THINKING FOR LEARNING

CONTENTS

PART ONE THEORIES AND DEVELOPMENTS

Introduction

"I have always been concerned to develop pupils' thinking. For example, I try to vary the types of questions I ask to make sure of this."

"Some people say you need a special course for the teaching of problem-solving and thinking skills – once a week, perhaps, for a term."

"Some children are born with an innate capacity to solve problems. It's in their genes."

"Intelligence is not a fixed commodity. All pupils can improve their ability to think and solve problems."

"There are certain things pupils need to know. It's not all about problem-solving and thinking skills."

"Surely it's not just about identifying generic thinking skills and strategies. Some subjects in the curriculum have subject-specific skills."

"At the end of a topic I always get pupils to think about the following questions – What have I learned? and Could I have done better?

"If pupils are going to improve their thinking they need to feel positive and in control."

The above comments reflect something of the range of issues that are covered in this report. They include for example the relationships between thinking, learning and intelligence and the place of knowledge and attitudes in the development of skills. The importance of both generic and subject specific thinking skills is discussed and examples of special courses and cross-curricular programmes are given. Some suggestions are provided on how teachers and schools might take the ideas forward. Finally a case study is included describing how one council is trying to raise attainment by focusing on the development of thinking skills.

Importance of Thinking

In a modern society mastery of the basics in literacy and numeracy is no longer sufficient. A much broader range of skills is required if young people are to meet the demands of modern living especially as these are reflected through the labour market. In a recent report entitled 'Redefining Work' the authors predict that within twenty years the world of work will be for many a very uncertain and uncomfortable world. Already more and more jobs require young people to develop skills that allow them to adapt quickly to changing situations, to think for themselves and to apply their knowledge creatively. The importance of active citizenship within a democratic society requires that individuals should learn to assimilate information from a wide range of sources, analyse it and make informed judgements. The report says:

"The education system must develop in students……the personal skills that will be needed, at much higher levels, to cope successfully with a more complex world characterised by

uncertainty……There can be no question about the importance of literacy and numeracy….. but they are only a start." [1]

Research has shown that intelligence is not a single, fixed commodity. Our capacity for intellectual activity can be strengthened or weakened depending on the experiences we have and the kind of teaching we receive. Children's mental capacities can be enhanced through appropriate interventions. When developing pupils' understanding for example teachers will use explanations, demonstrations, stories and analogies. The teaching of thinking is another way of helping pupils improve their learning. It gives a framework for the mental 'scaffolding' that pupils need to improve and enables them to operate as independent thinkers and learners. The need to raise achievement for all pupils has been identified as an important goal for schools and education services. The development of pupils' abilities to think, reason and solve problems can be seen as an important means of meeting this goal.

Pupils learn more effectively when they have increased awareness of their own thinking processes. This awareness of the strategies we use when thinking and learning normally takes the form of an internal conversation. Consequently it is easy to assume that individuals will develop these on their own. The evidence suggests, however, that these strategies and procedures have to be learned. Schools and teachers need to help pupils to develop a conscious awareness of themselves as thinkers and learners. [2]

Pupil progress is greatest in classes where teachers use more higher-order questions and statements to challenge and stimulate pupils' thinking. Pupil progress is also significant where pupils are encouraged to use their creative imaginations and to participate in problem solving activities. These gains in progress are linked to the use of discussion and dialogue as a key teaching strategy. [3]

"It seems that it is the amount, nature and content of teacher-pupil talk which is crucial to pupil learning and that communicating with groups and the whole class enables more children to experience sustained, higher-order, work-related interactions with the teacher." [4]
Caroline Gipps

"Probably the single most important class management skill responsible for the development of pupils' thinking, is the engineering of situations where the maximum of collaborative work and talk is taking place between pupils." [5]
P. Adey, M. Shayer and C. Yates

Although it can be argued that the development of pupils' thinking has long been seen as an important aim by teachers and schools we need to sharpen our awareness of how to do it better. Carol McGuinness writes:

"Developing thinking requires that interventions are made at the level of cognitive processing. If we want students to become better thinkers, we must make explicit what we mean by these better forms of thinking and devise ways of educating directly for thinking." [6]

There are teaching techniques and approaches we can perfect, particular kinds of questions we can ask, and practical skills and strategies we can teach. We need to consider how thinking and problem-solving skills can be taught more systematically across different ages and stages. Pupils of all ages need to develop and practise a

range of thinking and problem-solving skills and strategies so that they have confidence to use them in different areas of the curriculum and in real-life situations.

Thinking and Thinking skills

At its most basic 'thinking' is very much a natural function. It is rather like walking talking and running. All human beings who have developed normally have the capacity and ability to think. In order to understand and make sense of the world children need to focus on and take in the visual and auditory stimuli around them. They need to keep hold of this information in their mind while they decide how to respond. Some of the things they see and hear will be stored in their memory for future reference, while others will be forgotten in an instant. Some things, the sound of a passing train, will be familiar. They will recognise the sound and be able to relate it to the concept of a 'train'. Thinking does not function on its own – it requires other components to work efficiently such as perception, memory, concept formation and especially language.

According to Susan Greenfield, the renowned neuroscientist, 'thinking' is the mental activity that goes on between the stimulation that comes in through our senses and the response we make to it. [7] For the most part it involves us in using words and phrases that make connections with other aspects of our pre-existing knowledge and expertise. A general definition of 'thinking' that attempted to cover a wide range of mental activities from verbal daydreaming through to forms of thinking that are highly disciplined and logical might include three basic ideas:

1. Thinking is a process that involves some manipulation of information within the mind
2. Since it takes place internally it has to be inferred indirectly from behaviour
3. The behaviour is usually directed towards solving a problem or finding a solution. [8]

The particular problem we are faced with, its context and circumstances, will in large measure determine the nature and speed of thinking required. Guy Claxton for example, believes that there are three main types of human thinking that can be recognised by the speeds at which they take place. [9] The first and fastest takes place in situations of danger or crisis where an instantaneous reaction is required. It is also associated with those activities that we gradually learn to do automatically - driving a car, riding a bicycle, playing a musical instrument, taking part in sports. The second is slower and is associated with weighing up pros and cons, constructing arguments and solving problems. It relies on logic and reasoning. It is deliberate, conscious and purposeful. The third is even slower still. It is required when we are just mulling things over rather than earnestly trying to solve a problem. We may not have all the information to hand or the issue may be complex and ill defined. It is creative and relies some of the time on intuition.

About 30 years ago, two scientists, Roger Sperry and Michael Gazzaniga studied a group of people who had had the connection between the left and right hemispheres of their brain severed. They wanted to find out what happened when the two hemispheres of the brain were unable to communicate. They discovered that the two halves seemed to perform different but complementary functions. For example, the

left hemisphere was more concerned with analytical and logical thinking while the right hemisphere was more concerned with imaginative and metaphorical thinking. Much popular psychology interpreted the research to mean that improving our creative thinking involved engaging the 'right brain' which, it was said, we used very little of in our everyday lives. Research since the 1970's, however, has revealed a somewhat more complicated picture. Most experts today take the view that the brain works as a whole rather than as two separate halves. There is greater linguistic ability, for most right-handed people, in the left hemisphere of the brain than in the right; but the research shows that there is also language on the right side, just as there is also imagination on the left:

"The brain is made up of anatomically distinct regions, but these regions are not autonomous minibrains; rather they constitute a cohesive and integrated system organised for the most part in a mysterious way" [10]

Wilson states that there is no consensus as to what should be included in the category of 'thinking skills'. [11] And McGuinness points out that different researchers have produced different taxonomies of thinking. [12] Swartz and Parks, for example, regard 'thinking' as including the following skills: [13]

- sequencing and ordering information
- sorting, classifying and grouping
- analysing, comparing and contrasting
- making predictions and hypothesising
- drawing conclusions and giving reasons for conclusions
- distinguishing fact from opinion
- determining bias and checking for reliability in evidence
- generating new ideas and brainstorming
- relating cause and effect
- identifying and defining problems and setting goals
- exploring different strategies, anticipating and evaluating outcomes
- planning and monitoring progress towards a goal
- setting priorities, weighing up pros and cons, making decisions.

Some of the foundation skills implied by the above list and that could be developed by children are:
Sequencing: eg of time, activities, ideas; linking together the main points of a story
Classifying: eg giving an example, categorising objects and living things, making comparisons, recognising similarities and differences, distinguishing advantages and disadvantages,
Judging: eg expressing an opinion, giving reasons, considering alternatives, predicting consequences, taking into account the points of view of others,
Theorising: eg asking questions, putting forward hunches and guesses, forming hypotheses

Thinking and Intelligence

During the last ten years there has been increasing evidence that all children and young people can learn and achieve more than they seem capable of. Much of this insight comes from new knowledge about how the brain functions. One of the most fascinating discoveries about the brain and the way it learns is the fact that it has

plasticity. In other words, as a result of the experiences we have the physical structure of our brain changes. We now know that the brain is made up of billions of nerve cells, or neurons, which send out innumerable long fibres, or axons. These make contact with other neurons through special connections called synapses. A particular neuron may be receiving tens of thousands of connections from other neurons at the same time. In other words learning moulds the brain by growing new connections between brain cells. The greater and more varied the stimulation the more likely it is that new connections will be made. Continuing attention to particular kinds of learning and experiences will result in ever more intricate patterns of connections. Just like the muscles in our body, connections in the brain are strengthened through exercise and weakened by disuse.

"As we develop, as our bodies move around in the world, our brains are working incessantly on the use-it-or-lose-it principle…..the brain cells that are involved in the activities that occur most frequently will have extensive connections, whereas those that are used less frequently will be pushed out of the way, and their targets will be taken over by their more hardworking neighbours." 14

In the early part of this century part of the philosophy of education was to make secondary schooling available only to those whom it was felt would benefit from it. Those who could, the academic, were assumed to be largely middle-class destined for careers in government, the professions and business. In 1920 the Scottish Education Department wrote:

"The school population falls into two parts, - the majority of distinctly limited intelligence, and an extremely important minority drawn from all ranks and classes who are capable of responding to a much more severe call." 15

The supporters of this approach regarded intelligence as a general ability, largely inherited, and found in varying degrees in all individuals. They also believed that such intelligence could be measured. Intelligence testing arose originally from a decision of the school authorities in France to place children with severe learning difficulties in special schools instead of excluding them from the education system altogether. The tests to identify such children were devised by Alfred Binet in 1905 and later became known as IQ tests. Although Binet is remembered as the originator of the IQ test, he had himself no sympathy with those who believed that intelligence was a fixed quantity and could not be improved. He described this belief as "brutal pessimism". In his view intelligence was made up of a combination of smaller elements such as attention, memory, perception, analysis and judgement, all of which could be improved by training and education.

