critical thinking?
- Do you apply critical thinking to your own teaching?
- Do you ensure assessment for learning supports critical thinking? If so, how?

Information processing
The following are some questions to reflect on and discuss.

- How do you engage students in personal learning planning?
- Do you involve students in defining learning objectives?
- Do you help students in using verbal and visual strategies to record information?
- Do you discuss memory strategies and other learning strategies with students?
- Do you use strategies to help develop students' metacognition and self awareness?
- Do you help your students to become researchers? If so, how?

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