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Monograph:
Taggart, Geoff, Ridley, Kate, Rudd, Peter et al. (2005) Thinking Skills in the Early Years: A Literature Review. Research Report. National Foundation for Educational Research , Slough.

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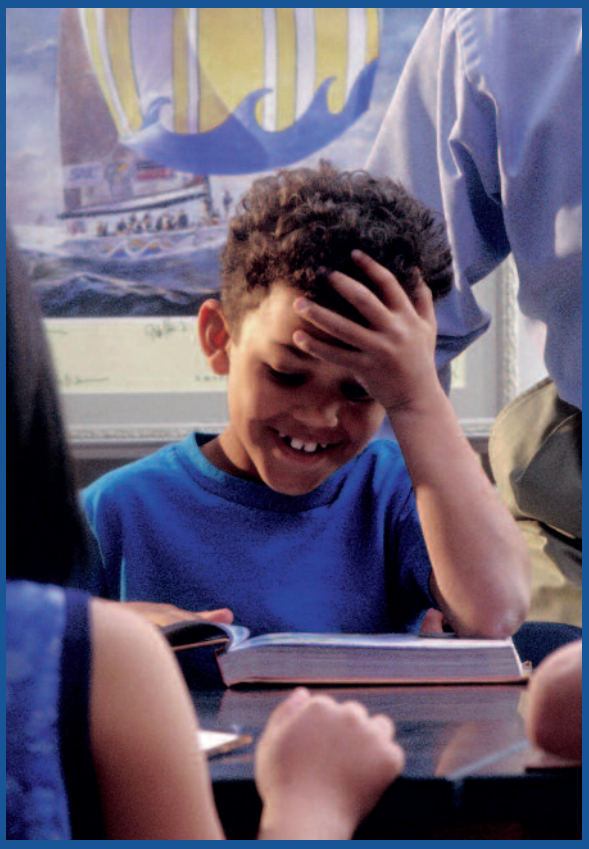
thinking skills in the early years

a literature review



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Published in November 2005 by the
National Foundation for Educational Research
The Mere, Upton Park
Slough, Berkshire SL1 2DQ
www.nfer.ac.uk

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Registered Charity No. 313392
ISBN 1 905314 12 4

Designed by Stuart Gordon at NFER
Page layout and figures by Patricia Lewis
Cover design by Helen Crawley at NFER

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Executive summary

Introduction

Since 1999, thinking skills have been included in the National Curriculum alongside 'key skills' such as those to do with communication and information and communications technology (ICT). Thinking skills are expected to be developed at all key stages and centre on: information-processing skills, reasoning skills, enquiry skills, creative thinking skills and evaluation skills.

This literature review consisted of three phases based on the following research questions:

1. What pedagogical approaches to developing generic thinking skills currently exist for children between the ages of three and seven?
2. What are the generic thinking skills that children are able to demonstrate at this age?
3. What is the relationship between these thinking capabilities and those that the pedagogical approaches aim to develop?

The review covered post-2000 literature in the area of thinking skills in the early years. It provides an update of the evidence base upon which thinking skills approaches have been established, suggests areas where more evidence is needed and makes some practical recommendations for researchers, policy makers and practitioners.

Key findings

The first phase of the research explored classroom-based approaches to developing thinking skills (i.e. research within an educational setting). The literature was divided into two broad categories based on McGuinness's (1999) distinction between 'infusion' approaches (enhancing pedagogy in general within everyday teaching) and 'discrete' approaches (using specific resources and techniques). The evidence relating to classroom-based research suggests that since 2000, little systematic evaluation has taken place of approaches to developing thinking skills in young children. In particular:

- many of the articles reviewed were examples/case studies within accounts of classroom practice and effective pedagogy and, though these were informative and useful, they were not methodologically rigorous
- more literature was obtained relating to infusion approaches than to discrete approaches, reflecting the pedagogy generally used within the early years
- infusion approaches included developing thinking skills as part of good teaching, applying curriculum subjects to teaching thinking skills and encouraging problem-solving
- discrete approaches were classified as influenced by the following: thinking together, philosophy for children, cognitive acceleration through science education, paired thinking, lateral thinking and brain gym
- compared to discrete approaches, infused approaches to thinking skills draw on a broader range of subjects and, in particular, a broader variety of play, i.e. drama and role-play
- compared to infused approaches, discrete approaches to thinking skills appear to allow children to develop their abilities more systematically, although little evaluation has been done to gauge their effectiveness
- the importance of creating opportunities for dialogue was stressed in both kinds of approach.

The second phase of the research explored the generic thinking skill capabilities of young children, as shown by pedagogical and psychological research. The literature here grouped around the following themes: the importance of language, the importance of play, understanding other minds, thinking 'counterfactually', problem-solving and the assessment of thinking skills. Many of the studies referred to cognitive stages of children's development but did not suggest how these stages may provide a basis for the formative assessment of thinking skills. The literature from Phase two indicated that, by the age of seven (and given the right assistance), children are generally able to:

- use 'thinking language' involving words such as 'think', 'know', 'guess' and 'remember'
- construct informal rules for the purpose of solving problems
- sort objects according to one or more criteria
- understand that the beliefs of others may be different from their own

- understand that because someone has partial knowledge of something they will not necessarily have all of it
- hypothesise about what might happen in relation to future events
- suggest alternative actions that could have been taken in the past (though this is more difficult than thinking about the future)
- reason logically from given precepts.

In the final phase of the research the findings from the previous phases were compared in order to indicate current strengths and gaps in the interventions for developing thinking skills in the classroom and the capabilities of young children. The following conclusions were reached.

- Pedagogical approaches to the promotion of thinking skills in young children are developmentally appropriate in helping children to construct rules for solving problems, hypothesise about possible eventualities, suggest alternatives or reason from given information.
- The expectations of the National Curriculum are generally appropriate in the light of young children's cognitive abilities.
- The emphasis on dialogue in pedagogical approaches is substantiated by the psychological literature, which stresses the importance of acquiring and developing a vocabulary of mental terminology and learning skills through communication with others.
- Questioning, dialogue, story and play are central to the process of developing and researching young children's thinking skills.
- Neither infused nor discrete approaches to thinking skills draw upon explicit strategies to help very young pupils develop their emergent theory of mind or their skills in counterfactual reasoning.
- Whilst the psychological literature reveals that children find some kinds of question more difficult or confusing than others, none of the studies relating to pedagogical approaches focused on questioning specifically.

Conclusions/recommendations

The researchers made the following recommendations. In light of the educational and psychological research reviewed, researchers should:

- conduct evaluations both of discrete and infused approaches to developing young children's thinking skills
- further explore the opportunities for the development of thinking skills within the Foundation Stage curriculum
- develop the psychological literature on creativity in relation to thinking skills – whilst classroom approaches aimed to develop reasoning, enquiry and creativity, the recent psychological research focused on reasoning and enquiry, but not creativity
- review the current state of the literature on teacher questioning in relation to the development of young children's thinking skills
- identify best 'educare' practice in helping pre-school children acquire a theory of mind and develop their counterfactual reasoning skills
- determine the extent to which young children are able to critically evaluate a piece of work
- make explicit the practical implications of research, for example, dissemination in publications targeted at early years practitioners.

The literature provided some pointers to how the National Curriculum, as it relates to thinking skills, may be developed in the future, by:

- considering explicit reference to play – the literature emphasises the importance of play in the development of thinking skills but play is not mentioned in this part of the National Curriculum
- encouraging the development of evaluation skills – classroom approaches have tended to focus on other skills such as problem-solving, but there is some evidence that young children can evaluate successfully (i.e. in relation to counterfactual reasoning)
- encouraging a focus on information-processing skills – although information processing appeared in both phases of the literature review (e.g. classification or sequencing), this was not generally the principal focus of the studies
- stressing the use of different media – whilst there was evidence to show that young children can compose a written argument, the discrete approaches emphasised spoken language only.

When teaching thinking skills in the early years, practitioners should consider the extent to which:

- their questions can focus specifically on stimulating children's thinking (see Table 1)
- they can create timetabled opportunities for 'thinking times', which signal to the children that a non-ordinary (and possibly counterfactual) kind of thinking is being encouraged
- more opportunities can be created in the classroom for structured dialogue
- children can be invited to construct written opinions and arguments
- 'story-time' can become an opportunity to develop children's thinking
- traditional sorting and sequencing tasks can be an opportunity to verbalise thinking
- play equipment can present children with possibilities for developing their imagination
- children can be given opportunities for solitary as well as social play
- children can be asked to evaluate their work critically
- additional adults in the classroom can be used to develop children's thinking
- creative activities can encourage creative 'possibility thinking' as well as creative skills.

Table 1 Types of question and thinking skill focus, based on a Winnie-the-Pooh story

Focus	Question
Evidence	How do you know Winnie-the-Pooh got stuck in the rabbit hole?
Reasons/theory	Why did Winnie-the-Pooh get stuck in the rabbit hole?
Counterfactual suggestion	What would have happened if Winnie-the-Pooh had not eaten the honey?
False belief	What does Winnie-the-Pooh think has happened to stop him getting out?
Future hypothetical suggestion	What could Winnie-the-Pooh do next?

About the study

The review focused on post-2000 literature on the generic thinking skills of children aged three to seven. We excluded the following from the review: research focusing on the contribution of a particular core or foundation subject, research that was specifically about special educational needs, and non-English-language research.

There were three phases to the research. The key focus of Phase one looked at classroom approaches to developing young children's thinking skills (27 documents were reviewed). Phase two covered current understanding about the generic thinking skills of young children (24 documents were reviewed). The final phase of the research systematically compared and synthesised the findings from the previous two phases to draw conclusions about the topic.

1 Introduction

Since 1999, thinking skills have been included in the National Curriculum alongside 'key skills' such as those to do with communication and ICT. Thinking skills are expected to be developed at all key stages and centre on:

- **Information-processing skills**
  These enable pupils to locate and collect relevant information, to sort, classify, sequence, compare and contrast, and to analyse part/whole relationships.
- **Reasoning skills**
  These enable pupils to give reasons for opinions and actions, to draw inferences and make deductions, to use precise language to explain what they think, and to make judgements and decisions informed by reasons or evidence.
- **Enquiry skills**
  These enable pupils to ask relevant questions, to pose and define problems, to plan what to do and how to research, to predict outcomes and anticipate consequences, and to test conclusions and improve ideas.
- **Creative thinking skills**
  These enable pupils to generate and extend ideas, to suggest hypotheses, to apply imagination, and to look for alternative innovative outcomes.
- **Evaluation skills**
  These enable pupils to evaluate information, to judge the value of what they read, hear and do, to develop criteria for judging the value of their own and others' work or ideas, and to have confidence in their judgements.

(QCA, 2000)

Guidance on how to implement the curriculum in the Foundation Stage was published in 2000 and suggested that practitioners should 'challenge children's thinking' and 'support children in thinking in open-ended ways'. However, the extent to which young children can reason or engage in 'metacognition' (thinking about their thinking) is unclear. This lack of clarity is partly due to a clash of educational paradigms, between a developmentalism typified by Jean Piaget and a constructivism typified by the work of Lev Vygotsky.

Piaget placed a strong emphasis on the stages of development that children go through as they mature. Piaget's legacy has had a continuing influence on devel-

opmental psychology, although many of his concepts and findings have been developed in recent years. Piaget suggested that children at a 'pre-operational' stage of development (for example, younger than six) are unable to reason properly, since they are 'egocentric thinkers' who think of everything only as it relates to themselves. The concept of 'readiness' is also intrinsic to the theories of developmental stages proposed by Montessori, Steiner and Froebel and these theories influenced the growth of early years pedagogy. According to these theories, it is inadvisable, if not harmful, to introduce intellectual demands too early in a child's life. The work of Soviet psychologists such as Vygotsky emphasises the social nature of development including, for example, how learning is helped through interaction with others and the view that we can achieve higher levels of processing when there are others to assist us and stretch us.

