REVIEW

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The impact of the implementation of thinking skills programmes and approaches on teachers

Review conducted by the Thinking Skills Review Group

The EPPI-Centre is part of the Social Science Research Unit, Institute of Education, University of London

UNIVERSITY OF NEWCASTLE

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We have tried to be consistent and transparent in conducting the review, working within the EPPI-Centre guidelines, methodology and quality-assurance procedures for systematic reviewing, and involving members of the core Review Group and Advisory Panel. We wanted to ensure that our own pre-existing interest in the implementation and evaluation of thinking skills programmes and approaches did not influence our working processes or findings. We can, however, record our keen interest in the outcomes of the review and acknowledge that this may have influenced the review in ways which are not apparent to us.

LIST OF ABBREVIATIONS

BDI	Biblioscape Database
BEI	British Education Index
BERA	British Educational Research Association
CAME	Cognitive acceleration through mathematics education
CASE	Cognitive acceleration through science education
CATE	Cognitive acceleration through technology education
CERUK	Current Educational Research in the UK (database)
CGI	Cognitively guided instruction
CoRT	Cognitive Research Trust
CPD	Continuing professional development
CT-PE	Critical thinking in Physical Education
DfES	Department for Education and Skills
ECO	Electronic Collections Online
EPPI-Centre	Evidence for Policy and Practice Information and Co-ordinating Centre, Social Science Research Unit, Institute of Education, University of London
ERA	Education research abstracts
ERIC	Educational Resources Information Centre
HEFCE	Higher Education Funding Council for England
HEI	Higher education institution

IBSS	International Bibliography of the Social Sciences
INSET	In-service training
ITE	Initial teacher education
LEA	Local education authority
OCLC	Online Computer Library Centre
OFSTED	Office for Standards in Education
P4C	Philosophy for children
REEL	Research Evidence in Education Library
SEN	Special educational needs
SSBPL	Strategy-supported project-based learning
TSC	Thinking in Science
TTA	Teacher Training Agency
WoE	Weight of evidence

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TABLE OF CONTENTS

SUMMARY 1

Background 1
Aims 1
Review questions 1
Methods 1
Results 3
Conclusions 3
Implications 4

1. BACKGROUND 6

1.1 Aims and rationale for current review 6
1.2 Definitional and conceptual issues 7
1.3 Policy and practice background 10
1.4 Research background 10
1.5 Authors, funders and other users of the review 11
1.6 Review questions 11

2. METHODS USED IN THE REVIEW 12

2.1 User-involvement 12
2.2 Identifying and describing studies 12
2.3 In-depth review 14

3. IDENTIFYING AND DESCRIBING STUDIES: RESULTS 17

3.1 Studies included from searching and screening 17
3.2 Characteristics of the included studies 17

4. IN-DEPTH REVIEW: RESULTS 19

4.1 Selecting studies for the in-depth review 19
4.2 Further details of studies included in the in-depth review 19
4.3 Synthesis of evidence 27
4.4 In-depth review: quality-assurance results 33
4.5 Nature of actual involvement of users in the review and its impact 33

5. FINDINGS AND IMPLICATIONS 34

5.1 Summary of principal findings 34
5.2 Strengths and limitations of this systematic review 38
5.3 Implications 39

6. REFERENCES 41

6.1 Studies included in the in-depth review 41
6.2 Other references used in the text of the report 42

Appendix 1.1: Advisory Group membership 45
Appendix 2.1: Inclusion and exclusion criteria.....46
Appendix 2.2: Search strategy for electronic databases 47
Appendix 2.3: EPPI-Centre keyword sheet, including review-specific keywords .49
Appendix 4.1: Details of studies included in the in-depth review.....51
Appendix 4.2: Results and findings of studies in the in-depth review.....63

SUMMARY

Background

The Thinking Skills Review Group is interested in establishing the extent of the research evidence of the impact of the implementation of thinking skills on teaching and learning, and the first review focused on the impact on learners. Having established in the Group's first review that there is evidence of a positive impact on learners, we turned to the question of the role of the teachers and this review takes that as its focus.

Aims

The aim of this review is to provide an overview of evidence that can inform practice and support the effective implementation of thinking skills programmes and approaches. The focus is very close to the interests and expertise of the authors and wider Review Group, who are either practising school teachers or have a role in initial teacher education (ITE) and the continuing professional development (CPD) of teachers. The overall approach of this review was to focus on those studies identified by the search strategy for the first review and which had significance as measured by the inclusion criteria for that review but then to direct attention to the role of the teacher and the impact of the interventions on teachers and pedagogy.

Review questions

What is the evidence for the impact of the implementation of thinking skills approaches on teachers?

The question of impact is explored in the context of any reported changes to teachers' pedagogical practice, attitudes towards pupils, and professional development following the implementation of thinking skills approaches.

Methods

Three lead reviewers were identified who had experience of thinking skills and teachers' professional development, representing a predominantly research, primary practice and secondary practice background respectively. The three lead reviewers met regularly and moderated the application of the EPPI-Centre review process at each key stage: that is, finding studies, applying inclusion and exclusion criteria, data-extraction and synthesis. Updates and reports were shared with the wider group via email.

The studies were drawn from those identified in the mapping stage of the Group's first review (sourced by searches run in 2002). Studies were included in the map if they:

- were set in schools and were concerned with any section of the school population (including pupils with special educational needs (SEN))
- evaluated the impact of the implementation of thinking skills interventions on teaching and learning; where
  - thinking skills interventions were defined as approaches or programmes which require learners to articulate and evaluate learning strategies and/or which identify specific thinking processes that are amenable to instruction, in order to improve teaching and/or learning,
  - interventions could be taught as separate programmes or infused into curriculum teaching, and where
  - measures of impact were broadly conceived and could focus on motivation and/or engagement and/or patterns of classroom interaction and/or self regulation and/or meta-cognitive monitoring and/or pupil attainment; and
- were concerned with the phases of compulsory schooling (5–16)
- contained empirical classroom research with data or evidence (pupil outcomes, classroom processes, teacher role)
- were written in English

A subset of studies in the map had received mapping codes that indicated that they might contain data relating to the impact of thinking skills approaches on teachers and teaching. These were screened against a further set of review specific criteria. Therefore, studies in the synthesis for this review met the criteria for the map in our first review but also:

- contained quantitative or qualitative data about the impact of thinking skills approaches on teachers and teaching; and
- included sufficient detail regarding the role and training of the teachers involved to enable conclusions to be drawn that are relevant to practitioners

The studies were read by two reviewers and references to other studies that might have teacher data were followed up. Also, authors were contacted to ascertain if they had teacher data which had not been written up or included in existing reports of their studies. In-depth data-extraction was conducted independently by two reviewers who then met to reach consensus. This process was moderated by EPPI-Centre personnel for a sample of studies.

