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HIGHER ORDER THINKING SKILLS

**An exploration of aspects of learning and
thinking and how ICT can be used to support
these processes**

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Learning

Learning can be defined as the act of acquiring knowledge, skills, ideas or understanding over and above those which existed previously. Learning can be thought of as a set of possible actions – an addition of ideas or skills, a reordering of ideas, or an acquisition of concepts, for example. The act of learning requires learners to be involved in three sets of processes:

- internalisation (the processes which enable ideas or knowledge to enter the mind from an external source);
- internal processes (those processes which enable the ideas or knowledge acquired to be compared or contrasted or integrated in some way with those which already exist);
- externalisation (the processes which enable ideas or knowledge or skills to leave the mind and to be observable by others from the exterior).

The processes involved in learning, or in aspects of learning, can be detailed to a greater extent:

- **internalisation** includes three distinct processes:
 - attention (a focus by the learner on the ‘new’ knowledge or ideas);
 - sensory stimulus (the ways or forms in which the new skills or knowledge are recognised by the learner);
 - acquisition or reception (the point at which these new skills or knowledge impinge upon the consciousness);
- **internal processes** include a range of other actions:
 - retention (the point at which new ideas are held in the mind);
 - rehearsal (the ways in which ‘new’ knowledge or skills are compared or contrasted to that which exists already);
 - recall (the ability to recognise, identify and refer to the new skills or knowledge again in an existing or new context);
 - short-term memory (where new ideas or skills are held in an existing context for a limited time);
 - long-term memory (where ideas and skills are held for longer periods of time and where they are often associated with other existing ideas or concepts);
- **externalisation** includes the processes of making skills or knowledge or ideas external to the individual:
 - motor stimulus (the means of making the internal range of ideas and skills external, and choosing the ways to do this).

