Module 11

Principles for teaching thinking

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Principles for teaching thinking

Objectives

- To consider how teachers can develop the skills of independent thinking in their pupils
- To introduce teachers to the principles for teaching thinking

Resources

- OHTs 11.1–11.4
- Handouts 11.1–11.2
- Appendix 11.1, Teaching thinking in the Key Stage 3 pilot
- Flipchart and pens

Session outline — 75 minutes

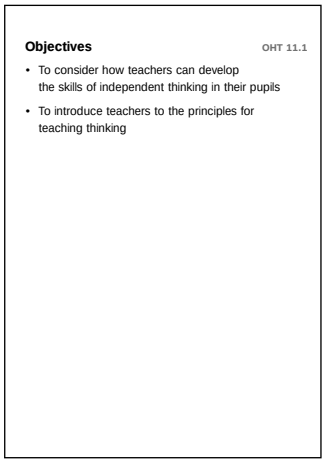
11.1	What is outstanding performance?	10 minutes
11.2	Understanding the principles of teaching thinking skills	20 minutes
11.3	Study time	20 minutes
11.4	Post-study discussion	20 minutes
11.5	Ready for more?	5 minutes

Note for presenters

This module requires only 30 minutes of initial meeting time and the rest can be undertaken individually, or together if preferred. A further 25 minutes is useful to start to consolidate and extend what has been covered. The module would fit well into two departmental meetings.

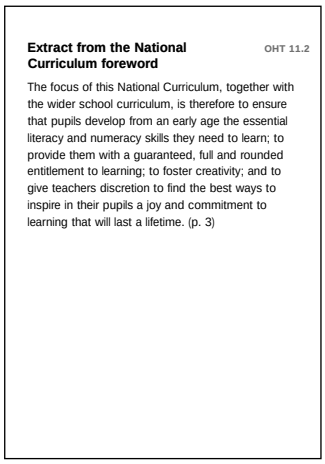
11.1 What is outstanding performance? 10 minutes

Show **OHT 11.1** and clarify the objectives of the module.



Explain that consideration of the role and importance of thinking skills tends to coincide with reflection on the goals of education. The teaching of thinking skills should enable pupils to leave compulsory education well equipped and motivated to continue learning. This does not conflict with more direct teaching of basic skills. This is expressed well in the National Curriculum foreword.

Show **OHT 11.2**.



If possible, participants should discuss the following question with another teacher of their subject – otherwise, they should reflect on it alone.

What characterises pupils who perform outstandingly in your subject, whether in written work, discussion or performance?

Allow about 5 minutes for discussion. Take feedback and record responses on a **flipchart**.

Show **OHT 11.3**.

What is outstanding performance? Some common responses OHT 11.3

- Seeing patterns in data
- Making links with other topics or areas
- Thinking laterally
- Being creative
- Generalising
- Solving problems
- Checking and refining solutions
- Seeing different viewpoints
- Using existing knowledge
- Knowing a lot
- Having a good memory
- Fast processing of information
- Working with others

Make these points:

- Intelligence may be regarded as the capacity to learn.
- There is general agreement among researchers that intelligence is not a fixed commodity. There is a possibility that we can increase the intelligence, or intellectual functioning, of most pupils.
- The task in teaching thinking is to move as many pupils as far as possible in the direction of outstanding, intelligent performance which equips them for being creative, flexible and committed learners.

Four ways to improve thinking are to improve:

- general thinking ability;
- particular thinking abilities;
- metacognitive thinking – the ability to monitor, regulate and select strategies in doing a task;
- the disposition to think.

11.2 Understanding the principles of teaching thinking — 20 minutes

Distribute **handout 11.1**.

Design a mammal Handout 11.1

Instructions

You have to design a mammal to live in the Canadian Arctic. You can choose up to six characteristics for the animal and these characteristics must make a sensible/competent animal. You must think hard about what the environment is like. You have 3 minutes to read the list, then you can ask any questions about the information or the task.

Characteristics	Characteristics
Can swim	White fur
Thick fur	Can hibernate
Can eat huge amounts at one time	Digging claws
Looks beautiful	Can close nostrils
Sharp incisors	Can hold breath for 30 minutes
Good swimmer	Stripes
Good sense of smell	Migratory
Eyes that look forward	Fast runner
Lives in large groups	Wary of humans
Good eyesight	Can swerve on the run
Prehensile tail	Long legs
Can eat fruit and leaves	Can get fat

Explain that the task provides the basis for understanding the principles of teaching thinking. If possible, participants should do the task in groups of three or four – otherwise they should think about it on their own. The task is to design something to match a particular context.