Results

Of the 191 reports in the map, 22 had mapping codes that identified that they might provide data about the impact of thinking skills programmes and approaches on teachers. Following screening with specific inclusion criteria for this review and follow-up of study references, 13 studies were identified for inclusion in the synthesis.

All 13 studies were included in the synthesis of evidence even though their rating in terms of the weight of evidence showed some variation. The justification for this was that, in most cases, judgments on the weight of evidence reflected inadequacies in the reporting of the study, which prevented the reviewer from being confident about the robustness of the research. As in the first review, the process of the systematic review of the evidence highlighted the need for studies to be accessed directly rather than solely through journal articles as is usually the case in education research.

The synthesis resulted in the following key areas emerging as significant:

- Changes in pedagogical practice, including teacher questioning/grouping of pupils/changes in planning and assessment
- Changes in attitudes towards pupils, including perception of pupil ability/facilitation of greater pupil responsibility and autonomy/access to pupil learning
- Implications for professional development, including practical tools being necessary, collaborative CPD (continuing professional development) being preferable, and partnership with researchers as co-inquirers and critical friends being beneficial

Conclusions

Strengths

- The review builds on and refines the review undertaken in Year 1 and so is based on an extensive search of the literature on thinking skills programmes and approaches, and their impact on teaching and learning.
- Close involvement of users in the review. As with the first review, members of the group have been fully involved in all stages of the process and this has helped ensure the link is maintained between research, the interpretation of that research and the development of practice in schools.
- The review not only builds on the previous work of the Thinking Skills Review Group but also demonstrates a high level of agreement with the

findings of another recent review (CPD Review Group) and so provides consolidation of evidence of effective practice in CPD.

- The focus of the review is particularly relevant, given the widespread use of thinking skills approaches and programmes in schools, and the position of thinking skills in key government frameworks and strategies in both primary and secondary schools in the UK. Schools are looking for ways to support teachers in developing innovative pedagogy and also to promote their professional development.

Limitations

- The studies included were only those written in English.
- Studies were found by searches conducted In 2002. Further updates of this review would need to search beyond this date.
- Attempts to retrieve additional information cited but not reported means that, among the excluded studies, there may be rich sources of data. Unfortunately, it was not possible to do more given the limitations of time and resources.
- There was poor quality of reporting of studies, particularly of qualitative data.

Implications

Policy

- The evidence from this review suggests that technicist, delivery models of implementation will not only reduce the professional involvement and motivation of teachers but may also reduce the effectiveness of the interventions in terms of pupil impact
- Thinking skills interventions appear to have potential to support and encourage teachers to develop pedagogy that enables students to achieve greater understanding, engagement and higher achievement but it is a process that requires close partnerships and sustained involvement of teachers working together within and across schools, as well as links with critical friends and this has resource implications.

Practice

- Joint planning and peer observation are effective means of supporting innovative pedagogy.
- The impact of teaching thinking on teachers is to provide greater insight into pupils' learning and assists in the meeting of the requirements for assessment for learning as well as promoting higher order thinking.

- Tools designed to assist the research/evaluation process in an intervention can also be useful in improving the range and quality of feedback to pupils.

Research

- The quality of reporting of studies needs to be improved so that judgements can more easily be made regarding the reliability and validity of findings and conclusions.

- More research in which the rigour of the qualitative research and quantitative research are matched and the sample sizes are greater would enable the findings from these studies to be tested and firmer conclusions drawn.

- This review, considered alongside the first review on impact on learners, shows where the gaps in existing research lie and there is a need to provide more comprehensive evidence drawn from a wider range of contexts.

1. BACKGROUND

1.1 Aims and rationale for current review

The first review conducted by the Thinking Skills Review Group (Higgins *et al*., 2004) found evidence that thinking skills approaches can have a positive impact on pupils' attainment. However, successful implementation of thinking skills approaches in the classroom is clearly dependent upon the effectiveness of the teachers. The review described in this report addresses this issue by asking what the impact is of the implementation of thinking skills programmes and approaches on teachers and teaching. The first review resulted in a map of the literature addressing the broad question, 'What is the impact of the implementation of thinking skills interventions on teaching and learning?' and this map has here been used to identify studies that contain data relating to pupils and also address the question of the impact on teachers themselves and on their teaching. We wanted to look at evidence on teachers that had this close link with this kind of 'classroom effect'. We felt that, although evidence of impact on teachers that did not connect with classroom effect might be of interest, it would not meet the needs of policy-makers and practitioners.

The Thinking Skills Review Group's previous review found that the majority of studies report positive impact on pupils' attainment across a range of non-curriculum measures (such as reasoning or problem-solving) and no studies reported a negative impact. The review also revealed the importance of the teacher in establishing the conditions in the classroom conducive to promoting thinking skills, such as establishing collaborative group work, effective patterns of talk and eliciting pupils' responses. The importance of pedagogy for the impact of thinking skills programmes and approaches highlighted the need to explore research that linked evidence of impact on pupils with insight into the role of the teacher. The aim of this review, therefore is to provide an overview of evidence that can inform practice and support the effective implementation of thinking skills programmes and approaches. The focus is very close to the interests and expertise of the authors and wider Review Group; who are either practicing school teachers or have a role in initial teacher education (ITE) and the continuing professional development (CPD) of teachers.

In the review described in this report, we also wanted to test a methodological hypothesis. The synthesis of findings from the earlier review of the impact of thinking skills approaches on learners enabled us to identify in which subject areas research had been completed. At the mapping stage, we found that the majority of studies were in three curriculum areas (mathematics, science and literacy) with social studies, including humanities, as the next biggest area. In the in-depth review, the predominance of the focus on mathematics, science and literacy was sustained and there were no studies that focused on the humanities and the arts. We were interested to test the hypothesis in this review that the shift in profile of curriculum areas represented may have been a consequence of the introduction of further inclusion/exclusion criteria in order to make the in-depth review stage manageable. In the first review, the additional criteria used to select studies from the map for the in-depth review related to specific types of study and types of data collected. Studies were only included in the in-depth review described in our first report if they were researcher-manipulated evaluations that collected not only quantitative but also qualitative data. This raised the question

for the group of whether research-producing quantitative empirical data was more likely to be produced in curriculum areas in which the subject discipline, and therefore teachers, were familiar with this paradigm. Was it the case that in the humanities and the arts there was a tendency to conduct qualitative research? The implications of any bias towards a particular paradigm for research linked to curriculum focus may be significant for research, policy and practice in terms of the availability of robust evidence of impact.