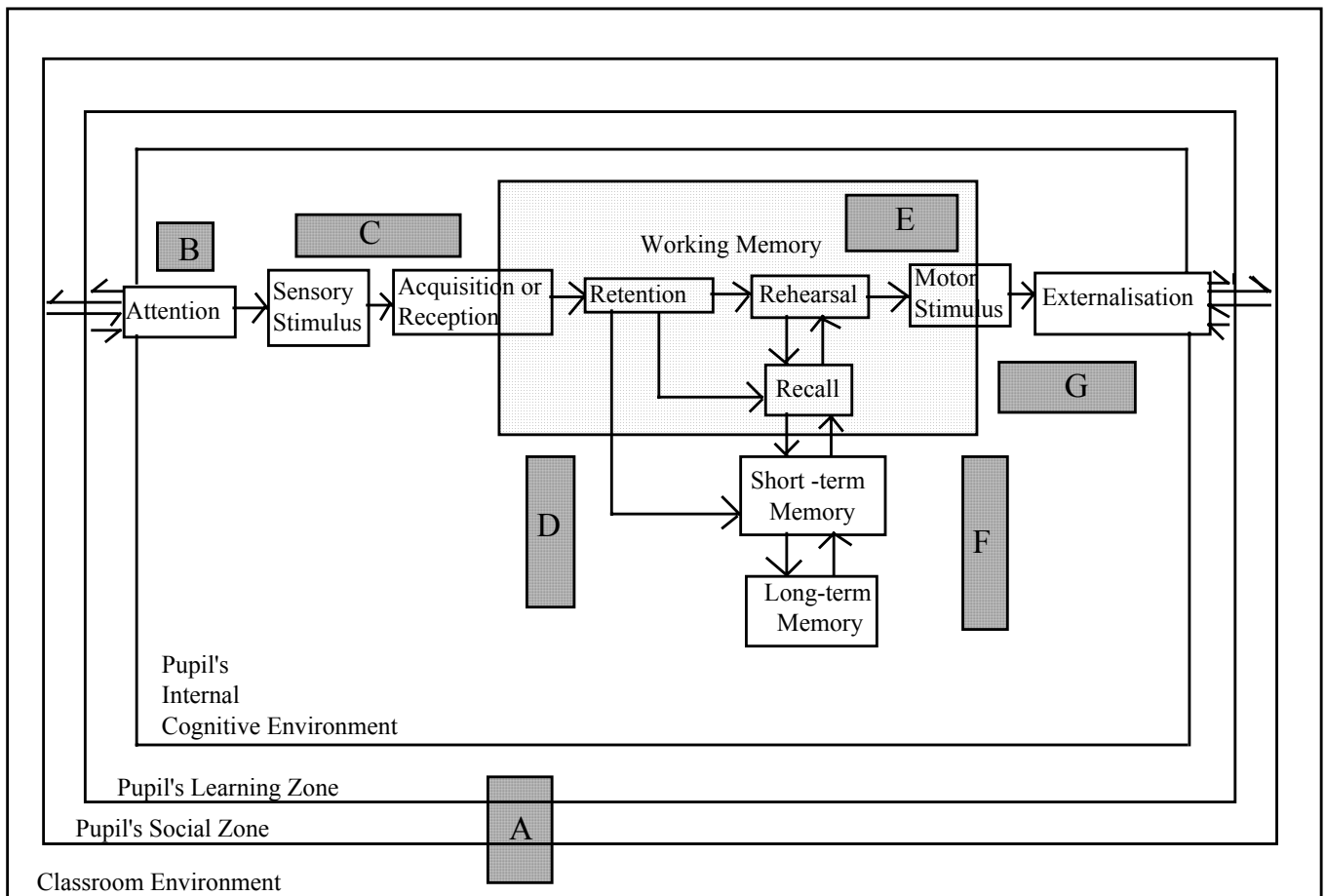
A model of learning

The set of processes outlined in the page above can be displayed as a simplistic model which relates together these processes, and places them in a school-based social and learning context made up from three overlapping arenas:

- the pupil's learning zone (that area or space through which learning is happening for the pupil);
- the pupil's social zone (that area or space in which the pupil acts and exists socially);
- the classroom environment (the area or space in which classroom or school-based learning might happen).

The entire model is, of course surrounded by a much wider social zone and learning zone which can go beyond the boundaries of the school.

From an ICT point of view, the parts of the learning processes within the model which are recognised as being affected by the uses of ICT are lettered from A to G.



Thinking as a role in learning

Thinking is a conscious act. Thinking demands space and time, and the act of thinking is often considered by using the terms which refer to a range of different thinking skills that might be used or applied in particular circumstances.

Thinking skills are at the heart of learning in that they make certain learning possible, and make possible the acts of carrying out certain tasks. It is possible to consider learning without thinking (learning by rote, or learning by accident), as well as learning with thinking, of course. The role of memorisation is clearly important here, since memorisation plays a different role in the case of learning without thinking to that which it does in the case of learning with thinking. Internalisation of information can occur in the same ways in both cases, but internal processing in the case of learning without thinking relies vitally upon memorisation, while in the case of learning with thinking memorisation is only a part of the wider internal processing of thinking and learning.

Thinking processes

There are a wide range of thinking skills or processes. What are the range of thinking processes that can be defined?

When asked about thinking skills generally, an audience might well come up with a fairly random range of skills, such as these:

creativity	questioning
	memorisation
conceptualisation	communication
	analysis
comparison	reasoning
	interpretation

As a worthwhile exercise at this point, you might want to add to this list, and perhaps use software such as Mind Manager to link and relate these types of thinking skills and processes.

How have such thinking skills been ordered or thought of in relation to each other already? What examples already exist that allow such relationships to be considered?

Categorising thinking skills

One way to categorise thinking skills is to use an existing framework. A framework which is still regarded as being helpful in this respect is that devised by Bloom (1952). He produced a taxonomy of knowledge handling skills where he used six categories:

- knowledge acquisition.
- comprehension.
- application.
- analysis.
- synthesis.
- evaluation.

Taking a range of thinking skills it is possible to categorise these using Bloom's taxonomy. Bloom's taxonomy is often considered as being able to give an overview of associated thinking skills, with a progression in terms of difficulty from knowledge acquisition (sometimes considered as a lower order thinking skill) up to evaluation (often considered as a higher order thinking skill).

An example of some associated thinking skills using Bloom's taxonomy is given below. As a further exercise you might want to elaborate and extend this list further.