As suggested by Riggs and Peterson (2000), engaging young children in thinking is potentially problematic because they are often extremely engaged by what is most concrete and salient to them, rather than what is intangible:

> *A powerful feature of human thinking is the ability to reflect on how the world might have otherwise been, or how it might be under different circumstances rather than how it is immediately presented to us. We often want to answer questions about things which are not immediately accessible: situations in the future, situations in the past, situations that do not exist, inaccessible places or even other people's minds.* (Riggs and Peterson, 2000, p.87)

It is not necessarily the case that young children find thinking about intangible or abstract things impossible. A cursory examination of the literature (e.g. Costello, 2000) reveals descriptive accounts of thinking skills programmes which suggest that young children do benefit significantly from being involved in them and that they do have the ability to reason, enquire and evaluate. These programmes place much emphasis upon the power of dialogue to allow children to construct meaning and articulate their thinking.

The ongoing debate over these various theories has particular relevance for early years education. However, a recent literature review of research into thinking skills (Higgins *et al.*, 2004) concluded that 'there is a greater proportion of research reported for 11–14 year-olds with comparatively little about 5–7 year-olds (key stage 1 pupils)'.

The current review was therefore inspired by the following research questions:

- What pedagogical approaches to developing generic thinking skills currently exist which are intended for children between the ages of three and seven?
- What are the generic thinking skills which children are able to demonstrate between the ages of three and seven?
- What is the relationship between these thinking skills and those that pedagogical approaches aim to develop?

This review attempts to address these questions through an analysis of the post-2000 literature in this area. It provides an update of the evidence base upon which thinking skills approaches have been established and suggests areas for which more evidence is needed.

2 Methodology

There were three phases to the research, which are discussed in turn.

2.1 Phase one: classroom approaches to developing young children's thinking skills

The first phase of the literature review investigated the extent to which the development of thinking skills at key stage 1 (or equivalent) has been explored and researched. In particular, the review took both a UK and international (English-language) perspective on research that has been conducted since 2000 into the effectiveness of different pedagogical methods in developing generic cognitive abilities in children aged three to seven. The key focus of this phase was on research within an educational setting.

Because of the generic focus of the research, the following literature was excluded:

- research focusing on the contribution of particular core and foundation subjects to the cognitive development of young children
- research which specifically addresses the special educational needs (SEN) of young children or which evaluate forms of remediation such as 'instrumental enrichment' (Feurstein, 1980)
- non-English-language research.

The review team began by drawing up a brief parameters document providing definitions and key questions. This was based upon the use of a database of classroom approaches to the promotion of thinking skills provided by the Thinking Skills Research Centre at the University of Newcastle, along with searches by the NFER library. The search strategy was then agreed between research and library staff (see appendix 1). Librarians were responsible for carrying out keyword and free text searches of relevant databases. Preliminary searches identified material of potential interest to the project. This was subject to careful scrutiny in relation to the agreed parameters. Literature that met the parameters of this review was obtained. For Phase one, the research team reviewed 27 documents in total.

The next stage of the process was to write a structured summary of each piece of literature. Research staff made use of a suitably adapted version of a well-estab-

lished NFER summary framework. In order to ensure consistency of approach, the first piece of literature was summarised independently by the members of the team. Their summaries were then compared and discussed and a final version was agreed. Thereafter, one person reviewed each piece of literature, but all literature was subject to review and editing by the project leader. In each case, judgements were also made about the quality of the methodology and the strength of the arguments and evidence provided.

The summaries of each item of literature were then brought together into themes relating to the questions identified at the outset, together with emerging issues.

2.2 Phase two: young children's thinking capabilities

The next stage of the literature review summarised current understanding about the generic thinking skills of young children, as shown by pedagogical and psychological research carried out since 2000. The emphasis of this phase was about what the capabilities of young children are. In particular, evidence was sought for the ability of young children to reason, enquire, evaluate, process information and think creatively.

Literature eliminated included:

- research focusing on the cognitive capabilities of children in relation to particular school subjects
- research which specifically addresses the special educational needs (SEN) of young children or which evaluates forms of remediation such as 'instrumental enrichment' (Feurstein, 1980)
- research into young children's creativity which does not address the subject of creative thinking
- academic psychological studies into the thinking of young children which do not involve an educational setting or an educational methodology, nor have an educational application
- non-English-language research.

The second phase of the research followed the same procedure as the first. The parameters document was informed by the definition of thinking skills provided by the National Curriculum and by the research team's knowledge of develop-

mental psychology (see appendix 1). As with the previous phase, appropriate material was obtained and summarised. For Phase two, the research team reviewed 24 documents.

2.3 Phase three: matching pedagogical approaches with thinking capabilities

The final phase of the research involved systematically comparing and synthesising findings from the two literature reviews. This synthesis made it possible, for example, to cross-reference those thinking skills young children are capable of with the thinking skills interventions that have been tried with them. In particular, the analysis focused upon identifying:

- omissions in the provision of training and materials on the subject of developing thinking skills in young children and, resulting from these, areas that should be developed
- good examples of approaches and materials which draw upon the National Curriculum and that are conducive to the cognitive abilities of young children
- training and materials on the subject of developing thinking skills that do not match the capabilities of young children
- the relative appropriateness of the National Curriculum expectations in the light of young children's cognitive abilities.

The next chapter summarises the main findings from Phase one of the literature review, which sought to identify research findings on current interventions and strategies aimed at developing young children's thinking.

3 Phase one: classroom approaches to developing young children's thinking skills

This chapter synthesises the literature examined in the first phase of the research, which consisted of studies on the subject of early years pedagogy in relation to thinking skills. McGuinness (1999) makes a helpful distinction between 'infusion' approaches to developing thinking skills and 'discrete' approaches. The former are primarily ways of enhancing pedagogy in general to maximise opportunities for pupil thinking. The latter are associated with particular resources and techniques. For the purposes of this chapter, the literature reviewed has been divided into these two categories. A third section briefly examines the assessment of thinking skills.

3.1 Infusion approaches

More of the studies reviewed investigated 'infusion' approaches to thinking skills in the early years than 'discrete' approaches. This imbalance reflects the strong emphasis within early years practice on the infusion and integration of skills and knowledge within themes or topics likely to be of immediate interest to children. Lessons in particular subjects, including thinking skills, are less common in the Foundation Stage than in years 1 or 2.

The material obtained fell into one of three categories:

- evaluations of best practice in general early years pedagogy, in which an infusion approach to thinking skills is described and recommended
- applications of curriculum subjects to thinking skills development
- research which aims to use empirical work to help structure and conceptualise the problem-solving process.

3.1.1 Developing thinking skills as part of good teaching

An extensive study of best practice was carried out by Siraj-Blatchford and Sylva (2004), who observed children in 14 Foundation Stage settings, dividing their observations into 'learning episodes'. These episodes were continuous, coherent

activities that were initiated either by children or adults and which lasted for at least one minute. The authors found that these episodes were frequently characterised by periods of 'sustained shared thinking', interactions where two or more individuals worked together in an intellectual way to solve a problem, clarify a concept, evaluate activities or extend a narrative. A characteristic of practice in excellent settings was the high degree to which staff picked up on and developed child-initiated activities with the purpose of deepening children's thinking about what they are doing.

In another study of pedagogical effectiveness in early learning (Moyles *et al.*, 2002), a practitioner made the following observation:

> *I'm just thinking in terms of … let's think … the woodwork table and thinking that obviously one would think that's just about skills but a lot of thinking has to go on with an activity like that in terms of understanding about the use of the tools and thinking about how they're going to hold the nail still while they try and tap it in and so on. And staff would be working alongside making the right kind of comments … often giving what we call verbal feedback, which is not direct teaching but is actually describing what the children are doing which helps them work out in their own brain ... it's almost like they know what they're doing but you're putting words to it and that helps them to think on to the next stage.* (Moyles *et al.,* 2002, p.44)

The authors made the point that very few of the early years practitioners interviewed were able to consider the issue of thinking skills to any extent, for example, by varying the kinds of question they use to develop children's inquisitiveness.

Devereux (2002) stressed the importance of appropriate questioning in stimulating thinking and gave some examples of key questions:

- 'What will happen if you …?'
- 'Have you thought about …?'
- 'What is your problem? How can you find out about …?'
- 'What happens when you test …? Why do you think this will happen?'
- 'How can you fix this? What do you notice about these numbers?'

In New Zealand, the Ministry of Education commissioned a synthesis of best evidence 'on quality teaching for reducing disparities and maximising learning

opportunities and outcomes for all young children' (Ministry of Education, 2003). The synthesis described seven characteristics of quality early years teaching, some of them focusing explicitly upon metacognition:

> *Pedagogy scaffolds, co-constructs, promotes metacognitive strategies and also facilitates children's learning in the context of adult/older child activities … Effective teachers teach metacognitively, reflecting on their own thinking and children's thinking as learners.* (Ministry of Education, 2003, p.2–3)

As examples, the report drew on two studies into metacognitive teaching strategies, on road safety awareness and environmental awareness. Lessons on both topics included opportunities for pupils to discuss their current state of knowledge on these issues. These pupils showed greater powers of recall and retention in relation to this knowledge than pupils in comparison groups.

A two-year research project in Cambridgeshire (Whitebread *et al.*, 2004) focused on 96 children aged three to five in different settings. Early years practitioners chose to promote independent learning through various forms of curriculum development, including developing writing through role-play areas and developing mathematical language through role-play and puppets. Drawing on the narrative and video data gathered from settings where such work was being done, the authors were able to reach conclusions about the capacity shown by children of this age to persist in their problem-solving:

> *Given the opportunity to make their own choices and decisions, the children were remarkably focused and organised and pursued their own plans and agenda with persistence and sometimes over surprisingly long periods of time … Sometimes when an adult became involved in an activity the children were more inclined to say they couldn't do something, but if they were working with another child they were less likely to question their ability and often mimicked the other child, gaining confidence in their abilities.* (Whitebread *et al.*, 2004, p.13)

One report (Hwang and Gorrell, 2001) provided evidence that pre-school children can be instructed in self-regulated learning through watching the video taped behaviour of children who are skilled at it. Epstein (2003) drew a similar conclusion in describing the High Scope approach to nursery teaching which encourages children to plan and review their work. She concluded that children's capacity for self-regulation is increased when periods of reflection are built into

the timetable, and when practitioners support the children's emergent thinking by asking open-ended questions or recording their developing ideas.

Taken as a whole, the literature reviewed in this category placed particular emphasis on the following activities:

- promoting persistence in problem-solving by encouraging independent play and enquiry
- using engaging and exciting classroom events, both planned and unexpected, to stimulate and challenge children's thinking
- reflecting, as a practitioner, upon one's own ways of thinking creatively and solving problems.

3.1.2 Application of curriculum subjects to thinking skills development

The next category of literature exploring an 'infusion' approach contains those studies which use an existing curriculum subject as a starting point for developing thinking skills of a generic type. That is, although mathematics or literacy are employed as the context for enquiry, the purpose of the research is to develop general metacognitive awareness rather than explore a more narrowly construed skill such as 'mathematical reasoning'.

Jacobs (2004) drew on the 'writers' workshop' approach to literacy in which children are given freedom over the subject for their writing. Examples of questions are given which practitioners put to the writers (children):

- Tell me what you were thinking about while you were writing?
- Why do you think you thought about that?
- How do you think that idea came into your mind?
- How did you decide what to write about?
- How do you think your writing went today?

Interviews with 16 kindergarten children, based on these questions, were conducted (and then transcribed) twice a month over a six-month period. Jacobs argued that the increase in metacognitive language over this period pointed to a growth in the children's awareness of their thinking. The research study concluded with the remark that 'using the setting of the writers' workshop seemed to

provide a meaningful and natural environment in which to nurture metacognitive thought in children' (Jacobs, 2004, p.23).