1.2 Definitional and conceptual issues

The teaching of thinking skills is an explicit part of the National Curriculum in England and Wales and contributes directly to the current initiative of the Department for Education and Skills (DfES), 'Teaching and Learning in the Foundation Subjects' at Key Stage 3. The descriptive review by Carol McGuinness (1999) provides an overview of current research into the teaching of thinking skills and builds on the work of earlier reviews in this area. Nisbet and Davies (1990) list 30 specific programmes and indicated that there were then over 100 on the market in America. Hamers and Van Luit (1999) show that this is not an English-speaking phenomenon and that interest in teaching thinking is evident among practitioners and educational researchers in many other European countries.

Thinking skills initiatives have been used in schools in the UK since the early 1980s and have been in existence for somewhat longer, but the term itself is ambiguous and there is disagreement about how it relates to aspects of pedagogy more broadly. Our working definition for the purposes of the review is that thinking skills interventions are approaches or programmes which identify for learners translatable mental processes and/or which require learners to plan, describe and evaluate their thinking and learning. These can therefore be characterised as approaches or programmes which:

- require learners to articulate and evaluate specific learning approaches
- identify specific cognitive, affective or conative processes that are amenable to instruction

Implicit in the use of the term is an emphasis on so-called 'higher-order' thinking, drawing on Bloom and colleagues' taxonomy (Bloom, 1956). This consists of six major categories arranged in the following order *knowledge, comprehension, application, analysis, synthesis* and *evaluation*. The relationship among the categories along the continuum was presumed to constitute a cumulative hierarchy. Appendix A of the Review Group's proposal[1] contains a discussion of some of the issues surrounding a definition of the term. With the focus on thinking skills in the curriculum in England and Wales at the present time, commercial interest in promoting specific programmes has created the need for teachers to have access to reliable information about the scope and impact of particular approaches for all pupils.

In the report of the first review, we used five broad categories developed by Nickerson, Perkins and Smith (1985), and accepted by Garnham and Oakhill

[1] http://eppi.ioe.ac.uk/EPPIWeb/home.aspx?page=/reel/review_groups/thinking_skills/home.htm

(1994) and Hamers *et al*. (1999) to typify the thinking skills programmes included as follows:

- *Cognitive operations*. Programmes in this category stress the need for certain basic skills like classification or seriation. The obvious exemplar here is Feuerstein's instrumental enrichment (IE) (Feuerstein *et al*., 1980). Instrumental enrichment sets out to foster the development of what are considered to be crucial underlying skills, such as comparing, classifying and clear perception. Such skills are thought often to be missing or poorly developed in children, because of inadequate early experiences. Feuerstein's ideas are generally acknowledged to be seminal in this area. They have directly inspired several other programmes, notably, in this country, the Somerset Thinking Skills Course (Blagg *et al.*, 1988), a series of generic thinking programmes, aimed at the secondary age-level, and Top Ten Thinking Tactics (Lake and Needham, 1993) aimed at primary children.

- *Heuristics (strategies)*. The essential feature of this approach is task analysis where a complex task is split up into more manageable chunks. Although his Cognitive Research Trust (CoRT) materials are not currently published in Britain and are not as frequently used in British schools as several other programmes, the name of Edward de Bono is probably the one which more British people would associate with thinking skills than any other. Throughout his writings (e.g. 1970, 1992), de Bono stresses the importance of consciously practising certain strategies in order to become a more effective thinker. His CoRT materials refer to 'thinking tools', which are made easy for children to remember, with mnemonic titles such as PMI, standing for Plus, Minus, Interesting – urging the student not to rush into a critical decision, but first to list all the things which are in favour of the idea, those which militate against it and those which are interesting, irrespective of critical orientation.

- *Formal thinking*. In the formal thinking approach, Piaget's stage theory of development underpins the emphasis on helping pupils to make the transition from concrete to formal operational thinking. Examples of this approach would be operational enrichment (Csapó 1992) or cognitive acceleration through science education (CASE) (Adey *et al.*, 1995) in the teaching of science for secondary-age pupils, although it also uses principles from Feuerstein. CASE has developed into other curriculum areas (Shayer and Adey, 2002), such as mathematics and technology education (cognitive acceleration through mathematics education (CAME) and cognitive acceleration through technology education (CATE)) as well as for use with younger pupils in science (Let's Think).

- *Thinking as manipulation of language and symbols*. Socio-cultural or socio-historical approaches have also influenced thinking skills programmes and approaches. Drawing on the work of the Russian psychologist, Lev Vygotsky, the emphasis is on talking and discussion, and 'scaffolded' experiences in which children develop understanding through communicating their ideas. The Thinking Together programme developed by a team at the Open University (Dawes *et al.*, 2000) draws explicitly on these ideas.

- *Thinking about thinking: metacognition*. In thinking about thinking or metacognition, it is assumed that improving understanding of one's own thinking will improve subsequent thinking. Nickerson *et al.* (1985) include in this category those programmes which focus on thinking as their subject matter. Foremost in this category is the work of the American philosopher, Matthew Lipman. His Philosophy for Children programme (e.g. Lipman, 1991) rests on certain assumptions, such as that discussion skills usually precede and form the basis of thinking skills (rather than the other way round). Through engaging in group dialogue in an open spirit of enquiry, in what is known as a 'community of enquiry', children can become more effective thinkers as they practise thinking about their thinking processes. There are several other programmes based on the 'community of enquiry' approach, such as Karin Murris' 'Teaching Philosophy with Picture Books' (which has recently been republished as Storywise (Murris and Haynes, 2001)), or Robert Fisher's work (Fisher, 1996, 1998; see also the Society for the Advancement of Philosophical Enquiry and Reflection in Education's (SAPERE) website. An interest in a philosophical approach, as opposed to a psychological one, tends to predominate in this area.

There has been recent interest in 'infused' approaches which seek to develop teachers' pedagogy at the same time as making learners' thinking explicit. Infusion and the use of pedagogical strategies (McGuinness *et al.*,1995; McGuinness, 1999; Leat and Higgins, 2002) tend to blend aspects of thinking skills programmes which makes classification into precise sub-categories challenging.