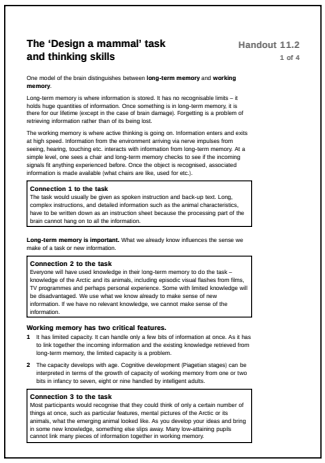
Allow participants about 10 minutes to complete the task. Take feedback from participants, focusing on these points:

- What can individuals say about their own thinking – what came into their minds?
- How did the group operate?
- What were the stages that their individual and collective thinking went through?

Note responses on a flipchart. Distribute **handout 11.2** for participants to read in study time.

11.3 Study time — 20 minutes

Ask participants to read handout 11.2.



The 'Design a mammal' task and thinking skills Handout 11.2 1 of 4

One model of the brain distinguishes between **long-term memory** and **working memory**.

Long-term memory is where information is stored. It has no recognisable limits – it holds huge quantities of information. Once something is in long-term memory, it is there for our lifetime (except in the case of brain damage). Forgetting is a problem of retrieving information rather than of its being lost.

The working memory is where active thinking is going on. Information enters and exits at high speed. Information from the environment arriving via nerve impulses from seeing, hearing, touching etc. interacts with information from long-term memory. At a simple level, one sees a chair and long-term memory checks to see if the incoming signals fit anything experienced before. Once the object is recognised, associated information is made available (what chairs are like, used for etc.).

Connection 1 to the task
The task would usually be given as spoken instruction and back-up text. Long, complex instructions, and detailed information such as the animal characteristics, have to be written down as an instruction sheet because the processing part of the brain cannot hang on to all the information.

Long-term memory is important. What we already know influences the sense we make of a task or new information.

Connection 2 to the task
Everyone will have used knowledge in their long-term memory to do the task – knowledge of the Arctic and its animals, including episodic visual flashes from films, TV programmes and perhaps personal experience. Some with limited knowledge will be disadvantaged. We use what we know already to make sense of new information. If we have no relevant knowledge, we cannot make sense of the information.

Working memory has two critical features.

1 It has limited capacity. It can handle only a few bits of information at once. As it has to link together the incoming information and the existing knowledge retrieved from long-term memory, the limited capacity is a problem.

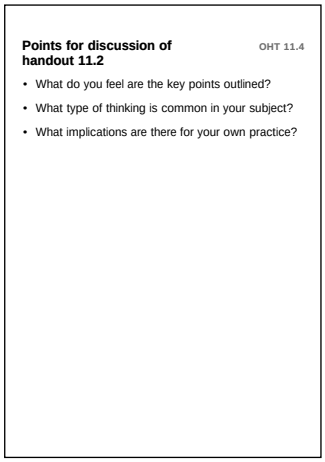
2 The capacity develops with age. Cognitive development (Piagetian stages) can be interpreted in terms of the growth of capacity of working memory from one or two bits in infancy to seven, eight or nine handled by intelligent adults.

Connection 3 to the task
Most participants would recognise that they could think of only a certain number of things at once, such as particular features, mental pictures of the Arctic or its animals, what the emerging animal looked like. As you develop your ideas and bring in some new knowledge, something else slips away. Many low-attaining pupils cannot link many pieces of information together in working memory.

x4

11.4 Post-study discussion — 20 minutes

Show **OHT 11.4**. Use it as the basis for discussion.



Points for discussion of handout 11.2 OHT 11.4

- What do you feel are the key points outlined?
- What type of thinking is common in your subject?
- What implications are there for your own practice?

11.5 Ready for more? 5 minutes

Distribute **appendix 11.1, Teaching thinking in Key Stage 3 pilot**. Participants should scan the text and decide on a strategy to try in their subjects.