Riley and Reedy (2005) investigated the extent to which children in years 1 and 2 could successfully express an argument in writing. The children used 'writing frames' which modelled the structures commonly used in making arguments. In year 1, the stimulus was a book about zoos that challenged the children's uncritical response to them. In year 2, the children interviewed a visitor who did not send his own children to school. After these experiences, 'for' and 'against' arguments were constructed together, as a class. Children then wrote short pieces expressing their views (see Box 1). The authors concluded that the pupils:

> *are able, intellectually, to grasp the complexity of an issue, and can develop an argument following the conventions of the discourse in a sophisticated way. (Riley and Reedy, 2005, p.51)*

Box 1

We think that zoos are good. We have some reasons for this. Our first reason is because they get fed. Each animal has a different food prepared for it. Our second reason is they get looked after by the vet. Our last reason is the zookeeeper cares for the animals. Although some people think that zoos are bad because the animals are taken away from their hoimes, we think we have shown our point.

Collaborative writing by group of year 1 children (Riley and Reedy, 2005).

Within the same broad curriculum area, Mallett (2004) provided a classroom account that showed that drama, as well as writing, can be a context for metacognition. A class of young children were read a story about a giant as part of a project about the natural environment. As preparation for writing letters arguing for the defence of a threatened natural habitat, the teacher read 'letters' from the giant and led a session in-role (as the giant), so that the children could rehearse their responses. This provided the children with time to prepare their thoughts on the issue and reflect on their arguments.

In the subject of mathematics, Lowrie (2002) evaluated an intervention designed to improve the ability of young children to form mathematical problems.

Trainee teachers worked with a class of five to six year-olds, challenging them to consider relationships between mathematical ideas, to offer alternative solutions to problems and to identify the components of a given problem that may be difficult to solve. They found that over 50 per cent of the pupils were able to generate open-ended problems such as 'How long would it take for me to tie your shoes up?'. Lowrie concluded that:

> *All of the children who participated in this study were able to pose problems and consider the type of mathematics content that would be required to complete the task successfully … Although the children were quite young, they were able to identify important components of the problem and suggest which mathematical operations would be required to solve the problem.* (Lowrie, 2002, p.361)

Although the research had a mathematical basis, the pedagogical strategy employed, of challenging pupils to consider relationships and offering them alternative solutions, has some of the same characteristics of general problem-solving, as described above, and so could be used in other subjects.

Information and communication technology also provides a resource for the development of thinking skills. Kumpulainen *et al.* (2004), used a computer-based simulation programme called PICCO with 22 Finnish children between the ages of six and seven to develop their verbal reasoning. The simulation was designed to challenge the understandings of the children in relation to their scientific knowledge about the natural environment. Although the results were inconclusive, the author reported that ICT can create rich contexts for the 'construction of explanations'. In a different study (Griffiths and Blat, 2004), the researchers worked with children aged between four and eight over 39 sessions using a robotic toy called éTuis in order to help them articulate their understanding about the learning process. The authors described how, with adult facilitation, the children moved through three phases:

- initial enchantment and projection of animate qualities on to the toy
- problem-solving involved in getting the toy to perform actions
- reflection on differences between the toy and oneself.

An example of using design and technology to promote thinking skills is provided by Pitri (2001). In this case, children were read a story called 'The Princess and the Rainy Forest' and were then invited to create something that would pro-

tect the princess from the rain. Pitri argued that the children's reasoning was involved in several ways:

- prediction of events, e.g. thinking about what can be found in a forest and what would happen if the princess had a car
- estimation of probabilities, e.g. drawing the conclusion that a princess would be likely to live in a castle
- reasoning about cause and effect, e.g. making assumptions about what would happen if the princess stayed in the rain and why she would need protection.

A similar study by Moran and Jarvis (2001) invited four year-old pupils to provide imaginative contexts for a variety of wire sculptures by incorporating them into their stories and drawings.

The value of the studies described in this section is that they show the relative ease with which existing practice can be adjusted to highlight the development of thinking skills. However, further research would be needed in order to provide evidence that the approaches suggested were the most effective, since it was not always clear that any observed benefits were actually due to the thinking skills strategy that was used, as opposed to being the result of the circumstances of the activity (in particular, the engaging and interesting nature of the task and the use of small groups with a good deal of teacher input).

3.1.3 Encouraging problem-solving

The articles included in this category used small-scale research projects with young children, either as the basis for observations about the nature of the problem-solving process or to suggest a particular technique for solving problems.

Craft (2003) used four vignettes from group work with three to six year-olds to show that problem-solving engages creativity and that this quality is not monopolised by the arts. These vignettes showed children engaged in conversation with the author, contemplating the options open to them in relation to a task they have been given. In this way, the children were said to be engaging in creativity, in so far as it is defined as 'possibility thinking'.

The examples of techniques suggested in this category of literature emphasise open-endedness. Potter (2004) provided a descriptive account of an activity with nursery and reception classes whereby children had to justify why 'teddy is

unwell' by looking at clues on cards. The cards are then sorted into plausible and implausible reasons for why he might be unwell. Humphreys *et al.* (2004) presents an account of using 'mind maps' with years 1 and 2 pupils whereby they were able to structure their knowledge in a non-linear, visual form. Both of these examples are typical of a teaching approach in which there is no 'one right answer'. As we saw in Section 3.1.2, one study (Lowrie, 2002) provides evidence that, in addition to solving open-ended problems, young children are able to form them.

Whilst the methodological bases of these studies and their generalisability are relatively limited, they provide a useful conceptualisation of problem-solving as a process which is creative, self-generated and embedded in an organic process of enquiry and learning.

3.2 Discrete programmes

The literature contained evidence of six discrete approaches to thinking skills being used with young children. These can be categorised as:

1. thinking together
2. philosophy for children
3. cognitive acceleration through science education
4. paired thinking
5. lateral thinking
6. brain gym.

Out of these six, most of the evidence related to the 'thinking together' and 'philosophy for children' approaches, with one or two pieces relating to the other approaches. The six approaches are described below.

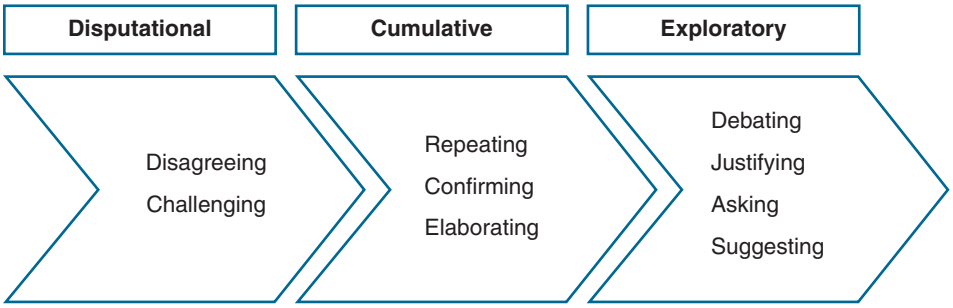
3.2.1 Thinking together

This approach stems from the research of Mercer (2000), who adopts a Vygotskyan perspective in analysing the importance of language in learning. Mercer's socio-cultural explanation of cognitive development 'depicts children's emergent understanding as the product of the collective thinking of generations, made available to children through observation, joint activity and communication' (Mercer, 2000, p.133). Mercer's work has resulted in the development of a peda-

gogical method and classroom resource that aims to help pupils enhance the quality of their thinking through small group discussion. The class are directly taught talking skills such as forming questions, constructive ways of challenging, reasoning and developing collaborative ideas. The groups also reflect on the quality of their teaching in plenary sessions.

This approach has been evaluated (with positive results) in relation to younger pupils at key stage 2. A study by Wegerif *et al.* (2004) sought to evaluate this approach as a means of developing verbal and non-verbal reasoning with younger pupils, from a purely disputational mode to a fully 'exploratory' mode (see Figure 1). Three experiment and three control schools were used and year 2 pupils were targeted. A non-verbal reasoning test was used as one of the pre- and post-tests along with a 'focal group' observation in which three children in each class were video taped during discussion. Teachers were trained in the method and were asked to devise and teach 'thinking together' lessons. Transcripts of subsequent focal group observation showed a marked increase in the prevalence of key words and phrases associated with reasoning such as 'because', 'why' and 'I think'.

Figure 1 Developing the quality of reasoning (based on Littleton *et al.*, 2005)



As with the evaluations of other discrete approaches, there have been methodological limitations. In the above study, for example, it was only possible to do post-tests in half of the control schools. A previous study (Wegerif, 2002) used a sample of only eight pupils and did not include a control group.

A resource called a 'talk box' has been devised for use in thinking together lessons with key stage 1 pupils (Littleton *et al.*, 2005). An evaluation was conducted in which the discussions of three groups of children were recorded and compared with three other groups of children who had not participated in the programme.

The frequency of words and phrases associated with reasoning was shown to increase more in the case of the former group than in the latter, although there was no formal test of significance.

3.2.2 Philosophy for children

Originating in the children's stories written by philosopher Matthew Lipman (1980), this approach seeks to develop pupils' philosophical skills such as reasoning, questioning evidence, drawing distinctions and relating ideas to real-life examples. Because the emphasis is clearly upon philosophical skills rather than philosophy as a discipline, this approach has shown its relevance to the concerns and abilities of primary-age children. However, the extent to which the children can still be said to be 'doing philosophy' has been widely debated.

In philosophy sessions, the children (usually seated in a circle) use an initial stimulus as the inspiration for their own questions which are listed and voted on. The stimulus is often a story: the moral dilemmas that abound in stories may explain why, in the UK, the approach has been used principally in RE or PHSE lessons. Using dialogical skills modelled for them by the teacher, the pupils discuss the questions. Trickey and Topping (2004) carried out a review of evaluations that have been made of this method. This showed that only two out of the ten evaluations featured focused specifically on young children. One of these studies trialled the approach with 229 five year-old pupils as a means of increasing reading ability. It is typical of such evaluations, in that whilst the instruments used pointed towards gains in thinking, listening and language skills, the study lacked a control group. Smaller-scale studies by Donnelly (2001), Hodgson and Laybourne (2002) and Lewis and Rowley (2002) are similar in this respect. Other articles (e.g. Andrews, 2004; Baumfield, 2000; Eagle, 2001) provided sample activities for teachers. The small amount of evidence available suggests that the approach can be useful in developing verbal reasoning, particularly in relation to moral/ethical issues, as well as promoting group cohesion through its model of the class as a 'community of enquiry'.

The key differences between this approach and the 'thinking together' approach are that practitioners of philosophy for children:

- traditionally use a single text as the main stimulus, rather than a range of stimuli
- engage the whole class in discussion as one group

- use the approach to promote understanding in RE and PHSE, as well as to promote speaking and listening skills.

3.2.3 Cognitive Acceleration though Science Education (CASE)

This approach is based on the Piagetian notion that children progress intellectually through different stages as they experience cognitive conflict between events and their current understanding of the world. In a study by Adey *et al.* (2002), 300 children in 14 year 1 classes were part of an experimental group. There was a parallel control group made of 170 children in eight year 1 classes. The groups received pre- and post-tests in conservation (understanding of the static nature of mass and volume, e.g. that there is the same amount of dough when it is rolled out as when it is in a ball) and in spatial awareness, the first being administered individually and the second collectively. The CASE intervention was based around a set of 29 activities, implemented in groups of six pupils at a time, designed to promote cognitive awareness and to encourage metacognition. The result was that there were significant effects on the conservation scores of the experimental group, compared to the control group, attributable to the CASE intervention. However, when the data was set against the variable of gender, the greater gains of boys in the experimental group did not reach statistical significance. A more qualitative study was conducted by Venville (Venville *et al.*, 2003) which found that children in CASE lessons more frequently explained and demonstrated their ideas and made suggestions.