Like Binet, most psychologists today see no clear evidence for the existence in individuals of a thing called 'intelligence'. As children grow older there is an increasing variation in their performance on different skills and abilities. The performance of very young children across different areas of intellectual behaviour tends to be fairly similar. In older children, adolescents and adults, on the other hand, there is often a marked discrepancy from one area to another. It is likely that as our ability to think and reason becomes more complex some skills, say in mathematics or language, develop more quickly than others. Our own natural inclination to concentrate on those areas in which we are experiencing success would then reinforce the process.

This is not to deny a genetic component to intelligence. Recently scientists in Britain and America claimed to have identified a gene that they believe is linked to intelligence. The problem is that it is never possible to say how much of any particular behaviour is caused genetically and how much depends on the environment. The problem with measuring how much genes affect a particular behaviour, says neuroscientist Ian Robertson, is that you can only measure the effect in a particular environment. For example, if a thousand children were given virtually no stimulation in infancy and childhood, genes would probably have a huge effect on how their abilities developed. If, on the other hand, they were all subject to the best stimulation that parents and schools could provide, the effect of genes would be much less and the quality of the environment would have a much bigger effect in deciding who was more intelligent than whom. 16

There is considerable evidence to justify the view that intelligence is not a fixed commodity and that our ability to learn can improve and expand. For example:

1 James Flynn of the University of Ontago in New Zealand, has shown that average IQ scores of groups all over the world, far from remaining fixed and static, in fact have risen significantly year after year and decade after decade. In many countries the increase has been about 15 points over two or three decades. 17

2 After reviewing the research into people with exceptional abilities, scientists concluded that what distinguished the most talented people was the amount of practice they did. They found that those who achieved the highest levels of achievement in everything from music to sport, and from science to the arts had invariably been through years of intense effort and self-sacrifice. At the 1992 Olympics for example the twelve year old members of the Chinese diving team had put in as many practice dives as had members of the American team who were in their early twenties. The top violin students at the best music academy in Berlin, all in their early twenties, had put in ten thousand hours of practice, while the second tier of students averaged about seventy five hundred hours. And they had the support of parents who had given up everything to ensure that their child's abilities were developed to the full. 18

3 Peter Mortimore and colleagues conducted a study of almost 2000 junior school pupils over several years of their school life. Although the main purpose of the research was to find out whether some schools were more effective than others in promoting pupils' learning and development, the findings showed that attainment can be improved significantly. The researchers concluded:

> "What our data show is that children's performance changes over time... many parents still regard their children's ability as fixed. We hope our data will persuade both teachers and parents that this is not so and that change is possible. We believe that, in the right circumstances, children can become more intelligent." 19

Multiple Intelligences

The idea that intelligence is not in fact 'one' thing at all but a 'set' of abilities, talents or mental skills is probably the most popular view today among psychologists and educationists. According to Howard Gardner, for example, learners all have the capacity to develop at least seven types of intelligence.

Linguistic intelligence: used in reading a book, writing a letter and understanding spoken words
Logical intelligence: used in solving mathematical problems, balancing financial accounts and in logical reasoning across a range of disciplines
Spatial intelligence: used in getting from one place to another, reading a map and in packing suitcases in the boot of a car
Musical intelligence: used in singing a song, playing a musical instrument or even in listening to and appreciating a piece of music
Bodily intelligence: used in dancing, running and all kinds of individual and team sports
Interpersonal intelligence: used in relating to other people such as understanding another person's behaviour, what motivates them, how to work co-operatively with them
Intrapersonal intelligence: used in understanding ourselves, who we are, what makes us tick, how we can change ourselves.

All normal individuals, he says, possess each of these intelligences to some extent, although individuals will differ in the degree of skills and in the nature of their combination. Gardner stresses that it is the interaction between the different intelligences that is fundamental to the workings of the mind and that in the normal course of events, the intelligences actually interact with, and build upon, one another. [20] Recently, Gardner has proposed an eighth intelligence, 'naturalistic'. [21]

Other writers have come up with different categories of intelligence. For example, Tony Buzan has identified 10 intelligences that include: [22]

Creative intelligence: Creative intelligence denotes the importance of new realms of thinking and expression. It is the ability to come up with new ideas and think in new ways.
Personal intelligence: Personal intelligence is concerned with self-knowledge and self-fulfilment and is fundamentally about understanding ourselves.
Social intelligence: When we are socially intelligent we understand and appreciate the very different personalities that we meet, as well as what motivates them and what their personal needs are.
Spiritual intelligence: Spiritually intelligent people are motivated by personal values that involve reaching beyond their own interests to those of the community at large. Contact with and an appreciation of nature is also a major aspect of spiritual intelligence.
Physical intelligence: Relates to health, fitness, coordination and the importance of achieving a balance between body and mind
Sensual intelligence: Concerns the ability to use each of our senses to the fullest extent including our 'sixth' sense, intuition
Sexual intelligence: A driving energy that combines and expresses all our intellectual and physical resources to ensure survival.

Numerical intelligence: The brain's ability to juggle with the 'alphabet' of numbers
Spatial intelligence: Spatial intelligence is the ability to see the relationships of shapes to each other, to see the relationships of things in space and to negotiate successfully the environment and the world around us.
Verbal intelligence: Concerned with vocabulary, reading, comprehension and logical argument.

Personal intelligences are usually thought to embody both cognitive and emotional elements. [23] Until recently it was assumed by scientists and non-scientists alike that our emotions and our thought processes were separate and were associated with particular parts of the brain. The emotional parts of the brain were considered to be irrational, monitored and held in check by the rational parts of the brain. It was even thought that when we are thinking logically and calmly there are no emotions present at all. Today most scientists believe that our emotions are intimately involved in the rational decisions and choices we make. Throughout life we build up a storehouse of memories and experiences including emotional ones. These come into play when we are preparing for and thinking through new situations and problems. The memory of a poor job interview or the feelings associated with an unproductive meeting will influence the way we think and behave in the present.

According to Daniel Goleman we need to work towards an intelligent balance between reason and emotion. He identifies a number of dimensions of emotional intelligence including self-awareness, motivation, empathy and social skills. [24] He also identifies within these a wide range of emotional competencies that are particularly important for the development of thinking skills eg

- recognising one's emotions and their effects
- being aware of one's strengths and limitations
- having a strong sense of one's self-worth and abilities
- taking responsibility for one's learning and performance
- striving to meet high standards of excellence
- being persistent in the face of obstacles and setbacks
- working with others towards shared goals

Strong emotions on the other hand, such as anxiety and stress, can overwhelm our ability to think. People who are under stress tend to select out and focus on those aspects of a situation that they believe are the most important. They often fail to take account of the different aspects of a problem and don't achieve a sufficiently broad overview. They see what they expect to see. This explains why in tests and examinations candidates often misread questions and why detectives often miss vital clues when under pressure to get a result.

Even mild degrees of stress can interfere with our ability to think. Researchers gave people the task of putting together sentences using a simple code that substituted numbers for letters. Before tackling some of the sentences the researcher would say calmly, "You seem to be taking rather a long time, can't you do it a little bit faster?" As a result these sentences tended to be completed more slowly and with more mistakes. As Guy Claxton has commented, even in such a straightforward task, being told to 'hurry up' is entirely counter-productive. [25]

According to neuroscientist Ken Richardson there is nothing new in the view that intelligence consists of multiple abilities. The idea of mental faculties was popular for a time in the early nineteenth century. What is new is the assumption that such a view can be supported from neurological research. However Richardson points out:

"…..there is no empirical evidence for such modules…. at the level of human intelligence whatsoever." [26]

Similarly Robert Sternberg has written:

"Since its being proposed, it is not clear that there has been even a single piece of research that could be interpreted as supporting, or even as testing, the theory" [27]

John White, professor of educational philosophy at the London Institute of Education, has no quarrel with the assertion that intelligence takes many forms but he questions whether it can be restricted to a small number of categories. He argues that Gardner's intelligences owe more to his social views than to proper science. They are simply based on what Gardner holds to be culturally important. [28]

Some developmental psychologists take the view that the particular types of specialised intelligences that flourish will to a large extent be determined by the cultural context in which children are developing. [29] And even within cultures the particular intelligences that develop will vary from person to person. There may, of course, be a number of abilities that develop in all cultures, for example language and certain social skills.

Whether we agree with this or that theory of multiple intelligences is not important. What is important is to recognise that the theory in general has drawn attention to the multiple nature of intelligence and supports the research evidence that intelligence is not a single, fixed commodity. In turn this has reinforced the view that all learners can improve and extend their thinking. Multiple intelligences also provide a wide variety of identifiable areas of knowledge and skills beyond the traditional verbal and numerical, including the personal, social and creative. By focusing on these and other 'intelligences' pupils can more easily discover that they have strengths and use the resulting gains in confidence to develop those areas in which they are weak.

Thinking and Learning

In the light of the evidence that intelligence is not a fixed commodity and that all children and young people can learn more than they seem capable of, many contemporary psychologists and researchers have emphasised the part played in learning by the social environment. David Wood claims that most contemporary scholars of child development still follow Piaget and believe that children actively construct their knowledge of the world, largely by reflecting on their own activities. Piaget accepted that social experiences and inter-personal dialogue were important. Talking and discussing with other children and adults will often lead us to rethink and review our own ideas and points of view. But for Piaget this played a rather limited and secondary role. Dialogue would only be worthwhile when pupils' level of understanding was at an appropriate state of 'readiness' for change. It is the structure of our thinking, he argued, our stage of development that determines when certain kinds of conversations can or cannot take place.