Bloom's categorisation	Associated thinking skills
Evaluation	Relevancy, ordering, prioritising, judgement
Synthesis	Collating, creating
Analysis	Categorising, characterisation, comparison, contrast
Application	Abstraction and transfer
Comprehension	Question, discuss, explanation, doing a task
Knowledge acquisition	Memorisation

Questions raised about thinking and learning

A number of questions are raised by any categorisation of thinking or thinking skills. A number of key questions are:

- Which thinking skills could be regarded as higher order thinking, and which as lower order thinking?
- Should higher order thinking be at a cognitive level (that is at the level of being able to undertake a task) or at a metacognitive level (that is at the level of being aware of and able to understand the ways that could be used to approach a task)?
- What is the difference between thinking skills at a cognitive and metacognitive level?
- How can ICT help with the cognitive and the metacognitive needs of pupils?
- How can pupils identify strategies that they and others can use, with or without ICT?
- How can pupils record thinking strategies?
- How can pupils store thinking strategies in ways to retrieve them?
- How can pupils select from the range of mechanisms or strategies available?

Learning and metacognition

Learning involves learners through activity – whether learners are listening, or making an item in wood. Learning activities should clearly involve thinking skills that are explicit, and pupils should know these are recognise them. In this way it is possible for metacognitive processes to be introduced or used.

Some examples of ways in which activities might account for cognitive and metacognitive needs are given in the table below. As a further exercise you might want to extend this table, or use it to consider how cognitive and metacognitive needs of pupils are addressed in any lesson or lessons.

	Cognitive What to do (Can undertake a task)	Metacognitive How to do it (Know how to approach it, the different ways of doing it, having methods available and understanding a range of possible processes and strategies)
Knowledge acquisition	Can read a text to find specific details	Knows a range of ways of finding which texts might contain specific details
Comprehension	Can answer questions about a document that has been read	Knows how to pick out key features of documents, and how to identify those things not known
Application	Can use information or techniques in other contexts or situations	Knows which techniques to use to recall specific information or skills in a range of situations
Analysis	Can ask questions about information, and can compare and contrast answers with existing knowledge or understanding	Knows a range of techniques that can be used when questions are asked of information or data
Synthesis	Can bring together information from a range of sources and create a coherent outcome	Knows a range of techniques that will enable coherent outcomes to be created when a range of sources of information and details are being used
Evaluation	Can make decisions about information or ideas using a specific range of criteria	Knows the techniques that enable evaluation to be undertaken reasonably and reliably

Thinking skills and learning across the curriculum

The National Curriculum pages (http://www.nc.uk.net/LACcs_thinkskill.html) on the DfES web-site list a range of thinking skills which should be included in the curriculum. The form of skills in this list offer ways to think about activities which could be established in the curriculum, across a range of subject areas, to cover these particular range of skills.

The thinking skills listed are:

- information processing;
- reasoning;
- enquiry;
- creativity;
- evaluation.

The list details the thinking skill aspects which should be included in developing that specific skill to the full. So the list of aspects under each thinking skill can be used when creating an activity. For example, an activity which seeks to generate creativity should involve at least a number of the different elements in the list associated with creativity:

- searching all topics;
- generating ideas;
- developing ideas;
- hypothesising;
- applying imagination;
- seeking innovative alternatives.

Thinking skills and ‘Hats’

De Bono has developed a range of ways of building thinking into aspects of everyday activities. His work on thinking offers ways to think about how to undertake ‘thinking activities’. De Bono offered six thinking ‘Hats’ as a means to consider how thinking might be developed and used effectively in six different types of situations.

The table below shows how De Bono suggests that these six coloured hats be used, as they represent different types of thinking.

Hat colour	Concerns	Key questions to involve in activities
White	facts, figures, information	What information do we have? What information do we need to get?
Red	emotion, feelings, hunches, intuition	What do I feel about this matter right now?
Black	caution, truth, judgement, fitting the facts	Does this fit the facts? Will it work? Is it safe? Can it be done?
Yellow	advantages, benefits, savings	Why can it be done? Why are there benefits? Why is it a good thing to do?
Green	exploration, proposals, suggestions, new ideas, alternatives for action	What can we do here? Are there some different ideas?
Blue	Thinking about thinking	Where are we now? What is the next step? What order is needed? How can we summarise?

Whilst the DfES thinking skills offer ways to look at how to set up learning activities with thinking skills in mind, de Bono’s ‘hats’ offer ways to put questions into activities, or sometimes they might even suggest ways to undertake the activities through the approaches needed to address the questions. The two different categories offered by the DfES and de Bono could be considered to relate to each other in the way shown in the table below (although you might want to construct a relationship for yourself).