3.2.4 Paired thinking

One study proposed a model of thinking skills development based on the practice of paired reading (Topping and Bryce, 2004). The model reflects those theories that emphasise social interaction to aid learning. In the study, a class of seven year-olds and a class of 11 year-olds in the same school received training in collaborative problem-solving. Pre-tests of reading and thinking skills were conducted. Over the subsequent ten weeks, the older pupils worked with the younger ones using fiction and non-fiction books as a stimulus for thinking exercises. Two similar parallel classes used the same books for paired reading sessions only. The younger pupils 'showed a significant difference in thinking skills at post-test compared to tutees who followed only the PR program' (Topping and Bryce, 2004, p.613). However, this result may be partially due to the fact that the post-test scores for the comparison group declined due to the greater

difficulty of the post-test. Interestingly, in contrast to the practice of paired reading, where the beneficial effects are commonly shared between tutor and tutee, this study found that only the younger tutees received any significant benefit in their thinking and reading skills.

3.2.5 Lateral thinking

One study was obtained which sought to apply the work of Edward de Bono (n.d.) to five kindergarten classes in Malta (Dimech and Pace, 2003). This work is based on the idea of 'lateral thinking', that divergent and creative approaches to problem-solving can be more successful than linear reasoning. The children took part in age-appropriate exercises in creative problem-solving and the kindergarten staff considered that the intervention increased pupils' self-expression and confidence. However, the lack of any rigorous methodology makes it difficult to draw any firm conclusions about the usefulness of this approach with young children.

3.2.6 Brain gym

The last of the six discrete programmes is that of brain gym. One publication was obtained in which the use of this approach was described as part of a *Thinking Schools, Thinking Children* project in Norfolk (Harris, 2003). Brain gym is based on the theory and practice of educational kinesiology (e.g. Dennison and Dennison, 1994), which suggests that developing bodily coordination can assist cognitive development. Brain gym sessions are therefore typically short periods before or within a lesson when the class performs exercises in coordination as a preparation for concentration or as a break from more formal working. Staff in Norfolk schools that used brain gym as part of the project reported that pupils demonstrated improved concentration and attentiveness and less disruptive behaviour. However, this approach was not systematically evaluated.

3.3 Assessment in thinking skills

The final section in this chapter examines whether any of the classroom-based programmes have explored the issue of the assessment of thinking skills. In New Zealand, research has been conducted into forms of assessment in early years settings and the way in which the substance of 'learning episodes' can be captured

and recorded (Carr, 2001; Claxton and Carr, 2004). In contrast to conventional modes of assessment, which check competence against a prescribed list of skills, Carr suggests that it is more important to assess the development of 'learning dispositions' in children. Five dispositions are identified which are characterised as:

- taking an interest
- being involved
- expressing a point of view or feeling
- taking responsibility
- persisting with difficulty or uncertainty.

The learning dispositions of 'expressing a point of view or feeling' and 'persisting with difficulty or uncertainty' are particularly relevant in assessing a pupil's thinking skills. These dispositions can be assessed through 'learning stories', narratives that focus on contextual, situated learning and which recognise that progress in learning is erratic rather than linear. Carr gave the example of annotated Polaroid photos that can be accumulated in a personal portfolio.

More recently, Claxton and Carr (2004) have proposed a framework for understanding the ways in which learning dispositions vary. In particular, a child's learning disposition can be assessed according to:

- **robustness** – the extent to which he or she responds in a positive way even when the conditions are not ideal
- **breadth** – the range of activities and contexts within which the child is able to employ the disposition
- **richness** – the flexibility or sophistication of the disposition.

The authors gave an example of how a child's persistence in problem-solving may be seen in terms of its 'richness': 'Whereas at one time "persisting" may simply have meant not giving up on a problem, later it can incorporate more elaborate strategies for mood repair, emotional maintenance or marshalling assistance' (Claxton and Carr, 2004, p.90).

The authors propose that these three concepts are used as a framework in the assessment of learning dispositions.

3.4 Conclusions

- Many of the articles reviewed were examples/case studies within accounts of classroom practice and were not methodologically rigorous.
- More literature was obtained relating to infusion approaches with young children rather than to discrete approaches.
- Infused thinking skills activities have taken place as part of lessons in literacy, drama, mathematics and design technology.
- Good pedagogy aims to draw out every opportunity for adult–pupil dialogue and 'shared sustained thinking'.
- Little evaluation has taken place of discrete approaches to thinking skills in relation to young children.
- Of the discrete programmes available, the Cognitive Acceleration through Science Education (CASE) programme is the one that has been most rigorously evaluated.
- Discrete thinking skills programmes have been designed principally for use in literacy, science, RE and PHSE.
- Recent research in assessment of thinking skills focuses on the dispositions needed to deepen and develop one's thinking such as persistence and taking a point of view.

This chapter has examined research on classroom-based programmes to develop children's generic thinking skills, drawing on key articles and books published since the year 2000. The next chapter takes this a stage further by looking at literature which examines the extent to which young children are able to demonstrate and use thinking skills.

4 Phase two: young children's thinking capabilities

This chapter synthesises literature obtained in the second phase of the research, which focused on the challenges involved in young children's cognitive development and the emergent thinking skills that they were able to show. Much of the literature was published in the field of developmental psychology. The six key themes that emerged from this literature were:

1. the importance of language
2. the importance of play
3. understanding other minds
4. thinking 'counterfactually'
5. problem-solving
6. assessment of thinking skills.

Each of these themes will be discussed in turn.

4.1 The importance of language

4.1.1 'Thinking' language

Some of the articles stressed the importance of children acquiring a specific vocabulary. In particular, this vocabulary was seen as important in helping children to understand their own thinking and that of others. Mitchell and Riggs (2000) observed that the language we use to refer to our thoughts, beliefs and values is totally non-representational: it does not refer to anything tangible. The development of such language is therefore strongly dependent on social experience in which such language is used as a matter of convention. For example, once we understand the phrase 'I said to you', we may be able to understand, by extension, the phrase 'I said to myself' or 'I told myself I had to do it'. In other words, we only develop a mental vocabulary *by analogy*, by transferring language used in a social context to a different, mental context.

Astington (2000) suggested a list of 'mental verbs' which, through their use, allow children to acquire an understanding of thoughts and beliefs:

- **cognition** – think, know, guess, remember, forget, trick, mean
- **desire** – want, need, like, love
- **perception** – look, see, show, watch.

She described research with 20 three year-olds whereby their use of such language in pretend play was recorded and seen to increase over a seven-month period. The same paper described a different study with over 100 four and five year-olds in which they were individually read a story (see Box 2) and asked to retell it. Whilst the older children were starting to incorporate the mental language into their retelling, the younger ones tended to retell the story purely as a sequence of actions taken by the characters.

Box 2 Sample of a story with 'mental verbs'

'Scott knows that Grey Squirrel will be sad because he won't know where his nut is. Scott decides to play a trick on Brown Squirrel. He decides to take the nut from the flower pot. He puts the nut back under the bush. Scott knows that Grey Squirrel will look for the nut under the bush because he thinks that's where it is. Scott knows that Brown Squirrel will look for the nut in the flower pot because he thinks that where it is ...'

(Astington, 2000, p.278).

4.1.2 Arguing and explaining

Other literature focused on the importance of vocabulary that could help children to reason more effectively. Mercer (2000), for example, tutored children in dialogical problem-solving and noticed that their use of the key words 'if', 'because' and 'why' increased: this language was strongly associated with critical, constructive discussion between pupils. Mercer's team also found that the children who received instruction in the language and methods of 'exploratory talk' were better at solving standard reasoning tests.

A particular feature of reasoning described by McWilliam and Howe (2004) is the use of 'justificatory speech'. This is the kind of speech that substantiates and justifies assertions and opinions. The authors acknowledged that pre-school children use this speech, but most often in situations of conflict. Their study sought to test the assumption that children of this age could be taught to use this speech

more constructively. Working with 22 pairs of children in various settings in Glasgow, the authors made use of an 'alien' theme in presenting the children with two puppets as extraterrestrial characters. It was explained to them that the puppets could only speak and understand certain kinds of language and that the children should help them. The puppets, the children were told, could only understand questions beginning with 'why' and could only understand responses beginning with 'because'. A parallel group of children worked with the puppets in a similar way but without these conventions. The children worked with the researchers in daily, ten-minute sessions over the course of five days, with the researchers gradually withdrawing their input. The key finding of the research was that, compared to the control group, the experimental group produced almost twice the number of examples of justificatory speech. The authors concluded that an intervention programme with a tight linguistic focus could be useful for children 'who appear to be uninterested in or struggling with basic reasoning processes' (McWilliam and Howe, 2004, p.520).

Kuhn (2000) shows that one of the key errors that young children make in their reasoning is confusing *explanation* with *evidence*. She showed pre-schoolers a sequence of pictures in which, for example, two runners compete in a race. Clues suggested why one runner would win (e.g. he has fancy running shoes). The final picture in the sequence provides evidence of the outcome; this runner is holding a trophy and smiling. Pre-school children did not distinguish between the two questions 'how do you know?' (i.e. 'what's your evidence?') and 'why did this happen? (theory/explanation). A typical response was:

Q: How do you know [he won]?

A: Because he's got fast running shoes.

Kuhn also provided evidence to support her conclusion that 'these confusions between theory and evidence diminish sharply among 6 year-olds, who are more likely to distinguish the evidence for their claim from a theory that explains it'. (Kuhn, 2000, p.313).

4.2 The importance of play

A small number of studies examined the role of children's play in the development of their ability to reason about alternatives and possibilities. Particular

importance is ascribed to symbolic play, where one play object is used to represent an imaginary one. Hobson (2000) referred to the work of Alan Leslie whose research on the subject was stimulated by the fact that children pretend and seem to understand pretence in others from as early as two years old. Leslie maintained that in thinking imaginatively that something is other than it really is, they are using the same mechanism that will allow them to understand how others may act in hypothetical situations. In both cases, the child understands that a mental representation of something or somebody can be different and separate from the object or person in front of them. Hobson noted a central criticism of this theory: it presumes that children have *awareness* of the fact they are pretending and that, for example, a child is simultaneously aware that the object he is talking into is both a pretend telephone and a real banana. Whilst they may not have such self-awareness, he argued that children do witness *one another* using the same object to stand for different things. In addition, in play, children have different attitudes and feelings towards the same things. Hobson argued that these:

> *constitute the route by which the infant comes to adopt, and in due course to recognise, multiple attitudes to the same things and events. If the same things can be objects of different attitudes, then things are different from thoughts. (*Hobson, 2000, p.12*)*

This realisation by the child involves recognising that mental representations of a real ball, for example, can be multifarious: the ball can become an orange in one context and a planet in another. Play, Hobson argued, provides a context in which children can come to understand the looseness and flexibility of representation as something separate from the world of people and things. This understanding is a necessary step towards both the comprehension of how written language 'works' and the comprehension of other people's beliefs and attitudes. In other words, it allows for the consideration of possibilities that may currently only exist in thought.

This connection between the skill in pretend play and reasoning about possibilities was investigated by Amsel and Smalley (2000). They made the observation that the consideration of possibility, like pretence, requires the participant to temporarily ignore or alter what presents itself to him or her in reality. Drawing on previous research, they maintained that when children respond to the question 'how could the situation be different?', they are making the same kind of mental substitution that they make when they 'see' a banana as a telephone. However,

like Hobson, they proposed that young children are not necessarily aware of the pretence or able to maintain in their minds clear representations of the false and true identities. They argued that the *context* of pretence is an overriding part of the mental representation. Hence, as the authors' research suggested, when a three year-old's actions of using a banana to 'comb' a teddy bear are ignored and the child is simply asked to point out, from a tray of objects, the object he or she pretended to have and the one which they 'really and truly' had, the child is likely to fail. The link between the true and false identities, presented by the play activity, is broken. The research therefore suggested that when a child makes the proposition, 'let's pretend that the banana is a comb', the action of pretending provides a context for the ascription of 'false' or 'true' identities and that, without this context, three year-olds are more likely than older children to select only the identity which is visibly salient (i.e. the actual comb rather than the banana).