Teaching thinking in the Key Stage 3 pilot

Appendix 11.1

There is no published programme for teaching thinking in the foundation subjects. In contrast, the CASE and CAME programmes (Cognitive Acceleration through Science and Maths Education) each offer 30 lessons with prepared resources as an intervention to be delivered approximately one lesson a fortnight over two years. This time is difficult to find in foundation subjects. The approach to teaching thinking in the Key Stage 3 pilot has been to use thinking skills strategies in normal lessons. (In planning lessons to develop thinking teachers have included subject-related objectives.)

In pilot schools the introduction of thinking skills into geography, history and RE has been relatively straightforward as there is a wealth of material available. These materials have been adapted to suit other foundation subjects.

Strategies for helping pupils develop their own concepts and principles

A variety of strategies have proved popular for helping pupils develop their **own** concepts and principles in topics. This is often more meaningful to pupils as it is the result of **their** thinking.

Sorting activities

Sorting cards with words, short pieces of text or even photographs or diagrams uses the basic skill of classifying. So, for example, pupils are given an envelope containing a collection of words printed on cut-up card. Their task is to sort the words into groups that have shared characteristics. They have to justify their decisions and explain their thinking to others.

As well as meeting subject-specific vocabulary objectives, the task helps pupils to develop their skills in information processing, reasoning, creative thinking and evaluation. Pupils classify words on the basis of shared characteristics, but they also do a lot of comparing and contrasting as they have to decide which characteristics are the most meaningful and powerful, which triggers the process of evaluating. Reasoning skills are developed as pupils have to justify their categories. Creative thinking is encouraged as there are no predetermined answers and pupils are free to explore the characteristics of the vocabulary. Evaluation skills are also emphasised when, in the plenary, the teacher encourages peer assessment of the emerging word groups.

Teaching thinking does not encourage an ‘anything goes’ climate, as pupils search for the best ideas and thinking available within a class. It should not be assumed that this will always come from the highest-attaining pupils.

To provide a more specific example, Year 7 pupils in one school had learned the German numbers one to ten. They were given the numbers one to forty (as words) and asked to sort them into groups that had features in common. The German endings to numbers that correspond with *-teen* and *-ty* became evident and the construction of number words in German apparent. The plenary asked pupils to explain how they had classified the words and to justify their answers. What was learned in this activity is especially important in the German language, which relies heavily on compounding for creating words. Pupils tend to remember patterns and generalisations that they have developed.

Odd-one-out

This has proved popular and useful, as it can be used as a quick starter or a full lesson depending on the learning objectives. It has been used in design and technology, art, music, RE and PE. Teachers put important words in a topic into sets of four, in which one word does not share the characteristics of the others in the set. Pupils have to justify their choice of the odd-one-out. Ambiguous sets of words are useful in showing that there may be more than one answer. This leads the pupils to use higher-order thinking as they reason and argue. Subject objectives are achieved as pupils develop greater familiarity with, and understanding of, important words in a topic.

Another variant of odd-one-out has been developed in modern foreign languages where pupils' understanding of grammar can be put into practice (subject lesson objectives), at the same time as providing an opportunity to assess learning. If the resource below is available on the desks or on an OHT as pupils arrive, purposeful work begins immediately.

> In your groups, discuss which is the odd-one-out in each list. There may be more than one answer. Give reasons for your choices.
>
> 1 j'ai parlé j'ai mangé je suis allé j'aime
>
> 2 nous sommes arrivés ils sont descendus ils ont mangé elle est entrée

There are several possible answers and, as pupils explain their decisions, important learning objectives such as recognising a range of tenses, the formation of the perfect tense and principles of agreement of the past participle are achieved.

Maps from memory, reading photographs and pictures, 5Ws

Subjects such as art, and design and technology, rely heavily on visual literacy, and thinking skills activities have helped with this. Maps from memory, reading photographs and pictures, and 5Ws (who, what, when, where and why) all contribute to pupils' ability to process visual information, to question the validity of images, to detect bias or to evaluate the work of an artist or photographer.

A task relating to maps from memory, which has worked well in food technology, uses a collapsed and flattened individual cereal packet. The teacher had the only copy of the flattened pack. The task was for each group to draw collectively their own version of the flattened packet. Working in groups of three or four, pupils took turns to visit the teacher's desk to observe the pack for 20 seconds, with no pencil and paper for recording. They then returned to the group to draw and write what they could remember, adding to what previous group members had seen.