Thinking skill	‘Hat’
Information processing	White
Reasoning	Black, Yellow, Blue
Enquiry	Yellow
Creativity	Red, Green
Evaluation	Black, Blue

Thinking skills and learning outcomes

Bloom's taxonomy offers a way to think about outcomes of the thinking process and outcomes of learning activities. Bloom's taxonomy helps to make decisions about the form of learning and levels of learning outcomes that could be derived from any activity.

For any thinking skill, therefore, it is worth considering which aspect of thinking is addressed (from the DfES categorisation), which questions or 'hats' can be used to define the activity more (from de Bono), and what the level of learning outcome desired might be (from Bloom). A set of possible relationships is explored in the table below (although you might want to construct this in a way to suit your own needs).

Thinking skills	Possible 'Hat'	Possible learning outcome level
Information processing	White	knowledge acquisition, comprehension
Reasoning	Black, yellow, Blue	analysis, synthesis
Enquiry	White, Yellow	comprehension, synthesis
Creativity	Red, Green	application, synthesis
Evaluation	Black, Blue	evaluation

So for any learning activity, such as exploring how gravity operates, there would be three aspects to take into account:

▪ the thinking skill(s) involved	It is an ENQUIRY
▪ the questions for the 'Hat'(s)	What information do we have? What information do we need to get? Why can it be done? Why are there benefits? Why is it a good thing to do?
▪ the level of learning outcome required	Comprehension or synthesis

Clearly making choices about which questions to ask, and which level of learning outcomes is required in this case makes a great deal of difference to the form of the activity, and how it is set up. From a learning and teaching point of view, this type of structure and analysis can enable you to focus on the learning aspects that are at the appropriate level of your choice.

Thinking and learning approaches or styles

Thinking skills are mediated by the particular learning approaches of individuals (sometimes alternatively referred to as learning styles or learning preferences). These are concerned with sensory approaches used in accessing facts and ideas, and the selection of ways in which they are most comfortably internally processed in the mind, or indeed externalised.

Gardner (1991) pointed towards a range of learning approaches that individuals might have:

- linguistic;
- logical/mathematical;
- musical;
- kinaesthetic;
- spatial/visual;
- interpersonal;
- intrapersonal.

It is clear from this list that sensory approaches and internal approaches to learning could be significantly different for different individuals.

The range of pupils using these different approaches in a classroom clearly provides a challenge for the teacher offering different ways to approach an activity. For example, Grinder (1989) pointed to the fact that eight out of 30 students in any lesson learn in only one specific way. So how can the range of approaches be accommodated within classrooms?

Particular learning approaches could be served most easily by learning resources being provided in particular forms. ICT can help in these respects by providing different forms of resources. In terms of learning approaches, ICT can support different learning approaches through the use of the range of resources shown in the table below (adapted from BCS, 1999).

Area of intelligence	Possible software
Linguistic	Word Processing Story Books
Mathematical	Spreadsheets Logo
Musical	Composing Software CD-ROMs Talking Books
Kinaesthetic	Collaborative Projects Data Logging And Control Activities E-Mail Interactive whiteboards
Visual Spatial	Presentation Software DTP Video Clips Digital Cameras Art Packages Interactive whiteboards
Intrapersonal	Myself Databases Internet Research Word Processing
Interpersonal	E-Mail Collaborative Activities Newspaper Publishing Video Conferencing Interactive whiteboards

These resources not only support learning approaches, but they also support particular learning outcomes when used in particular ways.

How ICT can support knowledge acquisition

Knowledge acquisition involves the identification of new knowledge, which can be read or heard. ICT can support knowledge acquisition in a number of ways. Researching on CD-ROMs or via the Internet about specific topics is a common way to consider whether sources offer new knowledge. These sources can be texts or spoken language. ICT can be used to locate non-ICT-based sources such as magazines, books or CDs if a suitable index or search mechanism is available such as those used for a library catalogue. Highlighting key words and phrases can be a useful way of identifying new knowledge, which can then be considered at higher levels of knowledge handling. Some students may copy texts rather than using them to specifically identify new knowledge. Limiting the number of sentences that can be copied or highlighted can be used as means to help students to focus on acquisition of new knowledge rather than on copying unknown knowledge.

How ICT can support comprehension

Comprehension involves being able to demonstrate an understanding of particular knowledge or information presented. ICT can be used to support comprehension. Listening to texts being read out and then highlighting words or phrases in response to questions asked is one technique which can be used. Another method is responding in writing to questions in an ICT-based medium. Reading ICT-based material and answering verbal questions offers another means, while reading ICT-based material and highlighting words or phrases in response to verbal questions is a fourth. Some teachers commonly use the completing of sentences and filling in gaps (perhaps Cloze procedures) to help students with aspects of comprehension.