Findings such as these suggest that the context of play, encouraging children to consider imaginative possibilities can stimulate divergent thinking. This hypothesis was tested in a Canadian study by Lloyd and Howe (2003), who focused upon solitary play in particular. Solitary play has been considered to offer less of a cognitive challenge to children than social play and the authors sought to critique this assumption. They observed the solitary play of 72 children with an average age of 4.5 years over the course of 20 days, observing each child for a 10-second period six times a day. They discovered a positive correlation between divergent thinking and solitary play that was active, often involving imaginative role-play. This is contrasted with more object-focused, solitary play, which contrary to the researchers' expectations, did not show such a correlation.

4.3 Understanding other minds

Several pieces of literature referred to research into the developing ability of young children to understand the thoughts and motivations of others. The scenario presented in Box 3 illustrates the common phenomenon whereby children, at around the age of three, show themselves unable to consider that someone else may have knowledge that is different from their own. This situation typically changes between the ages of three and five as a child develops a 'theory of mind', that is, an understanding that thoughts, beliefs, desires and feelings may be different from one's own. Theory of mind (ToM) was first used in the late 1970s by primatologists, who suggested that the behaviour of chimpanzees could be

explained by crediting them with the ability to impute mental states such as beliefs and intentions, in other words to engage in 'mind-reading'. The concept was taken up by developmental psychology in the 1980s. Mitchell and Riggs (2000) categorised studies of the reasoning that is considered to underlie children's understanding of others' minds. In their typology, such reasoning is either:

- a kind of *simulation* in which the thinker imaginatively 'tries out' the behaviour witnessed, or
- a kind of *inference* from a common-sense 'folk psychological' theory.

Box 3 Children without a 'theory of mind'

Pre-school children are shown a picture of another child doing 'bunny hops':

Experimenter: This is John. He's never seen a rabbit before and doesn't know what one is. What's he doing?

Children : Pretending to be a rabbit!

Based on Lillard (1998), as quoted in Amsel and Smalley (2000).

Mitchell and Riggs gave an account of a seminal study in the theory of mind literature in which very young children were asked to 'mind-read'. The children were presented with a scenario in which a character called Maxi put some chocolate in one location and left for school. While he was absent, the chocolate was moved. The children were then asked where Maxi would think the chocolate would be. Three year-old children tended to answer on the basis of their own knowledge, whilst older children, between the ages of three and five, were correctly able to answer based on Maxi's point of view. This is called a 'false belief' test, since it examines the ability of children to 'put on hold' their own knowledge in order to recognise the different, false knowledge of another.

In addition to this work, subsequent research has taken place to show that children can be more successful in false belief tasks if the task itself is more engaging and meaningful. Szarkowicz (2000), in a study with over 100 Australian children aged three to five, presented them with a false belief task as part of a story-book session in which the false belief questions arose out of the picture book being read. The book chosen concerned a white dog who gets so dirty that his family no longer recognise him and think he is a different dog altogether. Children were read the book individually and asked questions such as 'Who do

the family think the dog is?'. Their success in answering these questions was compared with their success in the false belief task about Maxi and the chocolate, described above. Whilst 47 per cent of the children were successful in the task, 57 per cent were successful in answering the questions arising from the book. The positive results from this strategy led the authors to emphasise 'the need to not merely read a story for children but to interact and share thoughts as a story is presented' (Szarkowicz, 2000, p.79). However, the authors stressed that, rather than the medium of the book, it is the presence of an engaging narrative which allows children to show their understanding: they gave an example of further research which shows that children of a similar age were even more successful in understanding false belief when the medium was a video presentation.

Kuhn (2000) argues that the acquisition of a theory of mind is a slow, developmental process. Drawing on previous research, she argued that the thinking of three year-olds is typified by their tendencies

- not to acknowledge that a person engaged in making a decision is thinking
- to say that they have been successful when asked 'not to think about anything'
- to deny their earlier false beliefs: a fact is referred to as something which they have 'always known'.

However, succeeding in false belief tasks does not signal an end to these difficulties. Children may still fail to understand that different minds can arrive at genuinely different and legitimate understandings following exposure to exactly the same information. Even at the age of eight, Kuhn argued, children may not understand the difficulty in predicting others' responses to ambiguous stimuli. She considered that it 'would be a mistake to see a particular age level or competency as marking a singular turning point in what is better conceptualised as a gradual evolution' (Kuhn, 2000, p.307). For example, she described research about changes in beliefs held by adults and observes that the tendency to deny that one ever held a different belief is just as marked in adults as in children.

A subsequent stage in the developmental process beyond the acquisition of a theory of mind was suggested by Kassawar and Homer (2000). They researched children's understanding of other minds in 'opaque contexts'. This is a context where something is described in a particular way depending on the attitude or knowledge of the person concerned. That is, the same person may be 'the boss', 'Mrs Smith' or 'mum' depending on the person talking.

The authors referred to a previous study with four to six year-olds who were presented with a scenario. A puppet knows that A is in the box (A is a dice) but did not know that A was a B (i.e. that the dice was really an eraser). The children were asked:

- Did the puppet know that the A was a B? (No)
- Did the puppet know that there was a B in the box? (No).

The children who were successful on a false belief task answered the first question well but the second one poorly. In another study (Kamawar and Olson, 1999), children aged three to seven were given three opacity and three false belief tasks. The opacity tasks concerned the characters Mark and Anna. In one of the tasks, Anna and Mark were at a doctor's office. Mark stood next to the doctor while she (the doctor) put a bandage on Anna's knee. Unknown to Mark, the doctor was in fact Anna's mum. The children were asked a 'transparent' question followed by an 'opaque' question:

- Did Mark stand next to Anna's mum? (Yes)
- Does Mark know that he stood next to Anna's mum? (No).

The first question ensured that participants knew that the substitutions of descriptions were permissible in some situations. The second question tested whether participants were sensitive to the fact that substitution was not allowed because Mark's mental attitude of 'knowing' was towards the proposition that represented the referent as 'the doctor' and not as 'Anna's mum'(see Box 4).

The results showed a significant relation between success in opacity and success in false belief tasks, although the two are not identical: opacity is more difficult. Children's performance improved with age on the opaque questions with the biggest jump in performance from age four to five.

Box 4 Transparent and opaque questions

Kate is a doctor treating a patient, Anna	Kate is a mother treating her daughter, Anna	**Referent (Kate) is both, so meaning is the same**
Mark knows that Kate is a doctor	Mark knows that Kate is Anna's mother	**Different meanings**

Based on Kassawar and Homer, (2000) in Astington (2000).

4.4 Thinking 'counterfactually'

Several of the studies reviewed gave details of research into the reasoning strategies which, in some cases, are considered to underlie the development of a theory of mind and, in others, to offer a substitute for it. In particular, they focused on children's capacity for *counterfactual* reasoning; that is, their ability to contemplate alternatives to the situation before them. These researchers questioned the assumption that we 'have' a belief in the same way that 'we speak of having a marble in our pocket' (Riggs and Peterson, 2000, p.89) and the notion that everyone holds a belief in finished form. Instead, beliefs and opinions are constructed *on demand* in response to a query through the use of reasoning. Riggs and Peterson, in one of the most comprehensive studies in this area, argued that 'the ability to ascribe false beliefs is symptomatic of a more general ability to imaginatively reason about inaccessible things' (Riggs and Peterson, 2000, p.90). The authors maintained that if children are able to consider counterfactual alternatives, they should also be able to succeed in a false belief task.

Riggs and Peterson (2000) referred to research which provided evidence that three year-olds are able to consider counterfactual scenarios and answer questions such as 'What if Carol had taken her shoes off, would the floor be dirty?'. In the authors' own research, 32 children aged three and four were tested on two stories: a conventional 'Maxi' story and a story about Sally and Peter; both contained a false belief (FB) and a counterfactual reasoning question (CR) (see Box 5).

Only four of the children answered differently between the two types of questions. There was a significant correlation between performance on the two tasks.

These two tasks had certain characteristics in common. In both tasks, children had to imagine the situation if something had not happened and they have to ignore what is physically present to them in their immediate environment. Further research presented by Riggs and Peterson (2000) therefore tests the hypothesis that the correlation, rather than being the result of similar reasoning processes, could be due to these similarities. For example, one of the further experiments explored the possibility of a correlation between success in a false belief task and success in counterfactual reasoning from a positive premise (i.e. 'what if X *had* happened?' rather than 'what if Y *had not* happened?'). The correlation was still found to exist, suggesting that it is due to the nature of the reasoning involved in both tasks. The authors' substantial experimental research indicated that, in learn-

Box 5 Counterfactual thinking and false belief

Story	'Maxi' story in which 'mummy' moves the chocolate to make a cake.	Sally and Peter were in their house but Peter wasn't feeling well, so he was in bed. Sally went to the shops but in the meantime the phone rang and the man from the post office asked Peter to help him put out a fire. Peter went. Sally then returned.
False belief Question	Where does John think the chocolate is?	Where does Sally think Peter is?
Counterfactual Question	If mummy had not baked a cake, where would the chocolate be?	If there had been no fire, where would Peter be?
The questions were divided between the 32 children in this way:		
Maxi story	CR question	FB question
Sally/Peter story	FB question	CR question

ing to understand the beliefs and attitudes of others, children are making use of a kind of thinking not dissimilar to counterfactual reasoning. In other words, in relation to the false belief task, the thinking required in answering the question 'Where does Maxi think the chocolate is?' would be similar to that required in answering the question 'Where would the chocolate be if it had not been moved?'.

Part of Riggs and Peterson's (2000) methodology is based on the assumption that counterfactual and future hypothetical reasoning place similar executive demands on the child. This assumption is questioned by research carried out by Robinson and Beck (2000), who suggested that young children find the latter easier than the former. In one of their experiments, three and four year-old children had to sort items with and without pictures into two containers. The researcher asked 'If I draw a picture on this paper, which box will it go in?', and then 'If I had not drawn on the paper, which box would it be in?'. Children were much more likely to answer correctly in the future hypothetical task than in the counterfactual one. The authors concluded that when two similar kinds of cognitive

demand are made, children are more likely to be successful in hypothesising about the future since they do not have to imagine an alternative situation to replace existing reality.

This skill of ignoring one's 'real-world' knowledge and working from the premises given can be seen as essential to the process of reasoning. Harris and Leevers (2000) noted that children have an 'empirical bias' when the problem is rooted in their experience but that, when presented with syllogistic problems based on fantasy (i.e. 'every banana is purple'), they can reason logically with what they are given. The authors sought to test the strength of this emergent ability by inviting children to reason according to premises that *run counter to* experience, rather than lying completely outside it, as in the case of fantasy. A suggested syllogism is 'All fishes live in trees. Tot is a fish. Does Tot live in water?' Harris and Leevers reported research that shows that children aged four to six are able to reason in this manner, particularly when a problem is presented as part of a make-believe game. Evidence from their own research shows that the effects of instruction in the make-believe setting applied a week later and that, even without a make-believe setting, encouraging the children to think about the problem produced a similar benefit.