Recent work by the Centre for Learning and Teaching (Moseley *et al*., 2004) has led to the identification of thinking skills frameworks as a means of categorising different ways of organising the specific skills of thinking, as opposed to focusing on programmes (although in some instances programmes and frameworks are coterminous). Four main family groups of thinking skill framework are identified:

- models and theories of personality, thought and learning (the all-embracing family)
- models and theories of instructional design (the designer family)
- models and theories of critical or productive thinking (the higher-order family)
- Models and theories of cognitive structure and/or cognitive development (the intellect family)

Thinking skills approaches not only specify the content of what is to be taught (often framed in terms of thinking processes, such as understanding, analysing or evaluating) but also require substantial changes in pedagogy. The teacher plays a crucial role in implementing a programme to encourage thinking skills and must master a greater variety of didactic strategies as they reorganise the way they teach students (Hamers *et al.*, 1999). However, while there is a degree of agreement in the research literature, even when the focus is not specifically on thinking skills – that a model of pedagogy which supports the active construction of meaning and endeavours to help students to learn about learning is desirable – research also shows that teachers may adopt a simplified model in order to cope with the complexity of classrooms (Watkins and Mortimore, 1999). If the teaching of thinking skills was seen to align the daily practice of teachers, their vernacular pedagogy (McNamara, 1991), more closely with models derived from research

into effective teaching and learning, this would be of considerable interest to policy-makers.

Concerns have been raised as to the methodological adequacy of studies of teachers' pedagogy and classroom practice. In a major review of research of teachers' pedagogical thoughts, judgements, decisions and behaviour (Shavelson and Stern, 1981) the reviewers state that they found it hard to evaluate studies because of their shortcomings in presenting the findings:

> One major finding of the review is that researchers studying teachers' thought, judgments and decisions often do not: (a) provide adequate descriptions of the methods, (b) incorporate methodological checks in their studies, or (c) systematically study methods used in this field of research (Shavelson and Stern, 1981, p 460).

This systematic review offers the opportunity to test the degree to which studies focusing on the impact of thinking skills in the classroom confirm or confound this trend.

1.3 Policy and practice background

The teaching of thinking skills in schools in the UK has gained in popularity since the revision of the National Curriculum in 2001 and now forms a key part of teaching for creativity in primary schools and the Key Stage 3 Strategy in secondary schools. In Key Stage 5, Critical Thinking as an A/S Level qualification is also becoming very popular with some universities using students' predicted grades in this examination as a discriminator in the selection of very able students. Schools are making links between aspects of thinking skills approaches and other initiatives, such as assessment for learning and inclusion. As the approaches gain in popularity, it is important for schools and local education authorities (LEAs) to identify best practice in the training and support of teachers, and this review provides a summary of evidence on the impact on teachers and the characteristics of effective practice in support and dissemination.

1.4 Research background

The findings from the first review conducted by the Thinking Skills Review Group (Higgins *et al*., 2004) that are most relevant for the issue of impact on teachers have already been presented above. Other research indicates that thinking skills approaches are generally welcomed by teachers and there is evidence that they seem to support changing patterns of interaction in classrooms (Baumfield and Oberski, 1998; Higgins and Leat, 1997; Leat and Higgins, 2002). This understanding is influenced by concepts and ideas derived from cognitive acceleration (Adey and Shayer, 1994), instrumental enrichment (Feuerstein *et al.*, 1980), Philosophy for Children (Lipman, 1994), 'probes' for understanding (White and Gunstone, 1992), reciprocal teaching (Palincsar and Brown, 1984), scaffolding and social constructivism (Wood and Wood, 1996), research on classroom talk (Edwards and Westgate, 1987; Mercer, 1995), self-theories (Dweck, 1999) and collaborative group work (Webb and Farrivar, 1994; Galton *et al.*, 1999). This work has been used in research and development work with trainee and practising teachers as a means by which teachers could put into

practice or ‘enact’ findings from educational research (Higgins, 2001; Higgins and Moseley, 2002; Leat and Higgins, 2002).

The literature suggests that using thinking skills strategies has significant implications for pedagogy as it involves teachers in developing new roles (for example, Leat and Higgins, 2002; Leat and Lin, 2003). In the first review, we found a number of studies that included a focus on the impact of the implementation of thinking skills approaches on teachers and we will use this second review to develop further the answer to the overarching review question ‘What is the impact of the implementation of thinking skills approaches?’.

1.5 Authors, funders and other users of the review

This report was written by a team of colleagues from the former Thinking Skills Research Centre (now the Centre for Learning and Teaching), based at the University of Newcastle upon Tyne. The authors have a range of experience in teaching in primary and secondary schools as well as a background in research; one of the authors is currently a deputy headteacher with responsibility for staff development in one of the largest secondary schools in the region. Funding for the review came from the EPPI-Centre, the Higher Education Funding Council for England (HEFCE) and partnership schools. The funding from the EPPI-Centre contributed to the administration and resource costs of the review, while HEFCE and school funding was in the form of time for the authors to conduct the review and write the report. The EPPI-Centre also enables the work undertaken to be made accessible to a wide and diverse audience through the Research Evidence in Education Library (REEL).

The review is aimed at researchers, policy-makers and practitioners, and all these constituencies were represented in the Review Group and participated at key stages in the process. The review will be widely disseminated not only through REEL but also through specially prepared digests aimed at particular audiences.

1.6 Review questions

Our main research question for this review is as follows:

What is the impact of the implementation of thinking skills programmes and approaches on teachers?

This question was explored in the context of any reported changes in pedagogical practice, attitudes towards pupils and professional development (motivation about teaching and retention of staff).

The review includes a comparison of the characteristics of this subset of studies with a focus on the impact on teachers with the subset of studies identified in the in-depth review focusing on pupil impact in our first report. This comparison will highlight where there are differences in terms of phase, curriculum focus or other potentially significant factors and will enable further investigation of the methodological issue raised in section 1.1 of what type of research is conducted in particular curriculum areas and / or phases of schooling.

2. METHODS USED IN THE REVIEW

2.1 User-involvement

2.1.1 Approach and rationale

The composition of the Review Group reflects the aim to include representatives from key constituencies of users, such as practitioners from primary and secondary schools, LEA advisers and the research community. It was also important to establish links across the range of thinking skills approaches and people who had experience of a range of interventions, either as practitioners or as researchers, were involved.

The approach adopted for the second review was to identify three lead reviewers with experience of thinking skills and teachers' professional development representing a predominantly research, primary practice and secondary practice background respectively.

2.1.2 Methods used

Users were fully integrated into the Review Group and participated at each stage in the review by offering advice and comments, principally by email as there were fewer meetings, given the demands on colleagues' time and the fact that the training had been completed for the first review. The data-extraction of the studies in the review was carried out by two higher education institution (HEI) members of the group, one of whom had only recently joined the university from an advisory teacher post in a local LEA, and one practitioner.