This is a superb opportunity for pupils to develop insight into part–whole relationships (information processing). Planning, checking and group cooperation are developed in deciding on the best strategies for working. These methods are at the heart of the enquiry skills (posing and defining problems, planning what to do, predicting outcomes and anticipating consequences, and improving ideas). Groups become competitive and enjoy the challenge. The intense study of the information and layout of the packet can lead to wide-ranging work about requirements of food labelling, design and construction of packets, artwork and so on. The task has been used as an introduction to packaging and as a revision task at the end of a unit of work.

Mysteries

This is a powerful strategy. It is an alternative to providing pupils with a page of text to be tackled through comprehension questions. Pupils are usually posed one big open question. The data is provided on small slips of paper, which allow pupils to move it around on the table as they develop, shape and evaluate ideas. The data usually has a story-line, some characters, important topic-related subject knowledge and, possibly, some red herrings. As in most thinking skills activities, pupils work collaboratively in groups.

One design and technology teacher has created a mystery with the central question 'Why did the Tay Bridge collapse?' Pupils start by sorting the 30 bits of information into those that they think are relevant and those that are not. They have to interpret and make links to put the cards in groups, check and refine their sorted groups and form a view of the cause of the disaster. All five thinking skills are being developed in the activity. The pupils are sorting, classifying and sequencing and making links between the single data items (the parts) and their theory (the whole). In small groups and the whole class they are making inferences and using evidence as they give reasons for their ideas. This encourages the precise use of language. They are asking questions, posing and defining problems and testing and improving ideas. They have to be creative in generating theories about the causes of the disaster and they also have to evaluate the theories of their own group and of others.

Developing thinking skills

The examples above provide an insight into how pupils develop the thinking skills of information processing, reasoning, enquiry, creative thinking and evaluation. Where thinking skills are taught well, the lessons:

- have open and challenging tasks that make pupils think hard;
- encourage pupils to use what they already know;
- offer opportunities for work in collaborative groups with high-quality talk;
- encourage pupils to talk about how tasks have been done;
- produce learning outcomes at different levels – some relating to the subject content but others to how learning can be used in other contexts.

General resources

Adey, P. & Shayer, M. (1993) *Really raising standards* (Routledge) – a very good background to theoretical frameworks.

McGuinness, C. (1999) *From thinking skills to thinking classrooms: a review and evaluation of approaches for developing pupils' thinking.* DfEE Research Report RR115 (Department for Education and Employment) – an extremely valuable review.

Objectives

OHT 11.1

- To consider how teachers can develop the skills of independent thinking in their pupils
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Extract from the National Curriculum foreword

OHT 11.2

The focus of this National Curriculum, together with the wider school curriculum, is therefore to ensure that pupils develop from an early age the essential literacy and numeracy skills they need to learn; to provide them with a guaranteed, full and rounded entitlement to learning; to foster creativity; and to give teachers discretion to find the best ways to inspire in their pupils a joy and commitment to learning that will last a lifetime. (p. 3)

What is outstanding performance? Some common responses

OHT 11.3

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Points for discussion of handout 11.2

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Design a mammal

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The ‘Design a mammal’ task and thinking skills

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Improving the ability to think

Cognitive ability is related to three factors:

1 **Genetic make-up:** There is much argument about the importance of genetics to intelligence, but there is some level of agreement that only about 20% of the variation in intelligence is accounted for by genetics.

2 **Time:** The brain develops with the maturing of the central nervous system, reaching its peak in the late teens or early twenties. Secondary-age pupils draw on greater resources than primary-age pupils.

3 **Environment:** Stimulating and supportive environments foster cognitive development. Home backgrounds and nurseries which are rich in experiences and challenges, with lots of opportunity to do things, play, hear stories and ask questions, give an advantage to young children. This is the only one of the three factors over which we have any influence.

Schools can help cognitive development by providing learning opportunities with challenge, which are pitched to avoid, on the one hand, boring, repetitive work and, on the other, tasks that are totally beyond pupil capability. In cognitive psychology this is referred to as 'cognitive conflict' and the struggle to think through challenging problems and issues has the potential to help to develop working memory or information-processing capacity.