Harris and Leevers concluded that children are able to perform well in counterfactual reasoning provided the context is clear and not confusing to them. As evidence, they described the success which young children commonly have answering counterfactual questions following a hypothetical mishap or accident. If a puppet is 'accidentally' dropped in some water, children as young as two years old could give a correct answer to the question of whether it would have got wet if it had been dropped in some popcorn or some milk. Exploring this ability further, the researchers presented pre-school children with two stories in which a young girl got dressed, went out to play and got cold. In one story, she chose a green cardigan rather than a yellow one. In the other story, she chose the green cardigan rather than a coat. In the story where the choice of a coat was an option, the children were more able to reason counterfactually when asked what the girl could have done. The authors concluded that children of this age are able to reason counterfactually when the context is meaningful. That is, children are likely to be confused when referred to a story character and asked 'what else could he or she have done?', unless the character has had a mishap or problem. Consideration of counterfactual possibilities in the absence of such misfortune, such as for the purposes of evaluation and improvement, requires greater executive control and mental maturity.

Whilst children are able to consider 'what could have been', this does not necessarily colour their judgement about how things really are (something that adults do regularly). Evidence for this difference was provided by Amsel and Smalley (2000) when they conducted comparative research with pre-school children and college students. They made use of a scenario common to quiz shows in which a participant, on receiving a prize, is shown 'what you could have won'. The effect on the participant is usually to induce either relief or disappointment. In the experiment, 16 pre-school children and seven college students were shown two dolls who 'chose' boxes containing the same prize. With the children, the prize was a toy, whilst with the students, it was money. As part of the story scenario, the participants were asked to rate the reaction of the dolls on a scale from 'sad' to 'very happy'. Each doll was shown what they could have won. In one case, the prize was of a higher value and, in the other, it was of a lower value. Both students and children correctly deduced that the dolls would either have been more happy or less happy if they had opened the other box instead. However, when they were asked a final question, about how happy the dolls are now, the knowledge of what the dolls could have won did not affect the children's estimation of how happy they were: they attributed to them the same level of happiness as they had originally.

4.5 Problem-solving

The open and often inconclusive nature of genuine problem-solving was highlighted by Lambert (2000), who drew on observations of a single child over a 10-week period. The characteristics of children's problem-solving were identified and contrasted with the supposed characteristics of academic problem-solving. Both are reproduced in Table 2.

Table 2 Characteristics of problem-solving, based on Lambert (2000)

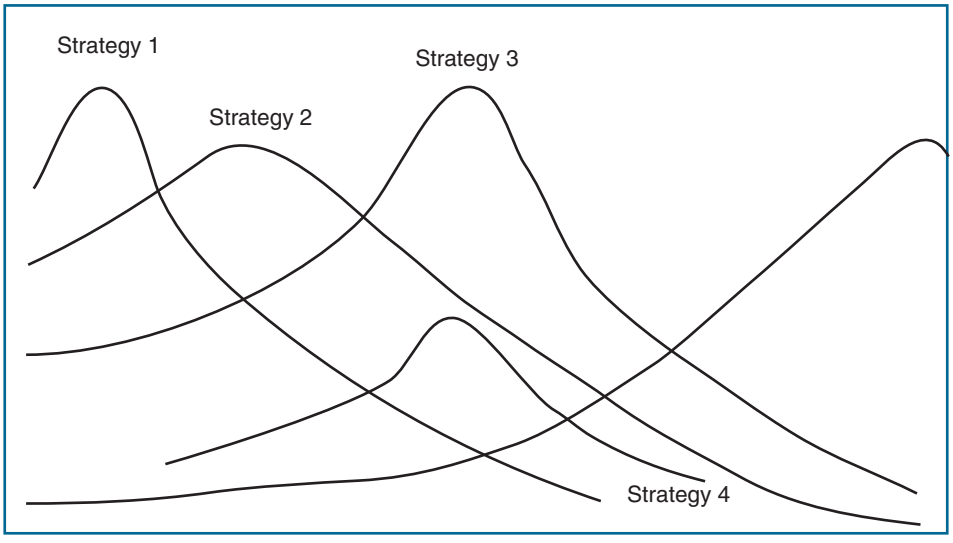
'School-based'	'Real life'
Determined by curriculum	Chosen by child
'Unknown' is chosen by teacher	'Unknown' may not be obvious
Specific information to solve the problem is given	Either a lot or sketchy information may be available
Often only one solution	Many solutions may be possible
Emphasis on speedy resolution	Often triggers further enquiry

In a further study, Lambert (2001) explored the metacognitive strategies that pre-school children used spontaneously when trying to solve an open-ended task. Sixty children aged four and five were selected from three pre-schools. In small groups, they were introduced to a board-game with a faulty spinner. They were then given various materials and the experimenter raised the issue of making a new spinner. The sessions were video taped and analysed. Characteristics used by the children were drawn up and subjected to factor analysis. Lambert argued that there were five factors of behaviour characteristic of children engaged in the activity:

- recognising and framing the problem
- subtractive restructuring (going back a few steps and trying something else)
- self-monitoring (talking to oneself about what one is doing)
- motivation to persist
- 'planfulness' (being purposeful and deliberate).

A study by Chen and Siegler (2000) on the developments in the mental resourcefulness of young children drew on a theory previously developed by Robert Siegler (1996). In this theory, the thinking strategies used by young children are seen as 'overlapping waves', which compete with one another (see Figure 2). As some strategies are strengthened in their original context, these same strategies are mapped on to novel problems. The child is increasingly able to choose between more subtle variants of a particular strategy and to execute it more skilfully.

Figure 2 Overlapping waves of problem-solving thinking (from Siegler, 1996)



4.6 Assessment of thinking skills

Two studies addressed the formal assessment of thinking skills. One study focused on children's ability to sort and classify information (Smidts *et al.*, 2004). This study was undertaken in order to pilot a test of mental flexibility for use with young children, an 'object classification task'. As part of the research 84 Australian children between the ages of three and seven were asked to sort toys into different groups. After practice trials, children were asked to categorise six toys into two groups. There were three available criteria: colour, size and type of toy, and children were asked to explain which criterion they used. If they were not able to sort the toys themselves, the researcher grouped the toys and asked the children to describe the criterion. Finally, if children were not able to do this, the researcher provided a criterion and asked them to apply it to the toys. Smidts *et al.* found that all children over the age of four could sort six toys once, but that many needed guidance to sort a second time. The seven year-olds were significantly better at sorting independently than five year-olds. However, the seven year-olds needed guidance in sorting a third time. Smidts *et al.* concluded that there appears to be a 'spurt' in cognitive flexibility around the age of four and five and that the benefits of this acceleration are refined between the ages of five and seven.

One other article (Baker and Cerro, 2000) was discovered on the subject of assessment of thinking skills: a review of literature about the assessment of metacognition. Two principal methods of assessment are described. The first invited pupils to think aloud about what they are doing, for example, while they are solving a problem. The second invited pupils to read a passage of writing which contains errors and to spot them: the assumption is that these errors disrupt comprehension, so the reader who is checking on his or her understanding should notice them. Clearly, both of these methods require a significant degree of linguistic ability, either in speaking or reading, and are unlikely to be relevant to young children. Only one instrument is referred to as suitable for use with seven and eight year-olds, although other evidence is cited which suggests that it is too difficult for them. The inconclusiveness of research in this area is suggested by the authors themselves, who explained that although instruments do exist that are reliable enough for research purposes, these were not robust enough to be used in school or clinical settings as a formal assessment method.

The one study considering assessment methods deemed as suitable for young children focused exclusively on information processing. No classroom tests of other skills, such as problem-solving or counterfactual reasoning, were found.

4.7 Conclusions

- Symbolic, substitutive play is important in developing young children's thinking because it teaches them that physical objects can 'stand for' a range of non-physical things like meanings, beliefs and attitudes: it teaches them that objects are separate and different from the thoughts one may have about them.
- Young children can develop skills in reasoning and understanding mental states by being tutored in the use of appropriate language.
- Given a game or fantasy scenario, young children can ignore their prior knowledge in reasoning strictly according to logical premises.
- Young children typically face a challenge in comprehending that other people's understanding of a situation may not be as complete as their own, or may be wrong.
- This challenge is similar in cognitive demand to the challenge of considering how an event could have happened, contrary to reality.
- Young children tend to be more successful in hypothesising about the future than in hypothesising about possible events in the past.
- Young children are more able to consider 'what could have happened' when the events concern an accident or mishap to a protagonist which they could have avoided.
- Young children are able to recognise and articulate problems and to show purposeful, motivated behaviour in solving them.
- Young children are able to sort by different criteria but tend to need guidance in sorting the same objects by more than two criteria.
- Many of the studies refer to cognitive stages of children's development but do not suggest how these stages may provide a basis for formative assessment of thinking skills.
- One study noted that no formal tests of metacognition are sufficiently reliable for classroom use with children, including children aged between three and seven.

5 Synthesis and recommendations

This chapter draws some conclusions from the previous phases of the research, synthesises the findings and makes some recommendations for future work in this area.

5.1 Conclusions from previous phases

The evidence from Phase one suggests that although it was possible to identify examples of such approaches, little systematic evaluation has taken place of either infused or discrete approaches to developing thinking skills in young children. In particular, we can conclude that:

- compared to discrete approaches, infused approaches to thinking skills draw on a broader range of subjects and, in particular, a broader variety of play (i.e. drama and role-play). Data is provided primarily by examples of effective pedagogy rather than rigorous evaluation
- compared to infused approaches, discrete approaches to thinking skills would appear to allow children to develop their abilities more systematically, although little evaluation has been done to gauge their effectiveness
- there is a small amount of evidence to show that 'writing frames' can be used to help young children write opinion and argument
- the importance of creating opportunities for dialogue is stressed in both kinds of approach.

Evidence suggests that children face a number of cognitive challenges before the age of six. The literature from Phase two indicates that, by this age and given the right assistance, children are generally able to:

- use 'thinking language' involving words such as 'think', 'know', 'guess', 'remember'
- construct informal rules for the purpose of solving problems
- sort objects according to one or more criteria
- understand that the beliefs of others may be different from their own
- understand that because someone has partial knowledge of something they will not necessarily have all of it

- hypothesise about what might happen in relation to future events
- suggest alternative actions which could have been taken in the past
- reason logically from given precepts.

However, they:

- may not know how they came to know something
- may confuse giving reasons with giving evidence
- may be confused by tasks without a clear context
- may need guidance in sorting objects by more than one criterion

We now move on to comparing the conclusions from both phases in order to indicate current strengths and gaps in the interventions that exist for developing thinking skills in the classroom and the capabilities of young children.

5.2 Synthesis

Synthesising the two phases of research leads to the following positive conclusions:

- Pedagogical approaches to the promotion of thinking skills in young children are developmentally appropriate in helping children to construct rules for solving problems, hypothesise about possible eventualities, suggest alternatives or reason from given information.
- The expectations of the National Curriculum are generally appropriate in the light of young children's cognitive abilities.
- The emphasis on dialogue in pedagogical approaches is substantiated by the psychological literature, which stresses the importance of acquiring and developing a vocabulary of mental terminology and learning skills through communication with others.

In addition, the synthesis highlights key features that are relevant to the process of developing and researching young children's thinking skills. These features are questioning/dialogue, story and play (see Figure 3) and can be seen as central to this aspect of teaching and learning.

Although the expectations of the National Curriculum are appropriate generally, the literature does provide some pointers to how the National Curriculum, as it relates to thinking skills, may be developed in the future:

- whilst the literature of both phases emphasises the importance of play in the development of thinking skills, play is not mentioned in this part of the National Curriculum
- whilst classroom approaches to young children's thinking skills aim to develop reasoning, enquiry and creativity, most recent psychological research has focused on children's powers of reasoning and enquiry exclusively (and not creativity)
- whilst there is some evidence of young children being able to evaluate successfully (i.e. in relation to counterfactual reasoning), classroom approaches to thinking skills have tended to stress other skills such as problem-solving
- the skill of information-processing appears in both phases of the literature review. For example, classification or sequencing feature as part of a test methodology or a pedagogical approach. However, apart from one study (Smidts *et al.*, 2004) the development or assessment of information-processing skills is not the principal focus of the studies in which it appears
- whilst there is evidence to show that young children can compose a written argument, discrete approaches to thinking skills emphasise spoken language only.