2.2 Identifying and describing studies

2.2.1 Defining relevant studies: inclusion and exclusion criteria

The studies focused upon in this report were identified from a map of research drawn up in 2003. Studies were included in this map if they met the following criteria:

- They were set in schools and were concerned with any section of the school population (including pupils with SEN).
- They evaluated the impact of the implementation of thinking skills interventions on teaching and learning, where
  - thinking skills interventions were defined as approaches or programmes which require learners to articulate and evaluate learning strategies and/or which identify specific thinking processes that are amenable to instruction, in order to improve teaching and/or learning

  - interventions could be taught as separate programmes or infused into curriculum teaching
  - measures of impact were broadly conceived and could focus on motivation and/or engagement and/or patterns of classroom interaction and/or self regulation and/or metacognitive monitoring and/or pupil attainment
- They were concerned with the phases of compulsory schooling (5–16).
- They contained empirical classroom research with data or evidence (pupil outcomes, classroom processes, teacher role).
- They were written in English.

These criteria are presented in full in Appendix 2.1.

2.2.2 Identification of potential studies: search strategy

The studies in the map described above were found through searches of a range of sources run up to 27 May 2002 of a range of sources. Studies were sought from bibliographic databases, citation searches of key authors/papers, reference lists of key authors/papers, key websites and direct requests to personal contacts and key informants; see Appendix 2.2 for a list of sources. Additional studies were identified for this review by reference-checking the reports of the 22 studies identified from the map as relevant to the review.

Search terms were agreed by the core Review Group through a series of meetings that looked at definitions of thinking skills and exercises were developed loosely based on personal construct theory to establish key terms and linked terms that were seen to be relevant by the members of the group. The terms selected were then circulated to the Advisory Panel for comment and amendment. The terms were consistently applied to all the databases (see Appendix 2.2 for further details). Terms were applied either individually, or in combination, depending on the specific search interface available. The date range was determined by the database. The cut-off date for obtaining papers was the 16 September 2002.

2.2.3 Screening studies: applying inclusion and exclusion criteria

All the citations identified in the searches were subjected to the inclusion criteria, which were applied to the titles and abstracts, or full studies if the abstract was not sufficiently clear. Studies were excluded if they failed to meet any one of the inclusion criteria as they were applied in sequence from 1 to 5. Where there was any doubt, studies were included.

2.2.4 Characterising included studies

Reports which met the inclusion criteria were keyworded using two coding tools: the *EPPI-Centre Core Keywording Strategy, Version 0.9.5* (EPPI-Centre, 2002) and a further set of more specific keywords developed by the core Review Group

with support from members of the Advisory Panel (Appendix 2.3). The EPPI-Centre keywords contain terms generally relevant to educational research (such as phase of education, curriculum focus and educational setting). The review-specific keywords contain more detailed terms relevant to aspects of teaching and learning in schools (such as age of pupils and terms relevant to thinking skills approaches and interventions).

2.2.5 Identifying and describing studies: quality-assurance process

The core Review Group moderated the use of the map inclusion and exclusion criteria through meetings where members worked in pairs to apply the criteria on a sample of abstracts and full studies. Keywording was done for the map through a process of initial moderation and then individual coding. Further detail on this process is provided in the full report of the Review Group's first review.

2.3 In-depth review

2.3.1 Moving from broad characterisation (mapping) to in-depth review

To identify studies for this review's synthesis of the impact of the implementation of thinking skills programmes and approaches on teachers, reports were sought that had received either of the following keyword codes in the map:

- ' teaching staff' ('…are the population focus/foci of the study' - question 8 of the EPPI-Centre keywording sheet)
- 'teacher attitude/beliefs/dispositions' ('kind of data' – question 19 of the review-specific keywording sheet)

Reports were then examined further only if they had also received a code in response to the question 'Method of data-collection' – question 22 of the Review specific keywording sheet – indicating that empirical data linked to impact on teachers had been collected.

Further sifting was achieved by applying the review-specific criteria:

- contained data on impact on pupils
- contained quantitative or qualitative data about the impact of thinking skills approaches on teachers
- included sufficient detail regarding the role and training of the teachers involved to enable conclusions to be drawn that are relevant to practitioners

These criteria are presented in full in Appendix 2.1.

It was considered that this approach would identify studies that might contain data relating to teachers, specifically, any reported changes in pedagogical practice,

attitudes towards pupils and professional development (motivation about teaching and retention of staff). The studies identified through these codes were read by two reviewers and references to other reports that looked as though they might contain teacher data were followed up. Also, when reports were examined and found not to contain data relating to teachers, authors were contacted and asked whether such data were available.

2.3.2 Detailed description of studies in the in-depth review

Detailed description of the studies was achieved by using a set of standard questions covering the study's aims and rationale; study research question(s) and policy and practice focus; study methods, sample, results and conclusions; and study quality (EPPI-Centre, 2003). We added review-specific questions to the data-extraction process so that the nature of the teacher impact reported could be identified and the strength of the link to pupil outcome data measuring impact ascertained. Data were entered using EPPI-Reviewer, the EPPI-Centre's online software. The complete data-extractions can be accessed via the EPPI-Centre's Research Evidence in Education Library (REEL).

2.3.3 Assessing quality of studies and weight of evidence for the review question

Three components from within these review guidelines were identified to help in making explicit the process of apportioning different weights to the findings and conclusions of different studies. These weights of evidence (WoE) were based on the following:

(i) the soundness of studies (internal methodological coherence), based upon the study only (WoE A);

(ii) the appropriateness of the research design and analysis used for answering the review question (WoE B) ,

(iii) the relevance of the study topic focus (from the sample, measures, scenario, or other indicator of the focus of the study) to the review question (WoE C)

(iv) an overall weight taking into account (i), (ii) and (iii) (WoE D).

After much discussion and moderation of preliminary coding by reviewers and the EPPI-Centre link person, the following procedure for arriving at D from A, B, C and D was agreed and applied. Ratings of high in the overall ranking (WoE D) were to be dependent on high ratings for WoE B and C (which focus on relevance of the study for our review) and a high rating for the quality of the execution of the study judged on its own terms (WoE A). Studies were given an overall rating of low if they scored low on more than two of these dimensions. All other studies were rated medium.

2.3.4 Synthesis of evidence

The synthesis was developed through discussions between reviewers and between reviewers and the wider Review Group. The synthesis was structured by looking at three ways in which teachers might be influenced by thinking skills:

through changes in pedagogical practice, changes in teacher attitudes towards pupils and implications for professional development. We also aimed to contextualise the studies in the light of the Review Group's first review to promote further discussion not only of the nature of impact on teachers and the indicators for successful support and training, but also to identify where there are issues in terms of the kind of research undertaken and the way it is reported. The process included comparisons between the two reviews, facilitated by the use of similar criteria and was the focus of discussions between the reviewers and the Review Group. Further calibration is planned as part of the wider dissemination strategy for the review.