Drawing on the work of the Russian psychologist, Vygotsky, and the American, Jerome Bruner, Wood emphasises how much we learn from interacting with other people, talking with them and observing what they are doing. . He argues that:

"adults, social interaction and communication play a far more formative role in the development of children's thinking and learning" than Piaget's theory allows…….children's knowledge is often a product of the joint construction of understanding by the child and by more expert members of his culture." 30

Pupils learn through first being exposed to new information and then attempting to make sense of that new knowledge by relating it to their existing knowledge. Pupils do this with books, computers, each other and their teacher. The teacher's role is to create the right climate for this to happen and to support their efforts. To do this the teacher has to make a judgement with regard to a pupil's level of understanding and provide appropriate comments and explanations to allow her to move on. This process is sometimes described as 'scaffolding'. 31 The view of learning that has emerged from this has been termed 'social constructivist.' Children are social beings who construct their understanding of the world around them by entering into dialogue with others more or less expert than themselves. The adult or teacher therefore plays a crucial role in supporting pupils' thinking. The social constructivist view of how children learn suggests that teachers can lead pupils to new levels of thinking by interacting and talking with them.

These ideas lie behind the importance that has been attached to direct interactive teaching - where teachers explain ideas, demonstrate practical activities, ask different kinds of questions, and help pupils to understand how well they have done. It is often contrasted with 'indirect teaching' where, for example, pupils work mainly on their own with books and worksheets.

"One way of providing challenge is to set pupils demanding tasks. But equally, it is important for teachers to organise their classrooms so that they have the opportunity to interact with their pupils: to offer explanations which develop thinking, to encourage speculation and hypothesis through sensitive questioning." 32

The interactive nature of new computer technologies makes it easier to create environments in which pupils can learn by doing, solve problems and think for themselves. For example, using video and computer technology real-world problems can be introduced into the classroom for pupils to explore and solve. Computer technologies can act as scaffolds to help pupils solve problems. In this way pupils can get involved in more advanced thinking and problem solving than they could without such help. Technology can also make it easier for teachers to give pupils appropriate feedback about their thinking and for pupils to revise their work. 33

Accelerated Learning

The view that children's intelligence and ability to learn can be improved and expanded has given rise to the notion of accelerated learning. Accelerated learning is an umbrella term for a series of practical approaches to learning that reflect new knowledge about the brain and how it is organised. One aspect of accelerated learning is on whole-brain learning with its emphasis on utilising not only the rational

and intellectual functions of the brain but also feelings, senses, imagination and intuition. Another aspect focuses on the importance of motivation, self-esteem and self-belief. Yet another aspect makes use of developments in cognitive psychology and focuses on accessing different sorts of intelligences and on retaining and recalling information. [34]

Alistair Smith uses Gardner's multiple intelligences as away of identifying, accessing and developing different kinds of knowledge and skills. He argues that there are four stages in the development of each intelligence: [35]

1. **Stimulation** – raising awareness of the intelligence through the use of exercises and activities eg games and puzzles
2. **Amplification** – involves practice to deepen and extend the intelligence eg the use of circle time for the 'Intrapersonal' and the use of poems, stories, word games, active listening for the 'Linguistic'
3. **Learning and Understanding** – focuses on structured learning tasks and problem-solving eg mock collaborative exercises which require empathy such as a committee meeting for the 'Interpersonal' and research using primary and secondary sources for the 'Linguistic'.
4. **Transferring and Effecting** – emphasises the application of thinking skills to real-life situations eg the use of case studies and problem-based learning for the 'Mathematical and Logical' and activities which require pupils to consider a range of alternatives and the points of view of others for the 'Interpersonal'.

Other writers have linked the idea that there are different kinds of intelligences to the different ways in which we learn and have identified different learning styles. Dryden and Vos believe that each of us has a preferred way of studying and learning although in practice most of us are able to make use of different styles. It is impossible to cater to every individual learning style all the time but we can take account of the main styles when planning activities in the classroom. By becoming more aware of the range of learning styles and consequently presenting new material in different ways, pupils' learning and thinking can be improved and accelerated. They argue for at least three main learning-style preferences:

Visual learners: These are people who learn best when they can see pictures, diagrams and videos of what they are studying – there is also a smaller percentage who are 'print-oriented and prefer to learn by reading.
Auditory learners: These are people who learn best through sound, by listening, by making use of rhyme, rhythm and song, and by talking and discussing things with others.
Haptic learners: from a Greek word meaning 'moving along'. These are people who learn best when they are actively involved, moving, experiencing and experimenting – sometimes called kinesthetic-tactile learners. [36]

Not only do we have preferred learning styles, say Dryden and Vos, we also have favourite 'thinking styles', each of which can be effective in its own way. The important thing is to become aware of which style works best for us. Once we know our own preferred style we can use it to our advantage. We can begin to improve on the others and also learn from those who have different styles. Thinking styles have been divided into four separate groups:

Concrete sequential: concrete sequential thinkers like to base their thinking firmly on what they can see, hear, and touch. They notice and recall details easily and remember facts, formulas and rules. They prefer to process information in an orderly, sequential and linear way. They need plenty of 'hands on' learning.
Concrete random: concrete random thinkers are experimenters. They also like to rely on their senses but they are willing to take a more of a trial-and-error approach. As a result they tend to be more intuitive and creative in their thinking. Their strength lies in exploring alternatives and doing things their own way.
Abstract random: abstract random thinkers organise ideas and information through a process of reflection. They place great emphasis on the importance of feelings and emotions and remember best if information is personalised. They work well with others.
Abstract sequential: abstract sequential thinkers are logical, rational and intellectual. They prefer the world of theory and abstract thought. They are adept at homing in on the key points and most significant details. They like to read and will conduct research thoroughly. They prefer to work alone rather than in groups. 36

A key principle of accelerated learning is that if we can relate what is to be taught to the wide range of ways in which people think and learn, memory and understanding can be greatly improved. One way of moving towards this is to link the different intelligences to examples of teaching activities:

Verbal-linguistic	discussions, word games, storytelling, journal writing
Logical-mathematical	brain teasers, number games, problem solving, critical thinking, flow diagrams
Visual-spatial	visual presentations, mind-mapping, visualisation, art activities
Bodily-kinesthetic	drama, hands-on-learning, tactile activities
Musical	songs, raps, jingles
Interpersonal	cooperative learning, peer tutoring, simulations, discussions
Intrapersonal	independent study, individual action plans
Naturalist	outdoor activities, field work. 37

Gardner's view that our different intelligences are interconnected and build on one another lies behind popular developments such as 'brain gym'. This focuses on the interdependence of physical development, language acquisition and academic achievement. The ideas had their beginnings in research into early reading and its relationship to thinking. Its aim is to help children overcome the learning blocks that can result from the stress and uncertainty of a new task by participating in certain physical exercises.

"Brain gym movements are a natural alternative to tension that we can use and teach others to use when challenges present themselves." 38

Mind mapping or memory mapping is also regarded as a key strategy for accelerating learning. As the creator of Mind Maps, Tony Buzan believes that these can help develop every one of our multiple intelligences. Mind Maps, he argues 'speak as the brain speaks', that is in colours, with images and with associations. When we think of

a word or idea the brain immediately produces associated words and ideas that spring from the central thought. This process of association and connections can continue indefinitely, radiating outwards from the initial idea. In the same way a mind map always radiates from a central idea or image. [39] Smith recommends this technique as a way of structuring notes and helping comprehension and thinking. He sees the method as much more than a way of simply organising information but as an activity that also requires interaction and understanding. [40]

Problem Solving

Our knowledge of thinking comes largely from two distinct traditions, philosophy and psychology. Philosophy has emphasised critical thinking while psychology has been more concerned with studying how the mind can generate ideas in the form of creative thinking. [41] Critical and creative thinking are closely related to problem solving, which can be described as applied thinking. [42] Problems such as organising the various tasks we have to do each day, managing our income and expenditures, buying a new car, deciding where to go on holiday or weighing up different viewpoints on a moral issue, all require a mixture of critical and creative thinking.

According to Bransford and Stein a problem exists when there is a discrepancy between an initial state and a goal state, and no obvious solution springs to mind immediately. [43] The initial state is where you are as you begin the problem and the goal state is where you want to end up when you solve it. They argue that problem solving applies to a range of everyday mental activities including memory and comprehension as well as critical and creative thinking. For example, a person may want to find the best way of remembering their mobile phone number or the combination lock for a bicycle. It may be by simply repeating the numbers over and over again, by grouping the numbers into 'chunks' of three or four or even by writing them down on the back of your hand. Comprehension, however, requires more than just memorising facts. It also involves trying to work out their relationships and significance. An effective learner will employ a number of strategies to aid their comprehension. Their methods are not unlike that of a good detective or researcher confronting a new problem. For example they might:

- identify what puzzles them
- ask questions and seek clarification
- explore different explanations
- search for additional information.

Initially, with young children, these kinds of strategies would be modelled by the teacher. With older pupils a series of strategies might be introduced through real problems. The strategies could then be employed in other areas of the curriculum. Problem solving stimulates and develops pupils' skills of thinking and reasoning. It provides the opportunity for children to apply their knowledge in new situations and develop confidence from being successful. It also encourages children to share ideas and learn to work cooperatively with others. Children's ability to solve problems can be enhanced by introducing them to a framework or a series of strategies that they can use.

There are basically two kinds of problems- familiar and unfamiliar. Familiar problems are those that are similar to problems we have solved before. In contrast unfamiliar are problems that require new thinking. In general, it is much easier to solve problems that are familiar than ones that are not. If you have experience of a similar problem you are likely to come up with a greater range of possible solutions than someone meeting it for the first time. For most people most of the time problems are likely to fall somewhere in between the familiar and the unfamiliar.

A growing body of research suggests that effective thinking and reasoning depends on the extent and quality of the information that a person has, that reasoning and problem-solving abilities often depend on specialised knowledge. If we are unsure of our facts or have failed to take account of important lines of inquiry, our ability to analyse an issue and draw conclusions will be hampered. The amount and organisation of a person's knowledge will strongly affect his or her ability to reason and solve problems. A doctor needs to have an extensive knowledge of anatomy and physiology. A chef needs to know about food and how to combine different flavours for the best effect. Individuals may be good at one kind of problem but poor at others. Even people's ability to solve straightforward intellectual puzzles are affected by their experience of doing them.