Other findings are that:

- neither infused nor discrete approaches to thinking skills draw upon explicit strategies to help very young pupils develop their emergent theory of mind or their skills in counterfactual reasoning
- whilst the psychological literature reveals that children find some kinds of question more difficult or confusing than others, none of the studies relating to pedagogical approaches focused on questioning specifically.

5.3 Recommendations

Based on the above analysis, the following recommendations are made.

Researchers should:

- conduct evaluations of both discrete and infused approaches to developing young children's thinking skills
- explore the opportunities for the development of thinking skills within the Foundation Stage curriculum

- review the current state of the psychological literature on creativity and young children's thinking
- review the current state of the literature on teacher questioning in relation to the development of young children's thinking skills
- identify best 'educare' practice in helping pre-school children acquire a theory of mind and develop their counterfactual reasoning skills
- determine the extent to which young children are able to critically evaluate a piece of work
- make explicit the practical implications of research: for example, dissemination through publications targeted at early years practitioners.

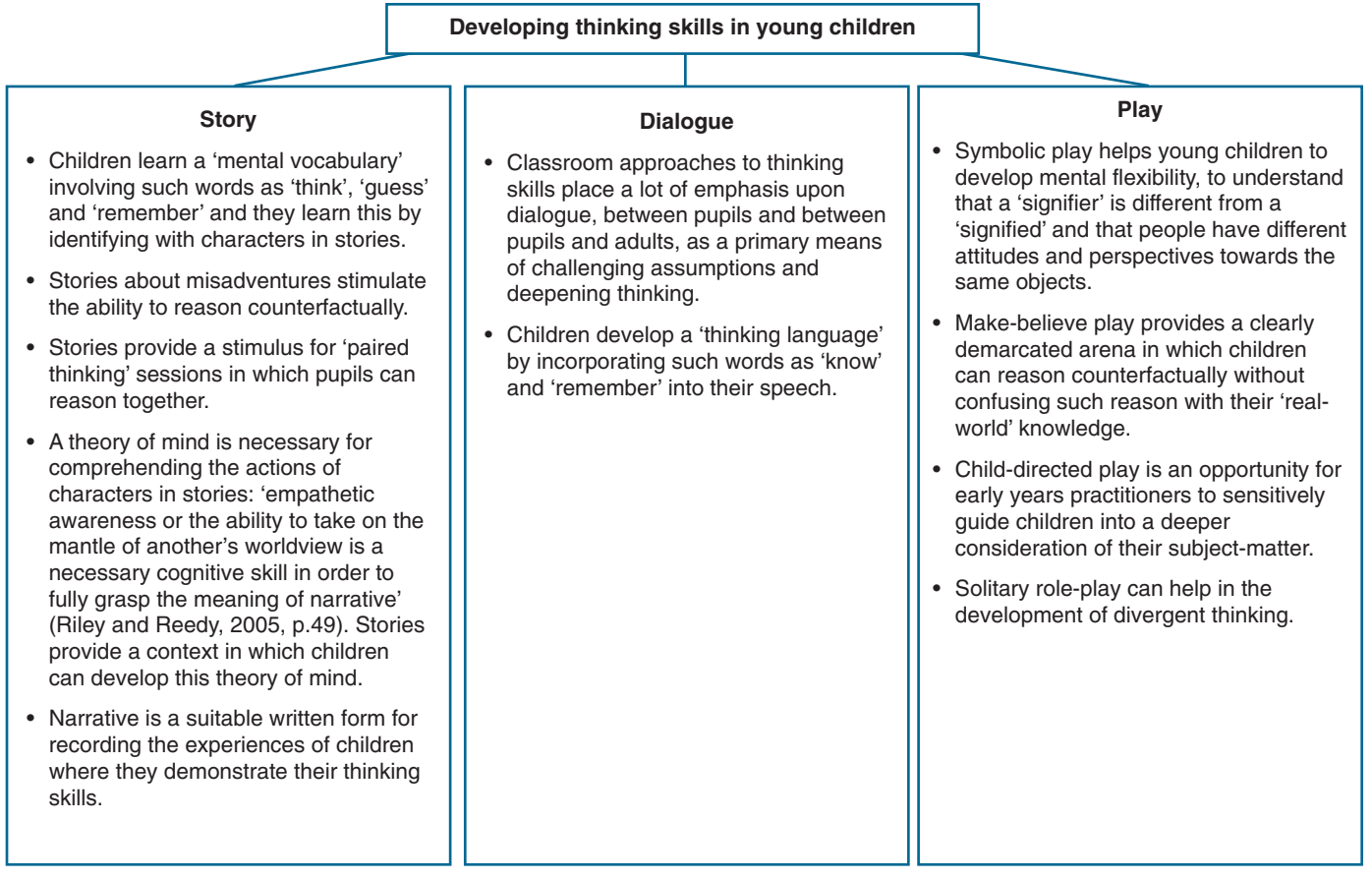
Practitioners should explore the extent to which:

- their questions can focus specifically on stimulating children's thinking (see Table 3)
- they can create time tabled opportunities for 'thinking times' which signal to the children that a non-ordinary (and possibly counterfactual) kind of thinking is being encouraged
- more opportunities can be created in the classroom for structured dialogue
- children can be invited to construct written opinions and arguments
- 'story-time' can become an opportunity to develop children's thinking
- traditional sorting and sequencing tasks can be an opportunity for children to verbalise their thinking
- play equipment can present children with possibilities for developing their imagination
- children can be given opportunities for solitary as well as social play
- children can be asked to evaluate their work critically
- additional adults in the classroom can be used to develop children's thinking
- creative activities can encourage creative 'possibility thinking', as well as creative skills.

Table 3 Types of question and thinking skill focus, based on a Winnie-the-Pooh story

Focus	Question
Evidence	'How do you know Winnie-the-Pooh got stuck in the rabbit hole?'
Reasons/theory	'Why did Winnie-the-Pooh get stuck in the rabbit hole?'
Counterfactual suggestion	'What would have happened if Winnie-the-Pooh had not eaten the honey?'
False belief	'What does Winnie-the-Pooh think has happened to stop him getting out?'
Future hypothetical suggestion	'What could Winnie-the-Pooh do next?'

Figure 3 Common features of approaches to the development of thinking skills in young children



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Appendix 1 Literature search strategy

Database searches

A range of different educational, sociological and psychological databases were searched. Search strategies for all databases were developed by using terms from the relevant thesauri (where these were available), in combination with free text searching. The same search strategies were adhered to as far as possible for all the databases. The NFER Library's own internal databases were also searched, as well as CERUK (Current Educational Research in the United Kingdom).

The database searches were supplemented by scanning the reference lists of relevant articles, thus identifying further studies. The team also searched relevant websites and downloaded documents and publications lists.

The bibliographic details of all papers identified through database searches and the potentially relevant papers found by hand, website and bibliography searching, and through personal contact, were entered on to a ProCite bibliographic database.

The keywords used in the database searches, together with a brief description of each of the databases searched, are outlined below.

Australian Education Index (AEI)

AEI is produced by the Australian Council for Educational Research. It is an index to materials at all levels of education and related fields. Source documents include journal articles, monographs, research reports, theses, conference papers, legislation, parliamentary debates and newspaper articles.

#1 Preschool Education
#2 Preschool Children
#3 Early Childhood Education
#4 Elementary Education
#5 Kindergarten
#6 Kindergarten Children
#7 Young Children

#8	Primary Education
#9	Primary Schools
#10	Primary School Students
#11	Key Stage 1 (ft)
#12	Foundation Stage (ft)
#13	Early Learning Goals (ft)
#14	#1 **or** #2 **or** #3 **or** #13
#15	Thinking Skills Program
#16	Critical Thinking
#17	Creative Thinking
#18	Concept Formation
#19	Cognitive Acceleration Through Mathematics Education
#20	Cognitive Acceleration Through Science Education
#21	Problem Solving
#22	Problem Based Learning
#23	Logical Thinking
#24	Information Processing
#25	Abstract Reasoning
#26	Metacognition
#27	Deduction
#28	Divergent Thinking
#29	Reflective Thinking
#30	LOGO
#31	Philosophy for Children
#32	Philosophy for Children Program
#33	Brain Gym
#34	Instrumental Enrichment
#35	Reasoning Skills (ft)
#36	High Scope (ft)
#37	Children's Thinking (ft)
#38	Enquiry Skills (ft)
#39	Evaluation Skills (ft)
#40	Learning Through Play (ft)
#41	Brain Based Learning (ft)
#42	#15 **or** #16 **or #or** #41
#43	#14 **and** #42
(ft)	Denotes free-text searching

British Education Index (BEI)

BEI provides bibliographic references to 350 British and selected European English-language periodicals in the field of education and training, plus developing coverage of national report and conference literature.

#1	Preschool Education
#2	Preschool Children
#3	Early Childhood Education
#4	Elementary Education
#5	Kindergarten
#6	Kindergarten Children
#7	Young Children
#8	Primary Education
#9	Primary Schools
#10	Primary School Pupils
#11	Key Stage 1 (ft)
#12	Foundation Stage (ft)
#13	Early Learning Goals (ft)
#14	#1 **or** #2 **or** #3 **or** #4 **or** #5 **or** #6 **or** #7 **or** #8 **or** #9 **or** #10 **or** #11 **or** #12 **or** #13
#15	Thinking Skills
#16	Reasoning Skills
#17	Critical Thinking
#18	Creative Thinking
#19	Concept Formation
#20	Cognitive Acceleration in Mathematics Education
#21	Cognitive Acceleration through Science Education
#22	Problem Solving
#23	Problem Based Learning
#24	High Scope Demonstration Preschool Project
#25	Logical Thinking
#26	Information Processing
#27	Abstract Reasoning
#28	Metacognition
#29	Deduction
#30	Divergent Thinking
#31	LOGO

#32 Philosophy for Children
#33 Instrumental Enrichment (ft)
#34 Children's Thinking (ft)
#35 Enquiry Skills (ft)
#36 Evaluation Skills (ft)
#37 Reflective Thinking (ft)
#38 Learning Through Play (ft)
#39 Brain Gym (ft)
#40 Brain Based Learning (ft)
#41 #15 **or** #16 **or** #17 **or** #40
#42 #14 **and** #41

(ft) Denotes free-text searching

British Education Internet Resource Catalogue

The Catalogue provides descriptions and hyperlinks for evaluated internet resources within an indexed database. The collection aims to list and describe significant information resources and services specifically relevant to the study, practice and administration of education at a professional level.

#1 Thinking Skills (ft)
#2 Creative Thinking
#3 Children's Thinking
#4 Logical Thinking
#5 Reasoning Skills
#6 Critical Thinking
#7 Cognitive Acceleration
#8 Cognitive Intervention
#9 Metacognition
#10 Problem Solving
#11 Concept Formation

(ft) Denotes free-text searching

Canadian Business and Current Affairs (CBCA)

CBCA provides indexing and full-text access to the principal educational literature publications in Canada, covering all significant reports of government departments, faculties of education, teachers' associations, large school Boards and educational organisations. Over 150 educational periodicals, plus educational articles in over 700 general journals and newspapers, are indexed.