2.3.5 In-depth review: quality-assurance process

Application of the additional review-specific inclusion and exclusion criteria was conducted by pairs of Review Group members working first independently and then comparing their decisions and coming to a consensus. Members of the EPPI-Centre assisted in applying criteria for a sample of studies. When new reports were found during checks of reference lists described above, these were keyworded independently by two reviewers and then moderated at a Review Group meeting. Moderation of the data-extraction and assessment of the weight of evidence was carried out using the same process as for keywording and the application of inclusion/exclusion criteria. Data-extractions of studies were first entered into EPPI-Centre software (EPPI Reviewer) by two reviewers and then a comparison run to identify any differences. Moderation between reviewers took place and the agreed version was finalised. Members of the EPPI-Centre also reviewed a sample of studies independently and three-way comparisons were made. We found the involvement of the EPPI-Centre particularly helpful in agreeing judgements regarding the weight of evidence criteria.

3. IDENTIFYING AND DESCRIBING STUDIES: RESULTS

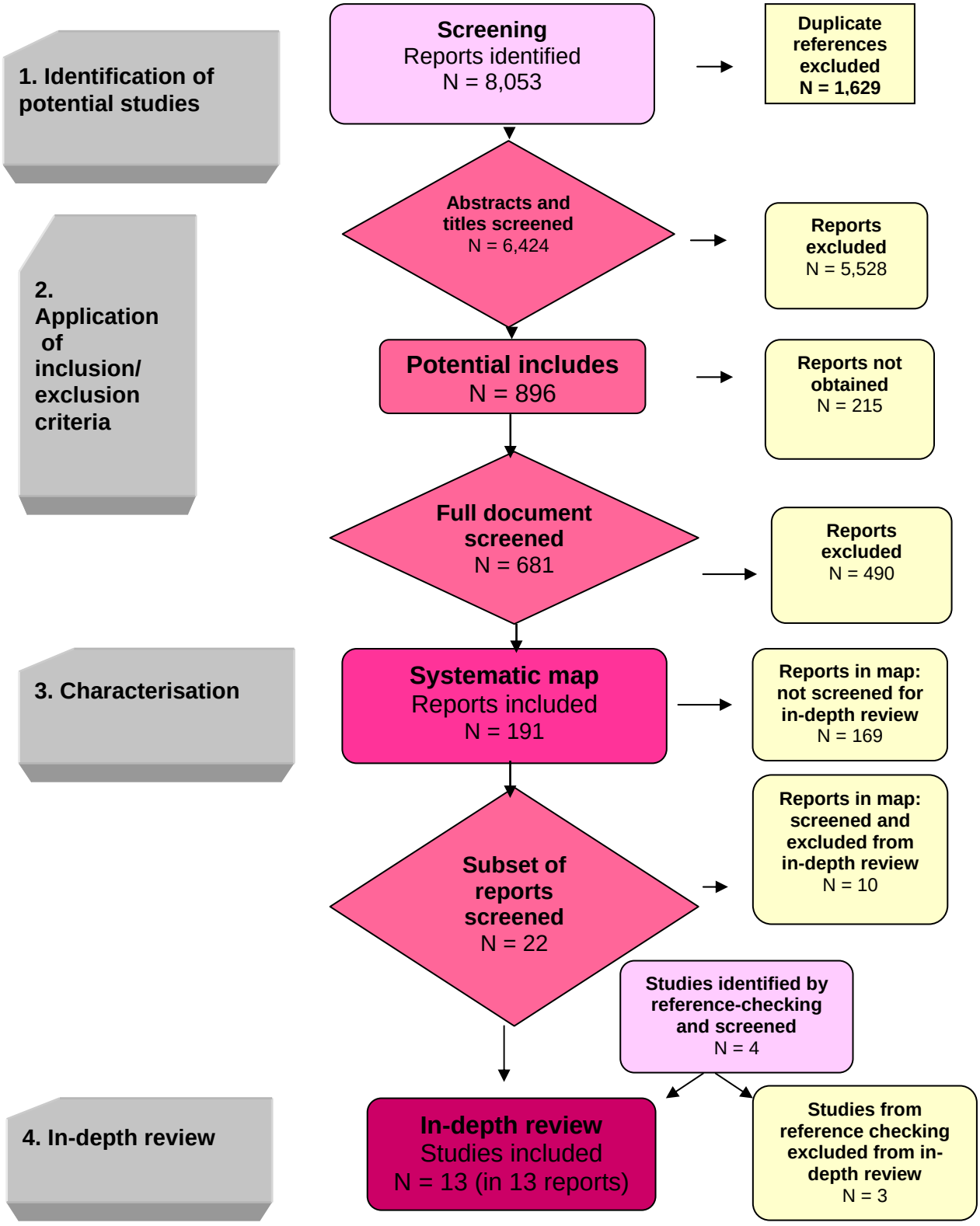
3.1 Studies included from searching and screening

As the report of the earlier review describes, a total of 8,053 studies were identified through searches, 681 full documents were screened and 191 reports of studies were included in a systematic map. Figure 3.1 illustrates this process of searching and screening. Results of the quality-assurance processes used to produce the map can be found in Higgins *et al*. (2004).

3.2 Characteristics of the included studies

Detail of the range and type of studies contained within the Thinking Skills Review Group's systematic map can be found in the first report from this group (Higgins *et al*., 2004).

Figure 3.1: Filtering of papers from searching to map to synthesis



4. IN-DEPTH REVIEW: RESULTS

4.1 Selecting studies for the in-depth review

A total of 22 of the reports contained within the systematic map were keyworded as having a focus upon teaching staff, or containing data on teacher attitudes, beliefs or dispositions, and then also reporting some form of data. From these 22 reports, a total of 12, describing 12 studies, met the criteria for the in-depth review described in section 2.3.1 above. Retrieval and screening of additional studies referenced in included reports identified one additional study that met these criteria. As a result, as shown by Figure 3.1, a total of 13 studies were identified for inclusion in the synthesis of studies addressing the impact of thinking skills programmes and approaches on teachers. Two of the studies were related (Fennema *et al*., 1996; Franke *et al*., 1998) in that the second used a sub-sample of teachers from the first to examine impact over time. A full list of the reports seen for these studies is presented in section 6.1.

The 23 studies evaluating impact on pupils, which were synthesised for this group's previous review and which serve as a point of comparison in the presentation of results below, are not indicated in Figure 3.1. Two sets of studies do, however, overlap with Hojnacki and Grover (1992) and Ritchie and Edwards (1996), featuring in both syntheses.