These ideas emerge from research over the last two decades that compares the performance of experts and novices. The research shows that it is not so much their repertoire of general strategies that differentiates the expert from the novice, but the fact that they have acquired extensive knowledge in their chosen field. Experts are able to draw on a bank of information that is detailed and highly structured. Their specialised knowledge allows them to understand when, how and why to apply specific strategies. Their knowledge affects what they notice and regard as relevant, and how they organise and interpret information presented to them. This, in turn, affects their abilities to remember, reason and solve problems

"The ability to plan a task, to notice patterns, to generate reasonable arguments and explanations, to draw analogies to other problems are all more closely intertwined with factual knowledge than was once believed." 44

"Research conducted during the past two decades shows that problem-solving abilities often depend on specialised knowledge in a discipline. Our ability to solve problems is not simply equivalent to a set of general problem-solving skills." 45

Knowledge is also important in so far as it involves awareness of relevant strategies. There are specialised skills and strategies specific to particular fields or certain kinds of problem and there are skills and strategies that are more generic. Both are required. Whatever field we are studying or working in there are likely to be specialised skills and strategies, knowledge of which, can help to make learning, thinking and problem solving more effective. For example Reece and Walker present three problem-solving strategies linked to business, science, and technology. Each begins with the identification of the problem and ends with evaluation:

Business: define the problem – gather facts – identify causes – possible solutions – select and take action – evaluate.
Science: state the problem – analyse the problem – inquiry (action plan) – select best solution – evaluate.

Technology: state the problem – consider restrictions – investigate solutions select best solutions – make/manufacture – evaluate. [46]

On occasions, however, we will all be faced with a problem that is unusual or unfamiliar when the normal methods of proceeding seem inadequate. It is at such times that we may have to fall back on more general strategies eg

- breaking a problem into parts
- using external representation,
- working backwards,
- using a simpler case. [47]

Developing a range of general strategies can help children with their learning. Teaching programmes and initiatives such as 'Communities of Learners' and 'Project RightStart' in the United States, the 'Top Ten Thinking Tactics' and 'A Guide to Better Thinking' in the UK have considerable practical significance for learning. A common feature of these initiatives is that they recognise the importance of pupils' knowing and using diverse strategies. The programmes differ but all are aimed at helping pupils to:

- understand how strategies can help them solve problems
- recognise when each strategy is likely to be most useful
- transfer strategies to novel situations

"Most recent work on children's thinking and problem-solving would suggest the importance of supporting cognitive development with the relevant use of language, together with assisting children to process relevant information ……and encouraging the development of more efficient strategies." (eg organisation strategies to help memory performance, effective routines for approaching thinking situations and for generalising them to other similar situations)" [48]

Creative Thinking

The kind of thinking that features particularly in logical puzzles and in aspects of mathematics is often called step-by-step thinking. The problems are often referred to as closed problems and tend to focus on one right answer. The assumptions are supplied and there are rules about how to move towards the solution. Vertical thinking involves starting from a single idea or definition and proceeding systematically. The next step must be related and logically derived from where you are at the moment.

"Logic is the tool that is used to dig holes deeper and bigger, to make them altogether better holes. But if the hole is in the wrong place, then no amount of improvement is going to put it in the right place. No matter how obvious this may seem to every digger, it is still easier to go on digging in the same place than to start all over again in a new place. Vertical thinking is digging the same hole deeper; lateral thinking is trying again elsewhere." [49]

Edward De Bono refers to step-by-step thinking as vertical thinking and he contrasts this with lateral thinking. He believes that children should be helped to see that when any sequence of vertical thinking breaks down they need to be able to move sideways ie laterally, before proceeding along another vertical track in a different direction.

Moving sideways means trying out different angles, different perceptions, different ideas. The emphasis is on searching for different approaches and different ways of looking at things that may at first seem unorthodox and illogical. By doing this they not only move closer to a satisfactory solution but they gain a better understanding of the issue involved in the problem, an understanding that will hopefully transfer to new problems in the future. De Bono's argument is that both vertical and lateral thinking have their place but that too often we use the first where the second would be more appropriate. While formal and informal logic is very much concerned with 'truth' and 'what is', lateral thinking is very much concerned with 'possibilities and 'what could be'. For De Bono lateral thinking can be used in two senses:

1 The process of exploring multiple possibilities
2 A set of systematic techniques for changing concepts and perceptions and generating new ones.

Although changing perceptions and concepts is the basis of creativity that involves new ideas, this is not necessarily the same as the creativity that involves artistic expression in say, painting or music. De Bono makes no claim that lateral thinking is the basis of this kind of artistic creativity.

Some make a distinction between convergent thinking and divergent thinking. [50] Convergent thinking takes place when a person answers a question or solves a problem that has a single acceptable answer. Divergent thinking, on the other hand, is the ability to generate a range of possible solutions to a given problem or issue for which there is no single right answer. Some psychologists have identified divergent thinking with creativity and as a result have attempted to measure it. For example a test of divergent thinking might ask people to generate as many uses for a paper clip as possible in a limited period of time. Such a test will certainly show that some people can think of lots of uses while others only think of a few. Others doubt whether simply coming up with possibilities in this way is really creative thinking at all compared with the discovery of a famous scientist or the work of a great artist. In other words, they argue, it misses important aspects of the creative process.

Researchers have suggested that there are four aspects to creative thinking:

Fluency: the ease and speed with which we can come up with new and creative ideas.
Flexibility: the ability to see things from different angles, to consider things from the opposite point of view, to alter your approach to a problem
Originality: the ability to come up with ideas that are novel, unusual or unique
Elaboration: the ability to build on, develop and expand upon ideas. [51]

Part of the creative process lies in the use of intuition. Intuitions are best seen as good guesses, hunches or hypotheses thrown up by the mind. [52] They are sometimes right, sometimes wrong. In other words they deserve to be treated seriously but not uncritically. They tend to work best in situations that are complex or unclear, where the information is incomplete and when time to respond is short. One psychologist devised experiments where some subjects were asked to take their time and think about a problem before making a decision, and others were asked for a snap decision. What he found was that those who reflected and deliberated carefully were more often

less satisfied with their decision a few weeks later than those who had decided intuitively. He concluded that when making important choices there are always many factors to take into account, not all of which can be easily put into words. When people are asked to be analytical and reflective they concentrate on those factors that they can put into words. They push to one side the factors that are vague and difficult to express, perhaps because there is not sufficient information, yet which nevertheless make them feel uneasy. As a result their choices, based on an incomplete picture, turn out at a later date to be less satisfactory. [53]

Critical Thinking

Critical thinking has been interpreted in a variety of ways. It has been equated with the development of logical reasoning, with evaluation and the application of judgement and with the ability to recognise bias and distinguish fact from opinion. It is also about being able to justify our ideas and actions, being able to set out reasons for and against choosing, deciding or believing something, preparing arguments and arriving at a balanced conclusion.

Recent research into critical thinking attempted to find out whether people of varying ages and with varying amounts of education could reason their way though open-ended issues and prepare arguments. They were asked to make notes for a discussion on such topics as 'Does violence on television influence the likelihood of violence in real life?' and 'Would a refundable 20% deposit on soft drink cans and bottles reduce the amount of litter?' The notes were scored in terms of their:

- overall length,
- the number of different arguments identified
- the consideration people gave to arguments which ran counter to their own views
- the overall quality of the argument.

While eleven year olds tended to produce on average less than two arguments, seven or more further years of education had increased the score for those about to enter university to just over three. Both groups concentrated on their own views paying little attention to the other side of the issue. Only those involved in postgraduate studies in fact showed significant improvement, particularly in the ability to consider counter-arguments. The researcher concluded that despite their ability to do better when reminded, most people, most of the time, come to quick conclusions without taking account of all the evidence and tend not to challenge assumptions or explore alternative points of view. [54]

In the early nineties a team of researchers at Hull University conducted research into ways of improving the ability of pupils to reason and argue well. [55] The research involved 10 primary schools and 10 secondary schools over a period of two years. On the basis of their research they produced a model outlining some of the key stages in the teaching of argument. The authors do not regard the model as being strictly developmental with individuals beginning at level 1 and having to work through subsequent levels in order. Children may well demonstrate skills that relate to two or more levels at the same time.

Levels 1and 2

The first two levels are designated pre-verbal; the first being attempts to make a point through various kinds of physical struggle and the second, ways of communicating such as crying, neither of which, say the researchers is age-related.

Level 3, 4 and 5
The third, fourth and fifth levels are concerned with pupils' ability to justify their opinions. For example, at an early stage children are able to offer an opinion or statement using words such as 'I like', 'I want', 'I think'. This is followed by being able to support their opinion or statement by giving a single reason. Later they are able to support their opinions with two or more reasons or with different kinds of evidence.

Level 6
The sixth level is when pupils can see that a particular argument doesn't really fit into their own perspective; they may say, 'I think John's argument is quite a good one, but its still not right because…'

Level 7
The seventh level involves pupils in sustaining an argument by presenting a case for or against something using different reasons and/or evidence.

Levels 8 and 9
Levels eight and nine involve being on the one hand able to evaluate both sides of an issue and then on the other to come to some sort of reasoned judgement or conclusion based on that evaluation.

Level 10
At the final level pupils will have understood that no argument ever represents the 'final word' in a discussion or debate.

Another aspect of critical thinking is about being able to identify flaws in logical arguments, for example in newspapers and magazines, radio and television programmes, and in statements from scientific, business and political leaders. A logical argument is one in which, if the basic facts are true, the conclusion that follows should also be true. The point here is not whether we like the conclusion that emerges from a particular train of thought but whether the conclusion follows from the facts or premise and whether the facts are true. Some of the flaws that might be found are:

- the facts or evidence upon which an argument is based are questionable
- the conclusion doesn't follow from the premise or starting point
- an authority is used to 'prove' an argument when the authority might well be wrong
- sources of information are vaguely referred to but are not actually identified
- the person who is putting forward the argument is attacked rather than the argument
- the argument contains contradictions and inconsistencies
- only the extremes are considered, in-between options are ignored
- favourable factors are selected, unfavourable ones missed out
- there is confusion between correlation and causation
- statistics are misunderstood

A Thinking Environment

There are two views about how thinking skills should be introduced and developed - within the context of children's normal learning or by means of a special programme and then infused across the curriculum. Valerie Wilson states that evaluation studies of thinking skills programmes are so far inconclusive. [56] There is some evidence, however, that broadening the focus beyond skills can produce better results. [57] For example, focusing on developing the right attitudes - self-confidence, open-mindedness, a willingness to take risks and to submit one's own views to the challenge of others - can help to foster a thinking environment that in turn improves thinking and learning.