How ICT can support application

Application involves the use of knowledge in another context, perhaps through writing in another form or talking about a written text. Using limited amounts of a source from one web-site, for example, and rewriting about web or CD-based sources in another context is one way to develop application techniques. Integrating ideas or content from one or more web-based sources into other ICT-based sources and material such as those in MS Word or MS PowerPoint is another way. When using web-based or CD-ROM based sources, considering relevance, reliability, bias, and validity are aspects of particular importance which should be encouraged. ICT-based texts can be annotated by the student in their individual ways, and in this way might be used in ways which lead more to the creating of an individual ICT-based 'text' book. Students should be concerned when involved in application of recognising where an ICT (or other) technique could be used in another topic or subject-related context.

How ICT can support analysis

Analysis involves being able to elicit questions about information that is given or presented, and to find ways of answering these questions. ICT can support this level of knowledge handling, by giving access to sources which can be used for comparison of content or evidence with sources that are non-ICT-based. Students may need to be given practice in creating questions to ask of ICT-based data. When trying to find answers to analytical questions, the use of frameworks as an analytical technique (such as comparisons of nouns or adjectives used in similar texts) can aid analytical understanding. Using highlighting as a method for analysis (such as that used for character analysis in texts) can be of help. Using replacement as a means to consider the impact of particular forms of words can also aid analysis (such as word replacement to change and identify change in ‘mood’ or ‘feel’ of paragraphs). Other techniques might involve creating other ways to display data to understand it and to indicate that understanding.

How ICT can support synthesis

Synthesis involves being able to use a range of sources, to draw together common themes, and to bring together a coherent explanation that accounts for the range of details observed. It is important that students are able to use search engines effectively to identify appropriate ranges of source if they are to undertake activities involving synthesis. They should become familiar with using a range of sources that are ICT-based as well as non-ICT based, and should be able to state the reasons for the number and range being selected. Students should be involved in activities in which they are selecting pertinent material from within sources, putting source evidence into an order and prioritising or reprioritising it (according to selected criteria). Using ICT-based frameworks for synthesis (such as mind mapping techniques to link ideas and to model relationships of concepts) can be valuable methods to explore techniques involved in synthesis. Using frameworks as guidelines (such as a set of MS PowerPoint slides which set out an argument in terms of description, pros, cons, personal views, 'expert' views, balance of views, and conclusions) can also support synthesis.

How ICT can support evaluation

Evaluation involves a critical review and reflection from which judgements can arise but which should be informed. Letting others see outcomes of work by sharing them via email and letting others comment on the work can enable students to gain evaluative feedback. Incorporating comments from a range of those giving feedback should be encouraged, and can be undertaken more easily when an ICT medium is used. Creating formats to gather comments from others, and identifying those targeted for feedback, may be necessary as a preparatory exercise for students to become involved in seeking evaluative feedback. If students are working at an evaluative level, they need to specify criteria for evaluation prior to undertaking judgements. These criteria can be written in an ICT medium, which offers the advantage of being able to modify them for gaining comment, and for incorporating them into written work more easily. Contacting experts and specialists via email to gain ideas and feedback on specific aspects when evaluation is being undertaken can be a useful technique. Work can be modified as a result of evaluative feedback, and ICT aids this process.

Tips for teachers

When creating activities for children, it is always worth asking some key questions to check the level and extent to which their higher order skills are integrated:

- does the activity involve rehearsal of ideas and knowledge rather than just retention and recall?
- does ICT help pupils to work within their learning and social zones, or extend these?
- does the form of medium or resource engage pupils, and if ICT is involved, does it help to engage kinaesthetic, spatial-visual, or intrapersonal learners?
- does the activity help to place ideas and knowledge in long-term memory?
- are pupils encouraged to externalise ideas or knowledge in their own ways?
- are pupils encouraged to reconstruct ideas or knowledge?
- does the activity address analysis, synthesis or evaluation appropriately and extensively enough?
- does the activity ask questions that are focused on higher order thinking skills?
- is ICT used to support the activity at a higher order thinking skills level?
- how can higher order thinking levels, or a metacognitive level of understanding be assessed?

References and useful sources

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National Curriculum pages on thinking skills can be found at:
www.nc.uk.net/LACes_thinkskill.html