Better processing capacity or cognitive development is likely to lead to better achievement at school. High-achieving pupils, with well-developed cognitive ability, tend to do well in most subjects, while low-achieving pupils, with poor cognitive ability, tend to do badly in most subjects. It is unusual for pupils to get As mixed with Fs, Gs or Us at GCSE or scores that are two levels apart in Key Stage 3 National Curriculum tests.

Connection 4 to the task

In the task there are many opportunities to struggle beyond the initial task, for example:

1 justifying choice of features in the light of information about the environment;

2 thinking whether the six features actually fit together to make a sensible animal;

3 being challenged with questions such as 'How would your animal actually catch its prey?' or 'How would it survive 3 or 4 months of permanent dark winter?';

4 presenting information about adaptations of its prey to avoid predation;

5 hearing other people's reasoning;

6 being asked 'Would the animal survive in a desert?'.

Improving specific thinking ability

If certain patterns or strategies are stored in long-term memory they are helpful. Experts generally don't have a bigger working memory but the structures in their long-term memory allow them to pick out patterns in incoming information. Instead of perceiving a jumble of information, they see a pattern. They are not seeing discrete pieces of information but bundles of connected information.

When successful pupils do a task they think at a variety of scales. They think about detail but they also think about pattern – the big picture – to see if the detail makes sense. Without conscious effort they skip backwards and forwards between scales of thinking. They use the big picture to check the detail and build the big picture from the detail. They don't do one first and then the other. They keep jumping about. Low-achieving pupils often lack the big picture or the reasoning pattern.

Connection 5 to the task

In the 'Design a mammal' task, once it is recognised as a planning problem in which the design has to fit the context and the parts have to make a reasonable whole, the demands of the task become easier. Many pupils will not have this advantage.

Sharing thinking

Another principle of teaching thinking skills is that good thinking is shared through talk (see module 12 'Thinking together). This acknowledges the idea of social construction (from Vygotsky). In simple terms, a group is capable of better solutions than an individual – the whole is greater than the sum of the parts. It is exploratory talk in which interpreting, questioning, connecting, summarising, speculating and predicting are common that is the key to this. Ideas and reasons are refined and improved. This shared activity develops the individual's thinking, because the processes that are generated in the joint thinking of the group can gradually be internalised by the individual. This difference between what individuals can do on their own and what they can do with the assistance of more capable peers is termed the zone of proximal development. Lastly, in terms of shared thinking, groups bring together a greater range of ideas, knowledge and resources (distributed cognition), which can become available to all.

Connection 6 to the task

In the 'Design a mammal' task, not only do individuals bring valuable specific information, but also collaborative talk contributes to the quality of the thinking and outcomes.

Metacognition

In simple terms, metacognition means thinking about thinking. However, metacognition is increasingly being seen as having a number of components. One of the most important of these is the ability to monitor and regulate thinking. This is consciously stepping back and reviewing progress and strategies and checking that what you are doing is matching the task. It also involves checking that the right information is being used, that no incorrect assumptions have been made and that there aren't better ways of doing the task. It helps if you have a vocabulary for thinking. Metacognition is particularly important when you are doing a difficult task. You don't need metacognition to cook a piece of toast, but you might need it to cook a four-course meal for 12, all with special diets.

Connection 7 to the task

In the 'Design a mammal' task, any references such as 'let's start by doing …' or 'what we have to think about …', or any reference to strategy or review or reflection on the task, are examples of metacognition. Pupils can be encouraged to use metacognitive language, particularly in plenaries.

Disposition to think

Pupils have theories about what learning is and about themselves as learners. Teaching thinking will work most effectively where pupils believe that intelligence is not fixed (so not thinking 'I'm no good at …'), and that they can become better learners.

Conclusion

Think back to the analysis of outstanding performance in your subject. The articulation of the processes underpinning the 'Design a mammal' task should provide examples of the characteristics of outstanding performance that reach across subjects – making links, seeing patterns, working with others, being creative, having more than one solution, monitoring and evaluating progress. Teachers' practices that maximise the learning potential from such tasks need to be developed. The learning potential relates to improving:

- general thinking ability (as in working memory/capacity);
- specific thinking abilities, retained in long-term memory;
- metacognitive ability and language;
- disposition to learn or self-theories.

Different teaching styles are appropriate for different learning outcomes. Teaching thinking and managing discussion well requires a repertoire of teaching strategies and skills. It involves focused intervention as well as effective instruction.