In relation to certain kinds of problems there is an element in all of us that might be described as the "I can't do this" attitude. Over time this attitude can result in self-fulfilling prophecies. We avoid situations in which we have to deal with the problems we don't like. Since we get little practice because we avoid it, our initial hypothesis about not being able to do it is quite likely to come true. In general, if we become convinced that we can't do something, we place limitations on ourselves that are not there to begin with.

Self-confidence is the positive belief in ourselves and in our abilities. It is the conviction that if we try out new things and take on fresh challenges, we are more likely than not to succeed. It is also the sense that we have a good degree of control over the world around us and in the future direction of our life. Pupils who are prepared to stick with a problem are more likely to be successful than those who are inclined to give up easily. Our ability to persist will be closely related to how well we cope with difficulties and deal with frustrations. When asked to come up with suggestions and possibilities and explore alternatives there is always going to be present the risk that we may make a mistake. Even from an early age some pupils can become locked into the 'mistakes mean I'm useless' view. As a result they find it hard to own up to difficulties or to venture an opinion.

For building confidence and encouraging risk taking brainstorming can be particularly valuable. To be most effective brainstorming should follow four main rules:

1 There should be no evaluation of or criticism of ideas, to make sure that pupils are focused on generating ideas rather than defending them
2 They should be encouraged to suggest the most outrageous ideas and solutions they can think of, on the assumption that these may contain some element of truth
3 They should be encouraged to come up with as many ideas as possible, on the grounds that out of quantity will come quality
4 They should try to build on and develop ideas that have already been suggested in the session. [58]

Brainstorming is best done in groups rather than with the whole class so that when the activity is complete and pupils turn to the job of evaluating the appropriateness and feasibility of the ideas, the groups can discuss ideas suggested by groups other than their own. This ensures that those pupils who put forward the strangest and most far out ideas are not embarrassed. The intention is to create a climate in which students can feel able to express their ideas without fear of being 'wrong' or being ridiculed in any way. An important aim is to move towards a situation where pupils are willing to submit their own ideas to the challenge of others. This involves creating an

environment in which pupils are encouraged to contribute their ideas and suggestions no matter how silly or irrelevant they may sometimes appear to be. Spontaneity, originality and intuition are to be valued.

Pupils also need to be open-minded and able to live with a good degree of ambiguity. The willingness to engage in discussion, to listen to other points of view and respond constructively to a variety of opinions will be important if pupils are to develop their thinking and problem solving skills. The difficulty, according to one psychologist, is that most of us have been socialised into thinking convergently rather than divergently. [59] We tend to believe that there is usually one answer to a problem, regardless of its complexity. From early primary pupils need to be discouraged from regarding every question they come across as having only one single correct answer. Instead they need to be encouraged to go on thinking, to hypothesise and suggest new possibilities.

The style of teaching required to foster a thinking environment is aptly demonstrated in the following description:

"What was so striking about her pupils was that they were manifestly thinking as they framed their answers. They were encouraged so to do by her refraining from saying that an answer was wrong; instead, if she thought it was not altogether right, she would respond non-committally in a tone that suggested to the pupil that he should go on thinking about what he had just said. In this way pupils were led to find faults in their own responses and amend them. Thus, for children in her class, knowledge and ideas were open-ended, originality was something to be valued, and their own views and interests counted." [60]

Thinking about Thinking

Also important is thinking about thinking or metacognition. Metacognition is about being aware of and in control of one's own knowledge and thinking and therefore learning. For example, knowing that a particular thinking strategy will help you to solve a problem is to have metacognitive knowledge. Displaying an attitude of perseverance in the face of difficulties is not metacognitive knowledge, but being aware that you have this attitude is. Paying attention to how well you understand something by asking questions such as What have I learned so far? Why am I finding this difficult? is a metacognitive activity. Other activities could involve:

- predicting outcomes
- explaining to oneself in order to improve understanding
- noting failures to comprehend
- correcting errors where appropriate
- calling on background knowledge
- planning ahead
- apportioning time.

The ability to monitor our own thinking is something that has its beginnings in early childhood. In one example 3 and 4 year olds were asked to watch while a small toy dog was hidden under one of three cups. The children were told to remember where the dog was. During the delay interval that followed some children displayed behaviours that resembled strategies designed to ensure good memory. For example, they looked at the correct cup and nodded yes or marked the correct cup by pointing

or resting a hand on it. Those children who actively prepared for remembering were more often successful in later locating the hidden dog. [61]

Throughout primary school children's ability to talk about and reflect on their own learning continues to grow. In his book 'Critical Thinking in Young Minds', Victor Quinn provides a number of examples of children from eight years old upwards participating in what he prefers to call meta-thinking. [62] He believes that children's thinking can never be extended successfully without the development of 'meta-thinking'. The following extract is from a lesson on 'learning about contradictions':

VQ: Remember, put up your hand if you spot a contradiction: '….and the girl thought to herself that it was a pity there was no language in that universe so that they could speak to each other….' (all hands up)
Amy, do you think that is a contradiction?

A: Yes, because if there was no language, 'pity' and all that (they are words), and if there was no language, she couldn't think it, if there were language. So she couldn't think!

VQ: Yes, she couldn't think those words, you are right. But the question is could she think that thought?

A: No.

G: I have never had a thought of how to think how to have a picture of pity in your mind. It is a pity in your mind. We say, 'It is a pity,' but I have never had that picture.

VQ: Right, just say that again.

G: I have never had a picture that says, 'It's a pity.'

Swartz and Perkins distinguish four levels of metacognitive thinking:

1. **Tacit use** – eg an individual unconsciously goes through various possibilities in their mind when choosing a birthday gift for a friend
2. **Aware use** – eg an individual is not only able to think of possibilities when they need to but is aware that and when they are doing so. This awareness can help people to recognise when they need to look at options; knowing that they are generating possibilities may help to focus their attention and maintain their efforts.
3. **Strategic use** – an individual recognises the importance of strategies and is able to direct their thinking by deploying them appropriately
4. **Reflective use** – an individual can reflect on their thinking at any point in the process by asking, How should I approach this task? How is it going? Could I have done better? [63]

PART TWO PROGRAMMES AND APPROACHES

A Case Study

One education authority that has taken a strategic approach to raising attainment through thinking and problem solving skills is Clackmannanshire. The Clackmannanshire Thinking Skills Initiative has its roots in a research project set up

under the Government's early intervention scheme. The original aim was to examine the effectiveness of accelerating reading and spelling among children who had just started their first year at school. The methodology included synthetic phonics teaching and making certain thinking strategies explicit through teacher modelling and rehearsal. The initial progress made by pupils was judged to be impressive. [64]

From there the project was taken forward by building on the high levels of reading and spelling achieved and by developing a programme to improve comprehension and thinking skills. This developed naturally from the synthetic phonics teaching that was already familiar to teachers and pupils. Currently it also uses some of the Robert Fisher materials, especially 'First Stories for Thinking'.

In the third phase of the project a decision was taken to link up with the work of Mike Lake on thinking skills, in particular his 'Thinking with English' materials. This development was seen as away of extending into P3 and P4 what had been achieved by pupils in P1 and P2. It was also felt that the trend in thinking skills was for more integration into the curriculum. It was important therefore not only to incorporate skills into individual subjects but to 'infuse' them into the whole curriculum. Since a core element of pupils' progress in the early and middle years is ability in Language, it was felt that a thinking skills programme based on this area of the curriculum would go a long way to raising attainment and achieving 'infusion' across the primary curriculum. Clackmannanshire's 'Thinking for Learning' programme in P3 is built around five strategies developed by Lake:

Pinpoint the problem:	finding out exactly what to do
Systematic search:	knowing what to look for and concentrating on that
Plan:	working out what to do before starting
Check and change:	constantly checking and being prepared to make changes if necessary
Compare and contrast:	making connections and being on the lookout for similarities and differences

A major development within the Clackmannanshire Thinking Skills Initiative is 'Philosophy for Children'. The development has four broad objectives:

1 To enable children to become more independent thinkers
2 To improve learning outcomes by promoting 'deeper' levels of thinking and understanding
3 To encourage teachers to increase their use of open-ended questions and to stimulate higher levels of dialogue in the classroom
4 To promote emotional/social skills developments in children

In the light of these objectives the Council believes that the 'Philosophy for Children' development is relevant to all five National Priorities for Education.

A central feature of philosophy with children is the idea of a 'community of enquiry' in which children are encouraged to listen and to talk to each other, and to discuss philosophical ideas. It requires pupils to think for themselves and to develop the confidence and ability to put forward their own ideas, views and arguments. The methodology is essentially about improving 'dialogue' in the classroom through the

use of questions. For teachers it provides a methodology that can potentially be applied across the curriculum. The method of dialogue and critical discussion is designed to develop thinking skills such as:

Information Handling – information processing skills enabling pupils to locate, interpret, analyse information and understand relationships
Enquiry – enquiry skills enabling pupils to ask relevant questions, pose and define problems, plan what to do and how to research, to predict outcomes, test conclusions and improve ideas
Reasoning – reasoning skills enabling pupils to give reasons for opinions, draw inferences and make deductions, use precise language, and make judgements and decisions informed by reasons or evidence
Creative Thinking – creative thinking skills enabling pupils to generate ideas, suggest possible hypotheses, be imaginative in their thinking, and look for innovative outcomes
Evaluation – evaluation skills enabling pupils to evaluate information, judge the value of what they read, hear and do, develop criteria for judging the value of work, and have confidence in these judgements

Philosophical enquiry is also concerned to help pupils to better understand themselves, their feelings and motives. The discussion of philosophical questions can potentially have an influence on pupils' emotional, social and spiritual development. This is particularly through the practical consideration of values and the exploration of moral and ethical issues and situations that are grounded in their own experience. Pupils become more aware of their own ideas and attitudes and hopefully are in a better position to make choices with regard to their own behaviour.