4.2 Further details of studies included in the in-depth review

Key characteristics of the 13 studies are presented study by study as Appendix 4.1. The following is a brief overview of the range of these characteristics across the studies taken as a group. As Table 4.1 illustrates, almost half (6) of the studies found were conducted in the USA, with all but one of the remainder coming from other English speaking countries (UK and Australia).

Table 4.1: Country of included studies (N = 13, mutually exclusive)

Country	Studies
UK	4
USA	6
Australia	2
Israel	1
Total	***13***

4.2.1 The thinking skills programmes and context studied

As Table 4.2 shows, the 13 studies in this review were more often set in secondary, rather than primary, settings. This contrasts with our previous review of studies of the impact on pupils, where more studies were set in primary schools.

Table 4.2: Educational setting (N = 13, mutually exclusive)

Educational setting	Studies
Primary	5
Secondary	8
Total	***13***

Table 4.3 shows that, in terms of subject area, work in mathematics and science dominated. The distribution of subject areas differs from that in the first review in so far as the humanities and art, absent in the first review, do figure to some extent.

Table 4.3: Curriculum focus (N = 13, mutually exclusive)

Curriculum focus	Studies
Art	1
Cross-curricular	1
History	1
Literature	1
Mathematics	4
PE	1
Science	3
Independent Thinking Skills Programme	1
Total	***13***

All the studies included in the in-depth review used named thinking skills programmes (Table 4.4). As the table shows, while some of these programmes were also featured in the first review, there are some new programmes evaluated in the studies in this second review.

Table 4.4: Thinking skills programmes (N = 13, mutually exclusive)

Thinking Skills Programme	Studies examining programme	Frequency in this review	Frequency in Higgins *et al*. (2004)
CoRT (Cognitive Research Trust)	Ritchie and Edwards (1996)	1	4
Thinking Maths	Hojnacki and Grover (1992)	1	4
CAME (Cognitive Acceleration through Maths Education)	Taverner (2001)	1	0
CASE (Cognitive Acceleration through Science Education)	Koufetta-Menicou and Scaife (2000), McGregor and Gunter (2001)	2	4
SSBPL (Strategy-Supported Project-Based Learning)	Feretti *et al.* (2001)	1	0
Philosophical Inquiry/Philosophy for Children (P4C)	Naisbett (1997), Wilks and Emery (1998)	2	4
CGI (Cognitively Guided Instruction)	Fennema *et al*. (1996), Franke *et al*.(1998)	2	0
CT-PE (Cognitive Training in Physical Education)	Donnelly *et al*. (1999)	1	0
Talents Unlimited	Crump *et al*. (1988)	1	0
Thinking in Science	Zohar (1999)	1	4

The programmes can be characterised, briefly, as follows:

- *Cognitive Research Trust (CoRT)*: This is a series of cognitive tools devised by Edward De Bono and designed to be taught as a discrete, structured programme, although the tools (such as PMI which is an acronym to remind the learner to look for Plus, Minus and Interesting points in any given topic or situation) can be infused into the curriculum.

- *Thinking Maths/CAME/CASE/Thinking Science*: Adey *et al*. (1995) developed CASE as a means of developing understanding of key concepts in the science curriculum. It is a structured programme built on a Piagetian framework. It is taught by subject specialists but as an additon to any existing curriculum provision. CAME is the sister programme for Maths and Thinking Maths and Thinking Science are based on the CASE model but with some adaptations, particularly in their explicit emphasis on metacognition.

- *Strategy-supported project-based learning (SSBPL)*: This is a curriculum model designed to help learners with and without mild disabilities to learn historical content and understand the processes of historical thinking. The programme is based on a frame incorporating authentic tasks and explicit cognitive strategies within a narrative framework.

- *Philosophical Inquiry / Philosophy for Children (P4C)* (Lipman, 1991): This is an approach based on Dewey's theories of the role of inquiry in learning and the importance of working within a community to construct understanding. The approach has close affinites with Socratic questioning and dialogic teaching, and can be taught as an independent programme using narratives devised by Lipman or as an infused approach where narratives are matched to subject

specific issues. Increasingly, teachers are using the pedagogy independently of prepared narratives.

- *Cognitively guided instruction (CGI)*: This is an approach whereby teachers develop their pedagogy by focusing on the children's thinking within a particular subject domain. The method is social constructivist and designed to enable learners to articulate their thinking and for teachers to make links between the feedback from learners and research into developing mathematical understanding.

- *Cognitive training in physical education (CT-PE)*: This aims to develop critical, reflective thinking that is used to make decisions about movement tasks in PE and is based on a series of problem solving activities where metacognition is encouraged.

- *Talents Unlimited*: This is a programme designed to develop 'talent areas' which are listed as productive thinking, decision-making, planning, forecasting, communication, academic. Nineteen thinking skills are nested within the talent areas and these are developed and reviewed as they are used within and across different subject areas.

If the programmes seen in the 13 studies are classified in terms of their predominant focus using the categories outlined in section 1.2 (bearing in mind the degree of overlap that is highlighted in all attempts to classify thinking skills programmes), there is a strong clustering around the Formal Thinking category with four of the 13 being concerned with programmes based on a Piagetian framework (Thinking Maths, CAME, CASE, Thinking Science). There is also an emphasis on metacognition in seven of the 13 programmes, with Philosophical Inquiry/Philosophy for Children being the approach most directly focused on this aspect. The four 'Formal Thinking' programmes mentioned above, however, also include thinking about thinking as do the Cognitively Guided Instruction and Cognitive Training in PE programmes. In two of the studies, the programmes can be characterised as focusing on Cognitive Operations and the CoRT programme can be classified as an heuristics approach. Interestingly, all the studies looked at the impact of one particular approach or programme rather than the use of more than one programme, although evidence from schools would suggest that there is often a degree of eclecticism in practice.

In terms of the distinction between infusion and independent approaches to thinking skills, 12 of the studies were concerned with the infusion approach to thinking skills with only one focused on an independent thinking skills programme.

If a thinking skills framework system of classification is applied, we find that eight of the 13 studies focus on cognitive structure with one in the instructional design family (strategy-supported project-based learning (SSPBL)) and four represent critical or productive thinking (CoRT, Talents Unlimited and Philosophy for Children (P4C)). However, it is again the case that there is overlap and the categories are intended to serve as a guide and not as a definitive taxonomy.