#1 Preschool Children
#2 Preschool Education
#3 Preschool Level
#4 Early Childhood Education
#5 Elementary Education
#6 Kindergarten Level
#7 Kindergarten Students
#8 Primary Level
#9 #1 **or** #2 **or** #3 **or** #4 **or** #5 **or** #6 **or** #7 **or** #8
#10 Thinking Skills (ft)
#11 Reasoning Skills (ft)
#12 Critical Thinking
#13 Creative Thinking (ft)
#14 Concept Formation
#15 Cognitive Acceleration (ft)
#16 Problem Solving
#17 High Scope (ft)
#18 Logical Thinking (ft)
#19 Information Processing
#20 Abstract Reasoning (ft)
#21 Metacognition
#22 Deduction (ft)
#23 Divergent Thinking (ft)
#24 LOGO (ft)
#25 Philosophy for Children (ft)
#26 Instrumental Enrichment (ft)
#27 Enquiry Skills (ft)
#28 Evaluation Skills (ft)
#29 Reflective Thinking
#30 Learning Through Play (ft)

#31 Brain Gym (ft)
#32 #10 **or** #11 **and** #9

(ft) Denotes free-text searching

Current Educational Research in the UK (CERUK)

CERUK is a database of current or on going research in education and related disciplines. It covers a wide range of studies including commissioned research and PhD theses, across all phases of education from early years to adults.

#1 Thinking Skills
#2 Reasoning Skills
#3 Critical Thinking
#4 Creative Thinking Skills
#5 Concept Formation
#6 Cognitive Acceleration
#7 Problem Solving Skills
#8 Problem Based Learning
#9 High Scope
#10 Children's Thinking (ft)
#11 Logical Thinking (ft)
#12 Information Processing (ft)
#13 Enquiry Skills (ft)
#14 Evaluation Skills (ft)
#15 Abstract Reasoning (ft)
#16 Metacognition (ft)
#17 Deduction (ft)
#18 Divergent Thinking (ft)
#19 Reflective Thinking (ft)
#20 Learning Through Play (ft)
#21 LOGO (ft)
#22 P4C (ft)
#23 Brain Gym (ft)
#24 Brain Based Learning (ft)
#25 Instrumental Enrichment (ft)

(ft) Denotes free-text searching

ChildData

ChildData is the National Children's Bureau database containing details of around 35,000 books, reports and journal articles about children and young people.

#1	Thinking Skills (ft)
#2	Reasoning Skills (ft)
#3	Critical Thinking (ft)
#4	Creative Thinking (ft)
#5	Concept Formation (ft)
#6	Cognitive Acceleration (ft)
#7	Problem Solving (ft)
#8	High Scope (ft)
#9	Information Processing (ft)
#10	Enquiry Skills (ft)
#11	Evaluation Skills (ft)
#12	Metacognition (ft)
#13	Deduction (ft)
#14	Learning Through Play (ft)
#15	P4C (ft)
#16	Brain Gym
#17	Brain Based Learning
#18	Instrumental Enrichment (ft)
(ft)	Denotes free-text searching

ERIC

ERIC is sponsored by the United States Department of Education and is the largest education database in the world. It indexes over 725 periodicals and currently contains more than 7,000,000 records. Coverage includes research documents, journal articles, technical reports, program descriptions and evaluations and curricula material.

#1	Preschool Education
#2	Preschool Children
#3	Early Childhood Education
#4	Elementary Education

#5	Kindergarten
#6	Kindergarten Children
#7	Young Children
#8	Primary Education
#9	Primary Schools (United Kingdom)
#10	#1 **or** #2 **or** #3 **or** #9
#11	Thinking Skills
#12	Reasoning Skills
#13	Critical Thinking
#14	Creative Thinking
#15	Concept Formation
#16	Cognitive Acceleration Through Science Education
#17	Problem Solving
#18	Problem Based Learning
#19	High Scope Demonstration Preschool Project
#20	High Scope Model
#21	High Scope Preschool Curriculum Study
#22	Logical Thinking
#23	Information Processing
#24	Abstract Reasoning
#25	Metacognition
#26	Deduction
#27	Divergent Thinking
#28	Reflective Thinking
#29	LOGO Programming Language
#30	Philosophy For Children
#31	Brain Based Learning
#32	Instrumental Enrichment
#33	Children's Thinking (ft)
#34	Enquiry Skills (ft)
#35	Evaluation Skills (ft)
#36	Learning Through Play (ft)
#37	Brain Gym (ft)
#38	#11 **or** #12 **or** #13 **or** #37
#39	#10 **and** #38
(ft)	Denotes free-text searching

PsycINFO

This is an international database containing citations and summaries of journal articles, book chapters, books and technical reports, as well as citations to dissertations in the field of psychology and psychological aspects of related disciplines, such as medicine, sociology and education.

#1	Preschool Education
#2	Early Years (ft)
#3	Early Childhood Education (ft)
#4	Elementary Education
#5	Kindergarten
#6	Kindergarten Students
#7	Key Stage 1 (ft)
#8	Foundation Stage (ft)
#9	Early Learning Goals (ft)
#10	Young Children (ft)
#11	#1 **or** #2 **or** #3 **or** #4 **or** #5 **or** #6 **or** #7 **or** #8 **or** #9 **or** #10
#12	Thinking Skills (ft)
#13	Critical Thinking (ft)
#14	Creative Thinking (ft)
#15	Divergent Thinking
#16	#12 **or** #13 **or** #14 **or** #15
#17	#16 **and** #11
#18	Concept Formation
#19	#18 **and** #11
#20	Cognitive Acceleration (ft)
#21	#20 **and** #11
#22	Problem Solving
#23	#22 **and** #11
#25	#24 **and** #11
#26	Metacognition
#27	#26 **and** #11
#28	Brain gym (ft)
#29	Brain Based Learning (ft)
#30	#28 **or** #29
#31	#30 **and** #11
#32	Instrumental Enrichment (ft)

#33 #32 **and** #11
#34 Theory of Mind
#35 #34 **and** #11

(ft) Denotes free-text searching

Websites

Thinking skills approaches

Philosophy for Children

SAPERE: The Society for Advancing Philosophical Enquiry and Reflection in Education
www.sapere.net

Dialogue Works
www.dialogueworks.co.uk

CASE: Cognitive Acceleration through Science Education
www.case-network.org

Early years research

Study of Pedagogical Effectiveness in Early Learning (SPEEL)
www.ltscotland.org.uk/earlyyears/pedagogical.asp

The Effective Provision of Pre-School Education
http://www.ioe.ac.uk/cdl/eppe/pdfs/eppe_brief2503.pdf

Centres

Newcastle University Thinking Skills Research Centre
http://www.ncl.ac.uk/ecls/research/education/tsrc/

Centre for Research in Early Childhood
http://www.worc.ac.uk/cms/template.cfm?name=centre_for_research_in_early_childhood_main

National Center for Teaching Thinking
www.nctt.net

IAPC: Institute for the Advancement of Philosophy for Children
http://cehs.montclair.edu/academic/iapc/

Singapore Center for Teaching Thinking
www.nie.edu.sg

Others

DfES Thinking Skills Site
www.standards.dfes.gov.uk/thinkingskills/

Thinking Together
www.thinkingtogether.org.uk/

Education-Quest – Teaching Thinking
www.teachthinking.com/

NESTA: National Endowment for Science Technology
www.nestafuturelab.org

12th International Conference on Thinking
www.thinkingconference.com

Journals handsearched

- British Educational Research Journal (2000–October 2004)
- Critical and Creative Thinking: the Australasian Journal of Philosophy for Children (2000–October 2001)
- International Journal of Art and Design Education (1997–2003)
- Early Years (2000–September 2004)
- Teaching Expertise (2003–Autumn 2004)
- Thinking – the Journal of Philosophy for Children (2001–04)

Appendix 2 Teacher resources

Books

Cognitive acceleration

ADEY, P., ROBERTSON, A. and VENVILLE, G. (2001). *Cognitive Acceleration. Let's Think!* Windsor: NFER-NELSON.

Philosophy for children

SHARP, A.M. (2000). *The Doll Hospital*. Camberwell, VC, Australia: ACER.

SHARP, A.M. (2000). *Gerlado*. Camberwell, VC, Australia: ACER.

SHARP, A.M. and SPLITTER, L.J. (2000). *Discovering Our Voice: Instructional Manual to Accompany Geraldo*. Camberwell, VC, Australia: ACER.

SHARP, A.M. and SPLITTER, L.J. (2000). *Making Sense of My World: Teacher's Manual for the Doll Hospital*. Camberwell, VC, Australia: ACER.

Thinking together

DAWES, L., MERCER, N. and WEGERIF, R. (2002). *Thinking Together: a Programme of Activities for Developing Thinking Skills at KS2*. Birmingham: Questions Publishing Company.

DAWES, L. and SAMS, C. (2004). *Talk Box: Activities for Teaching Thinking Together through Speaking and Listening at Key Stage* 1. London: David Fulton.

Other

COSTELLO, P.J.M. (2000). *Thinking Skills and Early Childhood Education*. London: David Fulton.

EGGEN, P.D. and KAUCHAK, D.P. (2001). *Strategies for Teachers: Teaching Content and Thinking Skills*. Boston, MA: Allyn and Bacon.

FISHER, R. (1999). *First Stories for Thinking*. Oxford: Nash Pollock.

FISHER, R. (2000). *First Poems for Thinking*. Oxford: Nash Pollock.

KELLY, P. (2005). *Using Thinking Skills in the Primary Classroom*. London: Paul Chapman.

MURRIS, K. and HAYNES, J. (2000). *Storywise: Thinking through Picture Books*. Somerset: Dialogue Works.

ROCKETT, M. and PERCIVAL, S. (2002). *Thinking for Learning*. Stafford: Network Educational Press.

STARICOFF, M. and REES, A. (2005). *Start Thinking*. Birmingham: Imaginative Minds Publishers.

WALLACE, B. (2002). *Teaching Thinking Skills across the Early Years: a Practical Approach for Children Aged 4–7*. London: David Fulton.

Websites

Philosophy for Children

www.sapere.net
www.dialogueworks.co.uk

Cognitive Acceleration through Science Education (CASE)

www.case-network.org

Early years research

Study of Pedagogical Effectiveness in Early Learning (SPEEL)
www.ltscotland.org.uk/earlyyears/pedagogical.asp

The Effective Provision of Pre-School Education
k.ioe.ac.uk/schools/ecpe/eppe

Centres

Newcastle University Thinking Skills Research Centre
http://www.ncl.ac.uk/ecls/research/education/tsrc/

Centre for Research in Early Childhood
http://www.worc.ac.uk/cms/template.cfm?name=centre_for_research_in_early_childhood_main

National Center for Teaching Thinking
www.nctt.net

Institute for the Advancement of Philosophy for Children
cehs.montclair.edu/academic/iapc

Singapore Center for Teaching Thinking
www.nie.edu.sg

Others

www.standards.dfes.gov.uk/thinkingskills/

www.thinkingtogether.org.uk/

www.teachthinking.com/

www.nestafuturelab.org

www.thinkingconference.com

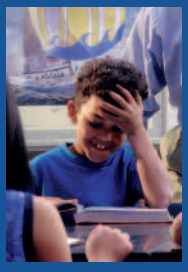
Thinking skills in the early years: a literature review

Since 1999, thinking skills have been included in the National Curriculum alongside key skills, such as those to do with communication and ICT. Thinking skills are expected to be developed at all key stages, and centre on information-processing skills, reasoning skills, enquiry skills, creative thinking skills and evaluation skills.

This review of literature on the subject of thinking skills provides an evidence base for researchers and practitioners on which thinking skills approaches have been established, suggests areas where more evidence is needed and makes some practical recommendations for researchers, policy makers and practitioners. The review answers these important questions:

- What pedagogical approaches to developing generic thinking skills currently exist for children aged three to seven?
- What generic thinking skills are children able to demonstrate at this age?
- What is the relationship between these thinking capabilities and those that the pedagogical approaches aim to develop?

The book reports the key findings from the review and makes recommendations for researchers, policy makers and practitioners. This is essential reading for all those keen to develop and enhance the thinking skills of young people.



ISBN 1 905314 12 4
NFER Ref: TSK

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