The 'Philosophy for Children' development needs to be seen in the context of the Council's policy 'Learning to Succeed'. [65] The policy commits schools and the education service to raising standards of attainment for all pupils by providing a curriculum based on:

- The development of a core group of skills, including thinking and problem solving
- The acquisition of and respect for relevant knowledge
- The promotion of personal qualities, capacities and shared values
- A wide range of formative and enriching experiences

The education service conducted a review of the different ways in which the development of thinking and problem-solving might be introduced eg through Feuerstein's Instrumental Enrichment, the Somerset Thinking Skills Course, Edward De Bono's CORT programme and Matthew Lipman's Philosophy for Children. The review commented on the implications of these different programmes for use as part of a whole council approach to promoting thinking skills and recommended that consideration be given to increased use of Philosophy for Children style of questioning and discussion. [66] Following a conference in May 2000 a working group of head teachers was set up to consider the way forward.

The development has been led by Paul Cleghorn, Headteacher of Sunnyside PS in Alloa. Initially work began in Sunnyside with P6 and P7 pupils. This session 2001/2002 pupils in P4 and P5 are also involved. P4 and P5 pupils are currently using the Robert Fisher materials, particularly his 'Stories for Thinking' and 'Poems

for Thinking'. A programme has been developed for P6/7. Sessions usually begin with a story, poem or news article. There are ten sessions each term making a total of 30 for the year. The programme takes up approximately 1 hour each week with the time coming mainly from Circle Time.

During the Spring term the10 sessions for P6 and P7 were as follows:

'Walking Away' – a story with the theme of 'wisdom'
'What was it?' - a poem with the theme of 'fear'
'Old Memories' – a story with the theme of 'service'
'Who broke the windows?' – a mystery about 'vandalism'
'By the Loch' – a story about 'beauty'
'Myself/Me' – a poem about 'myself'
'A Pencil in the Hand of God' – a story about goodness

A typical 'philosophy session' might consist of:

- Conducting a calming exercise to get pupils in the right mood for thinking
- Linking up with the previous philosophy lesson and ask if there are any further observations or ideas
- Introducing the stimulus – a story, poem, picture, event
- Allowing children some time to think about the stimulus and come up with their own ideas and questions – usually in pairs or small groups
- Examining a theme from the story through whole class dialogue and connect with personal experience
- Summing up

Teaching materials consist of a story or poem, teaching notes, questions for thinking and a 'thought for the week'. For example in relation to the theme of fear the 'thought for the week' is:
"During the week see what things make you scared. Are they things that are real threats or are they imaginary things in the mind? Can you do anything about fear?"

In addition to Sunnyside PS, there are from this session (2001-2002) an additional 8 primary schools taking part in the development involving teachers and pupils of P6 and P7. Paul Cleghorn has been given one day a week to support the development in these schools. From next session the schools are to extend the programme to P4 and 5. Teachers receive two days training which includes an opportunity to see a lesson being taught and an opportunity to be observed in turn.

The initiative is being evaluated by Steve Trickey, Council psychologist, and moderated by the Psychology Department of the University of Dundee. Evaluation consists of before and after measurements of pupil behaviour within the schools taking part as well as measurements of the same behaviours in 'control' schools. Evidence of improvement in learning outcomes will be sought in the number of children attaining Level D in National Testing as well as in verbal and non-verbal ability as measured by the Cognitive Abilities Test. At the time of writing the pre-initiative data corresponding to each of the methods used has already been gathered and is in the process of being analysed. The main methods involved are:

- Before and after testing using the Cognitive Abilities Test (CAT) and National Test results
- Pupil questionnaires eg. 'Myself as a Learner Scale' (MALS)
- Teacher questionnaires regarding pupil behaviour both in class and outside the classroom eg Taxonomy of Problematic Social Situations (TOPS)
- Video evidence of changes and developments in classroom interaction.

A Variety of Approaches

There are currently many different approaches to the development of thinking skills in Scottish schools. Some of these involve complete programmes, either school-based or commercial packages. Others reflect more a process of dipping in to established programmes eg Edward De Bono's programme or Somerset Thinking Skills. Still others simply involve encouraging pupils to make use of particular strategies to enhance their learning and raise attainment eg mind mapping. Among the most common are:

- Philosophy with Children, particularly school-based programmes and materials published by Robert Fisher
- Ann Kite's 'A Guide to Better Thinking'
- Matthew Boyle's 'Learning File'
- Cognitive Development through Science Education (CASE)
- Mike Lake's 'Thinking through English'
- David Leat's 'Thinking Through Geography'
- Aspects of Edward De Bono's Thinking Skills programme and thinking tools such as his Six Thinking Hats
- Thinking skills within enterprise and PSE programmes
- Somerset Thinking Skills Course particularly the first module 'Foundations for Problem Solving'
- Mind mapping
- Brain gym
- Study skills

The programmes and approaches reflect different views about what it means to develop thinking skills and different interests and experiences on the part of individual teachers and headteachers. There seem to be at least three purposes that teachers and schools might have in mind when developing pupils' thinking. These involve introducing activities, units and courses that will help pupils to:

1. Think for themselves: eg by putting forward their own ideas, views and arguments.

2. Think more deeply about content and concepts: eg by following certain prescribed processes and methods.

3. Develop skills and strategies: eg relating to improving memory; comprehension; problem-solving; critical and creative thinking.

The three purposes are not mutually exclusive. The development of the ability to think for themselves will be aided by acquiring certain skills and strategies. Part of what is meant by thinking more deeply will be putting forward their own ideas, views and arguments. And strategies that pupils learn for improving memory comprehension and critical thinking will help to achieve deeper thinking.

The purposes are offered as a framework through which teachers and schools might continue the task of raising pupils' attainment by improving their thinking. Each purpose is illustrated by a number of examples and a range of possible ways forward are suggested.

Thinking for Themselves

The ability to put forward our own ideas and solve problems starts from thinking, talking and working with others. If pupils are to put forward their own views and arguments and solve problems independently and confidently, they need to be encouraged to do so. Paying attention to the kinds of questions asked is one important way of helping to develop and improve pupils' thinking. Questioning is an important part of teacher-pupil interactions and can form part of everything from quick reviews of previous work through to thoughtful discussion. Although on occasions questions will be of the 'closed' variety inviting recall of what pupils have learned, much of the questioning needs to be 'open' if it is to stimulate their thinking. Careful consideration needs to be given to the sequencing of questions so that pupils can build on information and ideas that they have already discussed.

Also important during questioning is the need to give pupils sufficient time to respond. Pupils require time to reflect, to mull things over in their minds and come up with an answer. This is especially true for 'open' questions that are inviting a more thoughtful response. There is a great temptation to wait only a second or two after having asked a question before asking someone else or even providing the answer before quickly moving on. Short waiting times are likely to encourage short answers, whereas allowing more time is more likely to produce responses of greater length.

Among the most important forms that questions can take to develop pupils' thinking are:

Questions that seek clarification
Can you explain that? What do you mean by…? Can you give me an example of…? How does that help us? Does anyone have a question to ask?

Questions that look for reasons and evidence
Why do you think that? How do we know that? What are your reasons? What evidence do you have?
Questions that explore alternatives
Can you put that another way? Is there another point of view? What if someone were to suggest that…? What might someone who disagreed with you say? What difference is there between those points of view?
Questions that consider implications and consequences
What follows from what you say? What might be the consequence of that? What might happen if…? Does that agree with what we said earlier? How can we tell if its true?
Questions that attempt to pull things together
Where have we got to? Can anyone summarise so far? How does that connect to…? Are we any closer to resolving the problem? [67]

Opportunities for extending pupils' thinking through discussion can also take a number of forms, for example:

Brainstorming - Students work in groups where the idea is for each member to think up as many ideas as possible about a problem or issue. Individual contributions are gathered together without any attempt initially to categorise them or establish a priority. Once the brainstorm is complete, groups turn to the task of thinking more critically about the ideas that have emerged, so that some basis for choosing what is relevant or important is established. As we have already noted brainstorming helps to develop confidence as well as the important skill of imagining alternatives.
Buzz groups – these provide an opportunity for pupils to say what they think and ask questions about what they have been studying. It allows individual difficulties and points for clarification to surface within a small group context. The relaxed nature of the exercise should also help to develop confidence.
Think-Pair-Share – initially individual pupils spend time considering a problem or issue on their own before pairing up with a neighbour to compare notes. The results of their deliberations are then shared with the rest of the class.
Rainbow groups - each pupil in a group is given a number or a colour. When the group has worked together, all the pupils with the same number or colour form new groups to compare what they have done. In this way pupils' initial thoughts and suggestions can be challenged and extended by others.
Twos to fours - here pupils work initially in pairs before joining with another pair to compare notes. Again this provides a valuable opportunity to explain their own points of view and respond to the views of the others.
Listening triads – pupils take on the roles of talker, questioner or recorder. The talker explains their own point of view on an issue or comments more generally on both sides of an issue. The questioner seeks clarification and asks questions. The recorder takes notes and at the end of the time gives a report of the conversation. Next time the roles are changed.
Critique session – in groups, pupils offer constructive suggestions and comments about ways to improve each other's work. [68]

Questioning and discussion are key aspects of 'philosophy for children'. Philosophy for children was originally developed by Matthew Lipman in the late 1960's. [69] As a

professor of philosophy at Columbia University Lipman had become aware of the low level of thinking skills among college students. He became convinced that if this situation was to improve it had to be tackled early while young people were still at school. Philosophical enquiry is essentially a process for exploring philosophical questions through the practice of 'Socratic' dialogue. Socratic dialogue is essentially a question-and-answer method of philosophising used by Socrates in Plato's early dialogues. More generally, Socratic method is any philosophical or pedagogical method that seeks to clarify and analyse ideas through critical discussion.

According to Lipman the best way to teach children to think for themselves is through the discussion of stories. Stories introduce ideas to be explored and thought about, ideas that give rise to questions about our most basic beliefs and values. Richard Fox's collection of stories, for example, is based on ideas that arise within a range of curricular areas, and focus on conversations between pupils in a class. For example, 'The Maths Lesson' moves from daydreaming and perfect squares to questions about personal identity and infinity. [70] According to Robert Fisher, another proponent of this approach to the development of thinking, philosophical enquiry is about helping pupils to:

- Explore issues of personal concern such as love, friendship, death, bullying, and fairness, and more general philosophical issues such a personal identity, change, truth and time.
- Develop their own views, and explore and challenge the views of others
- Be clear in their thinking, making thoughtful judgements based on reasons [71]

As well as being part of something called 'philosophy', the stories can be used in personal and social education and in English listening and talking. In a recent publication Mike Lake and Frankie Fisher advocate a similar approach in relation to themes such as self-esteem, shared responsibility, friendship, peer pressure, and bullying. [72] The themes are introduced by stories, letters, dialogues and poems and detailed 'enabling questions' are provided to help teachers initiate and maintain dialogue. For example self-esteem is introduced by means of a letter from a girl to her grandmother. Among the questions to help pupils' thinking are:

- Why do some people run themselves down a lot?
- Is it because they set themselves high standards?
- Is it because other people have criticised them so much and made them feel small?
- Is it because they want other people to disagree with them and tell them how good they really are?

In one secondary school units are being introduced into S1/2 to help pupils to think for themselves, particularly through the development of critical thinking. [73] They are being developed by the Philosophy/Religious Studies department and make use of puzzles and games for thinking, as well as the 'Good Thinking' books on moral decision-making published by the Citizenship Foundation. The units are intended as a foundation for doing philosophy in S3 and S4. The APT sees his department as to some extent a service department with respect to the development of thinking – developing the kind of skills and attitudes that can also benefit pupils' learning in other departments.

In another secondary school pupils' development as independent thinkers and learners is enhanced through the Award Scheme of the Development and Accreditation Network (ASDAN). Intended for pupils in S3 and S4 each award is designed to develop, assess and accredit a number of core skills and recognise personal achievements. Among the core skills to be developed are problem solving. communication and working with others. The pupil booklet contains twelve topics including information handling, sport and leisure, the environment, technology, health and survival, beliefs and values. Each topic is divided into two or three sections and each section represents a quarter credit. Pupils have to achieve two full credits to gain a bronze award. Creative thinking is developed by encouraging pupils to take on and complete a range of challenges. There are also opportunities for critical thinking through the discussion of issues and the presentation of conclusions. 74

To help pupils think for themselves teachers could:

- Widen the range of questions they use in the classroom
- Set up a 'community of enquiry' approach to PSE
- Take appropriate steps to develop pupils' confidence and willingness to take risks
- Give more opportunities for pupils to talk through ideas and issues by using a wider range of discussion methods
- Introduce stories and poems for thinking into language work in the primary school
- Begin a course of 'philosophy for children' in P6 and P7
- Discuss with pupils in S3/4 a structure for writing argumentative essays
- Ensure that pupils have opportunities to develop their own views on a range of political, economic, social, moral and environmental issues
- Introduce a course to enhance pupils development as independent thinkers and learners eg Award Scheme of the Development and Accreditation Network (ASDAN) for S3 and S4
- Provide opportunities through drama and role play to discuss differences and resolve conflicts

Thinking about Content and Concepts

There is a great tendency across all subject and curricular areas to focus on what has to be taught and to assume that pupils' thinking about what is being taught will happen as a matter of course. Yet, as we have seen, thinking is something we can learn to do and get better at. One of the ways of helping pupils to think more deeply about ideas and concepts is to encourage the development of a range of self-questioning techniques that they learn to use automatically when they are working on tasks. In order to help pupils develop these teachers need to model the questions at every opportunity. Among the questions that are likely to be important in most subjects and curricular areas are:

Thinking questions	**Thinking about thinking questions**
What am I being asked to do?	How can I check my progress?
Have I met this before?	Am I doing this correctly?
What information do I have?	Why can't I do this?
How much do I understand?	Is there another way to do this?
What do I need to know?	Did I solve the problem?

How can I find this out?
Who can help me?
What do other people think?
What are the most important ideas?
What are the arguments for and against

Would I do it differently next time?
Did I work as well as I could?
How did I learn what I learned?
Could I use what I learned in another situation? Can I think of one?
Why did I find that difficult?

According to Reuven Feuerstein the Israeli psychologist, learning needs to take place at three levels if it is to contribute to effective thinking. [75] These are:

Input: the input level is reflected in the pupil's ability to gather and organise relevant information. Are they able to complete tasks or solve problems satisfactorily? Do they often fail to find sufficient information? Pupils may not be clear as to what they are looking for in the first place or they may not conduct their search in a systematic way. They need to develop planning skills including the ability to set clear goals, identify sources, locate and record information.
Elaboration: the elaboration level is reflected in the way in which pupils handle the information they have gathered. Are they able to see relationships between objects or events, to generate new information from what is given, to look for reasons and causes? They need to be able to reflect on experience, consider alternative explanations, and to express their own opinions and draw conclusions.
Output: the output level is reflected in the way pupils communicate their thinking and share their ideas. Do they think things through before giving a response? Are they able to deal with false starts and correct their mistakes? They need to be able to use appropriate language clearly and concisely and to take account of their audience.

Bloom's taxonomy has been one of the most influential in curriculum development and has been widely used, particularly in America, to plan teaching programmes. Benjamin Bloom and his associates argued that there are six levels of thinking.

1. **Knowledge:** having an awareness of facts, key terms and concepts
2. **Comprehension:** having an understanding of the meaning and significance of this knowledge
3. **Application:** applying knowledge and comprehension to real and imaginary situations
4. **Analysis:** breaking down material into its main parts and to see the relationships between them
5. **Synthesis:** coming up with new ideas and relationships
6. **Evaluation:** making judgements and to assess; it is characterised by questions such as - which do you prefer, how successful is it, how practical, is it relevant, why do you think so, do you agree.

Each level of thinking is comprised of a number of specific skills through which pupils can demonstrate their knowledge, comprehension, analytical and evaluative thinking. For example, if pupils are working:

At Level 1 (knowledge), they would be stating what they know, listing, identifying, describing, defining;
At Level 2 (comprehension), they would saying what something means, giving examples, explaining, relating, comparing;

At Level 3 (application), they would be talking about their own experiences, using strategies to solve problems, demonstrating; applying what they know to real life
At Level 4 (analysis), they would be distinguishing, explaining differences, using sources, predicting consequences
At Level 5 (synthesis) they would be expressing opinions, compiling evidence; generating ideas, proposing solutions;
At Level 6 (evaluation) they would be giving reasons, drawing conclusions, assessing arguments, arguing a case. 76

Researchers at King's College, London conducted a controlled experiment using 'Thinking Science' materials in which two similar groups of young people between 10 and 14 years were taught science. The first group, the control group, had no access to the materials. The second group, the experimental group, was taught to think and reflect on their thinking as well as their science using the materials. When the groups were followed up two and three years later pupils in the 'thinking' group did significantly better in GCSE science. Not only that, they did significantly better in mathematics and English too.

According to the authors of 'Thinking Science' the essential feature of their materials is the concentration on improving pupils' thinking about science. If this is to be achieved, they say, it is important that teachers have an understanding of the methods or processes to be used.

"Simply proceeding through the 32 activities as practical exercises in which pupils do experiments, make observations, record results and struggle by themselves to reach conclusions is unlikely to have any useful effect." 77

The central processes in 'Thinking Science' are:

Cognitive conflict:	where pupils are led to make observations that do not fit with their expectations
Discussion:	both with the whole class and with individuals and small groups
Metacognition:	through questioning pupils are helped to become aware of and articulate about the sort of thinking they are using to solve different problems eg How did you solve that?
Bridging:	linking what has been developed to the broader science curriculum.

This emphasis on following a process and using certain methods is a common element among approaches that intend to help pupils to think more deeply about content and concepts. For example in 'Thinking Through Geography' one of the key aspects of the process is 'debriefing'. The authors maintain that:

"This is the very hardest part of teaching thinking to get right, but at the same time it is the most crucial." 78

Debriefing is the process of finding out whether pupils have consolidated their learning and transferred it to other contexts. It has four elements. Elements 2 and 3 together make up the metacognitive or thinking about thinking element:

1 Getting pupils to explain their answers or solution at length
2 Asking pupils about their mental processes as they did a task or tackled a problem
3 Asking pupils about any patterns in their reasoning that they employed or that emerged in discussion
4 Drawing the attention of pupils to other contexts where the same reasoning can be used. These may be in other geography topics, in other subjects or in their everyday lives. This is called 'bridging' and is concerned with getting pupils to transfer their learning from the geography lesson to other contexts.

In September 2001 Learning and Teaching Scotland published staff development materials for RME 5-14. [79] The intention was to encourage teachers to reflect on their current practice and to improve their understanding and teaching skills. Opportunities were included for teachers to think about and practise different teaching strategies. A teaching model was suggested and exemplified through a series of topics covering the range of classes from 5-14. The model has four stages:

1. Preparing the way
2. Finding out
3. Making connections
4. Thinking it over

The process is essentially concerned with 'teaching for thinking'. It is intended to help pupils to think about and develop their own beliefs and values by drawing them into thoughtful dialogue with the beliefs and values that are found within the world's religious and non-religious belief systems. The climax of the process is the 'thinking it over' stage. This stage involves thinking about and evaluating the ideas that arise from their studies. The learning is to be challenging, dealing with issues that push children's thinking beyond their immediate knowledge of the content. The issues invite discussion on a range of questions to do with suffering and evil, life and death, the existence of God, relationships, moral and social values, the origins and condition of the natural world. Among the methods regarded as essential to the process are questioning, discussion and positive feedback.

To help pupils think more deeply about content and concepts teachers could:

- Present pupils with stimulating challenges to make them think
- Ensure that pupils have sufficient opportunities to reflect on their thinking
- Model questions for 'thinking' and for 'thinking about thinking'
- Make explicit the specialist skills associated with different subject areas
- Provide opportunities for pupils to think about and make judgements about ideas, evidence, arguments and assumptions eg in relation to sources both contemporary and historical
- Introduce special programmes for thinking established in various subjects eg. CASE Science, Thinking Through Geography
- Absorb the methods and processes used in a special programme into normal teaching
- Encourage pupils to apply their knowledge and skills to the real world through questions, examples, case studies and problem-solving
- Implement a system for interacting and talking with groups on a regular basis
- Introduce pupils to the principles and practice of effective study eg having a clear purpose, studying in short periods, reading, note-taking

Developing Skills and Strategies

This includes a range of approaches from the development of individual skills to a series of strategies within more extended inserts and courses. The focus may be within particular subject areas, the curriculum as a whole or a special programme.

According to a recent Standards and Quality report from HMIE pupil's performance in using different strategies to solve mathematical problems is the weakest aspect of attainment in mathematics. [80] In one primary school the difficulties pupils were having with this aspect had already become clear from their national test results. [81] It was clear to staff that pupils were able to do the calculations necessary to solve problems but were unable to get to this stage because they didn't understand the 'language' of the problem. The school decided to give pupils more practice at tackling problems. Each morning when pupils arrive in class they find three problems on the board. Pupils know that when they arrive they are expected to 'think.' The discussion of the problems will usually last 5-10 minutes. The emphasis is on how to approach problems and to make use of strategies rather than on getting the right answer. One of the main strategies used is encapsulated in the acronym RACECAR:

R read the question
A ask yourself what is wanted
C choose how you will do it
E experiment or try to work it out
C check your working
A answer
R report

Another acronym, PROBLEMS, is sometimes used to help pupils tackle problems that may include knowledge and skills from a range of curricular areas – 'real' problems such as:

Organising an end of term dance
Starting a school magazine
Creating a school garden
Helping out at a school fete
Planning an assembly
Tackling litter
Deciding on school rules
Designing a new game

The steps involved provide a useful framework for approaching such problems in a systematic way. They are matched to key questions that guide the learners through the process: [82]

STEPS	**KEY QUESTIONS**
Pose the problem	Does the problem concern us? What is our goal?
Refine into areas for investigation	What does the problem involve? What needs investigating
Outline the questions to ask	What questions do we want to ask? Would the answers help us?
Bring the data home	What information do we need? How will we collect it?
Look for solutions	Does it answer our question? What is the solution?
Establish recommendations	Who will be affected?
Make it happen	How do we know our solution works?
So what next?	

The work of Edward De Bono also provides a good starting point for teachers wishing to help pupils develop their creative skills. He has devised a series of strategies or 'thinking tools' that can help pupils to generate ideas. [83] They are intended to direct children's attention to aspects of a situation or problem that might otherwise be neglected eg.

AGO: Aims, Goals, Objectives
This strategy is intended to help us focus more clearly on the task at hand. Setting their own personal and school goals can also help pupils to develop a greater sense of control over their own lives and their own learning. Without some sense of where we are going and why, our ability to think creatively will be reduced.

PMI: Plus, Minus, and Interesting
This is a useful brainstorming technique in which the good points of an idea are listed under P (Plus), the bad points under M (Minus) and points neither good or bad are (Interesting). This forces us to explore ideas, situations and problems before coming to a judgement about them. Interesting points are neither benefits nor drawbacks but simply points of interest. They consist mainly of observations and comments.

CAF: Consider All Factors
While PMI is concerned to make judgements about whether certain points are good or bad, CAF is simply concerned to ensure that when making a decision we take account of all the possible factors that are relevant.

FIP: First Important Priorities
Having generated a number of ideas it is important to decide which are the most important for the task at hand.

OPV: Other People's Views
This is useful in helping pupils to see and understand a situation or issue from someone else's point of view. If we are to come up with good ideas and solve problems we need to look at what other people have to say and consider alternatives.

C&S: Consequences and Sequel
This, says De Bono, is one of the most important strategies for thinking in real life. If our thinking is going to result in any kind of action or decision then we need to take account of what might happen in the future as a result.

One programme currently being used by a number of primary schools to develop thinking skills is 'A Guide to Better Thinking.' It consists of a teacher's guide and pupil book. It is intended for use by 10-12 year-olds, although the teacher's guide says that it has been used successfully with both younger and older children. It main aims are to:

1 Provide teachers with a theoretical framework that is easy too use and manageable
2 Introduce to pupils a broad range of skills and strategies in positive, critical and creative thinking

The guide emphasises co-operative learning strategies and the development of metacognitive skills to help children become more aware of their own thinking. Each section ends with a 'How am I doing?' section designed to help children monitor their own progress. A major principle of the programme is that the activities should be closely related to situations in pupils' own lives. Children are involved in making decisions about problems that affect their lives.

"The development of thinking skills is far more effective when children's thinking is challenged by real problems and real decisions." 84

Characters are used to model the thinking strategies for children. At the beginning of the guide the main character, Sparky, has poor thinking skills and needs a guide to help him make them better. The idea is that children will identify with the character and spark off their own thinking. Kara, the other main character, provides the 'scaffolding' for Sparky, clarifying ideas and helping him when he gets stuck.

Six steps to successful thinking are set out:

Think you can do it:	Say it before you start. I can do it if I think I can
Think of your goal:	Know what your goal is – be clear about the task, then think of all the questions you should ask.
Think of your plan:	Plan your thinking – decide which options are best, then consider the arguments for and against.
Think of the consequences:	Think of the consequences - How does it look to you? Then think how it will look from other points of view
Think of how to monitor:	Monitor your thinking as you go along. Ask how am I doing? And change it if its wrong
Think and reflect:	When your thinking has worked out fine, ask 'Could I make it better to use another time?'

The programme was evaluated by means of controlled trials set up in schools with different socio-economic backgrounds. Children in the experimental classes were taught the programme while children in the control classes continued with their normal curriculum. At the end of the trial post-test scores on four different tests were significantly higher for the experimental group than for the control group. Further trials of children using the programme have shown significant gains in national tests for reading. The author believes that thinking skills need to be taught first through a special programme and then infused throughout the curriculum. She writes:

"Most authors and developers of major cognitive curriculum projects agree that direct instruction in thinking skills is imperative." 84

A similar thinking skills framework is that of TASC – Thinking Actively in a Social Context. The authors take the view that to become lifelong thinkers, learners need to have the skills and strategies they use actively embedded in the whole curriculum, in real life problems and in relevant contexts. Consequently, they offer a basic 'starter kit' of core thinking strategies or tools for effective thinking across the curriculum. Although the TASC model attempts to highlight the essential elements that should be part of any thinking skills programme it is not prescriptive with regard to how it should be applied in different areas of the curriculum. Examples are included for English, mathematics and science.

The core thinking strategies identified are:

Clarifying goals:	What are we trying to do?
Creating a 'think tank':	How many ideas can we think of?

Looking at both sides of an idea:	What is the opposite view?
Exploring the consequences:	What will happen if?
Looking all round an idea:	What are all the factors to consider?
Prioritising:	Which is the most important?
Consulting others:	What do other people think?
Making connections:	How do the ideas link?

The current materials are based on work done in the mid-1980's by Belle Wallace and Harvey Adams. Having surveyed the main thinking skills packages that were already published, they conducted an action research project with groups of disadvantaged learners and their teachers over a period of ten years. Strategies and methodologies were trialled, evaluated and reflected upon by the researchers, the teachers and pupils involved, as well as a group of educational psychologists. The process culminated in the publication of TASC: Thinking Actively in a Social Context (Wallace and Adams 1993), which sets out a generic framework for the development of a thinking and problem-solving curriculum.

"Teaching problem-solving and thinking skills within subjects and across the curriculum in a planned and coherent way actively develops learners' skills of learning how to learn and actively increases their mental capacities." [85]

A recent thinking skills programme called Let's Think! puts the emphasis on developing specific skills. [86] Designed for five and six year olds it comprises 30 activities, each of which takes about 30 minutes to complete. The programme can be spread over a year with each activity being used with a different group of children each day, and a new activity each week. Many of the activities involve the use of resource cards and three-dimensional objects, and most of these are supplied. Although the Let's Think activities are not attributed to any particular subject, the authors point out that they link especially with science and mathematics. Among the skills to be developed are:

- The ability to put things in order to form a series (seriation)
- The ability to sort objects into groups using a number of variables (classification)
- The ability to place a set of events in order, so that they make sense (time sequence)
- The ability to imagine the view of a scene from different positions (spatial perception)
- The ability to see the link between cause and effect (causality)
- The ability to imagine the thoughts and perceptions of others (theory of mind)
- The ability to see the relationships between a number of concrete factors or variables (concrete modelling)

In order to develop pupils' thinking the authors describe 'five pillars' of cognitive acceleration which make up the process within each activity. They are:

Concrete preparation
Involves introducing the children to the language and materials of the activity
Cognitive conflict
Involves setting the children a challenge or task and encouraging them to puzzle over it.
Social construction
Involves encouraging pupils to offer suggestions and to comment on one another's suggestions; pupils are asked to justify their statements and to explain 'why they think that'.
Metacognition
Involves encouraging children to develop conscious awareness of their own thinking eg 'What did you find difficult about that?' and 'How did you solve that?'
Bridging
Involves linking the kind of thinking that is being developed in a particular activity to other times when that type of thinking could be useful eg from an activity about classification the teacher might point to an aspect of science work in which it was also useful to put things in groups.

The materials were evaluated across 14 Year 1 classes drawn from 10 schools in the London Borough of Hammersmith and Fulham. Tests of spatial perception and conservation at the beginning and end of the school year showed that the children who who used the Let's Think! activities made significantly greater gains than the control groups. The authors write:

"Both the theory and the experience……indicate that gains in cognitive development lead to gains in academic achievement. Children who think better, learn better." 86

To help pupils develop skills and strategies teachers could:

- Use mind maps and encourage pupils to use them
- Introduce a strategy to help primary pupils with problem-solving in mathematics eg RACECAR
- Use thinking strategies to improve comprehension in Language in P3 and P4 eg Mike Lake's 5 thinking strategies
- Introduce strategies for improving memory eg breaking down information into smaller chunks, adopting an efficient revision strategy
- Introduce a programme for developing general thinking skills and strategies eg Let's Think! in P2; 'A Guide to Better Thinking' in P6; The Learning File in S1
- Use a framework for tackling 'real' problems eg PROBLEMS
- Encourage pupils to use strategies to develop creative thinking eg De Bono's thinking tools
- Use lateral thinking puzzles and games to develop pupils' creativity, especially their fluency and flexibility
- Set pupils creative tasks and problems to develop their powers of originality and elaboration
- Introduce a course on critical thinking for pupils in S2

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