4.2.2 Study designs and methods.

Table 4.5 shows that reviewers judged that, while most studies were of a design that involved researcher manipulation of who did or did not experience a thinking skills programme or approach, other designs were also used. Reviewers judged

that studies could be coded as having more than one study type. The synthesis within the Review Group's first review focused solely on researcher-manipulated interventions.

In terms of comparisons between study groups or measurements, only one study (Ritchie and Edwards, 1996) had both teacher and pupil control groups. One study (Hojnacki and Grover, 1992) had a pupil control group but no teacher control group and a further study (Koufetta-Menicou and Scaife, 2000) made comparisons between the same teachers when they were using the intervention and when they were not.

Table 4.5: Type of study and measurement (N = 13*)

Study type	**Frequency**
Description	1
Exploration of relationships	2
Evaluation (naturally occurring)	3
Evaluation (researcher manipulated)	8

Instrument to measure impact on teachers	**Frequency**
Self-rating questionnaires	2
Self-report	2
Teacher log	4
Videotape of lessons	3
Audiotape of lessons	3
Formal observation	5
Interviewing	5
Belief scale	1

*Codes for 13 studies; studies could be classified as having more than one study type and could use more than one method for measuring impact.

Data on the impact of the thinking skills approaches on teachers was gathered using a range of methods, the most commonly being observations of teacher behaviours and teacher-pupil interactions in lessons through the analysis of transcripts of audio- or videotapes. Impact was measured in terms of those aspects of classroom interaction known to support conceptual understanding in learners, such as the quantity and quality of pupil talk, pupil-to-pupil mediation, and types of teacher questions (Newton and Newton, 2000). Teacher self-reporting also featured in the form of diaries or logs, self-rating questionnaires and semi-structured interviews in order to probe teachers' responses to the intervention and the effect on their attitudes and beliefs about teaching and learning. All the studies included used more than one measure of teacher impact as well as data on impact on student achievement so that links could be made between improvements in students' learning and changes in teachers' practice.

Details of sample sizes were not always clear in the studies and this was more likely to be the case for the reporting of the sample of teachers than it was for pupils. Three studies use relatively large samples (at 87, 64 and 22 teachers). In a further six studies, the sample is fewer than five and, in two instances, data

relate to one teacher only. In the remaining four studies, no details are given as to the number of teachers involved.

Details of the analysis of the teacher data were scant (and sometimes completely absent) in many of the studies. In this sense, the studies included are often weaker than might usually be the case in terms of their apparent command of qualitative research methods. This may, however, be a consequence of the reporting of studies rather than inherent problems with the methods used. The studies included were from the systematic map for the first review and needed to include impact data on pupils as well as provide details regarding the teachers involved. In some instances, the references to the teacher data is not the main focus of the report of the study where rigorous analysis of pupil data is not matched by the analysis of the teacher data. In other instances, the teacher data serves to validate the pupil data and is not explored in great depth in the report. However, there are studies that have focused on the impact on teachers, while still providing insufficient detail regarding the analysis of the data; these studies do not discuss the validity and reliability of the evidence in sufficient depth. Where data analysis methods are referred to, the use of grounded theory approaches are mentioned, although some studies try to quantify qualitative data by presenting frequency scores of codes as percentages, for example.

Data on teachers' perceptions of pupil ability relies on self-reporting by teachers; the evidence therefore originates from the aspect of the studies that is least robust. However, the studies have measures of positive impact on pupils and so this category is of interest as it offers a focus for further investigation in order to evaluate whether the shift in teacher expectations is a significant factor in the effectiveness of thinking skills programmes

(See Appendix 4.1 for further detail on each study's methods.)

Weight of evidence judgements

Applying the weight of evidence criteria was problematic given the serious lack of reporting quality in the majority of the studies (see section 4.4).

On the basis of available reports, most (10) of the 13 studies were judged to have a medium weight of evidence for addressing the question of how thinking skills programmes or approaches might impact on teachers (table 4.6). Two, related studies (Fennema *et al*., 1996; Franke *et al*., 1998) were judged to have a high weight of evidence and one was judged as low (Ferretti *et al*., 2001). The study rated low overall had a medium rating in WoE A, resulting from an imbalance between the quality of the quantitative aspects of the study which were high and the less coherent qualitative aspects. The deficiencies in the reporting of the qualitative aspects of the study meant that the rating for WoE B (the appropriateness of the research design/analysis for the review question) was low as it was the qualitative aspect of the study that was most relevant. WoE C was also rated low as the study was focused on pupil impact with the teacher aspect being concerned with explaining the pupil responses rather than being a major aspect of the research. Looking across the scores for the different aspects the overall weighting (WoE D) was low. However, the decision was made to include the study in the synthesis because it did make a contribution to our understanding of the role of the teacher; any conclusions drawn from this study alone would have to be treated with caution.

The kinds of study aspects that led to studies being judged medium or low in WoE B were the use of an eclectic range of measures that were not always pertinent to the aspect of the study referring to teacher impact in our review and/or deficiencies in the provision of detail regarding the data on teachers, particularly the way that any data was analysed. For WoE C, the decision involved making a judgement regarding the extent to which the question of the impact of thinking skills on teachers and teaching was central to the study. Within the Review Group this led to some debate as to how far distinctions between impact on teachers and impact on teaching should be discriminated and moderation involved deciding, for example, the extent to which teacher responses were relevant regarding the training workshops that often preceded an intervention.

Table 4.6: Weight of evidence (WoE) judgements for the 13 studies in the in-depth review

Study	**WoE A** Internal methodological coherence	**WoE B** Appropriateness of research design/analysis for review question	**WoE C** Relevance of the study topic focus for review question	**WoE D** Overall weight
Crump *et al*. (1988)	medium	medium	medium	medium
Donnelly *et al*. (1999)	high	medium	medium	medium
Fennema *et al*. (1996)	high	high	high	high
Ferretti *et al*. (2001)	medium	low	low	low
Franke *et al*. (1998)	high	high	high	high
Hojnacki and Grover (1992)	medium	high	medium	medium
Koufetta-Menicou and Scaife (2000)	low	high	high	medium
McGregor and Gunter (2001)	low	high	high	medium
Naisbett (1997)	medium	high	high	medium
Ritchie and Edwards (1996)	high	low	medium	medium
Taverner (2001)	low	medium	high	medium
Wilks and Emery (1998)	medium	high	high	medium
Zohar (1999)	low	medium	high	medium

4.3 Synthesis of evidence

All 13 studies in the in-depth review were included in the synthesis of evidence presented below even though, as the previous section indicates, their rating in terms of the weight of evidence showed some variation.

Table 4.7 summarises the contribution the reviewed studies make to our understanding of the impact of teaching thinking skills on teachers. In this table and in the narrative synthesis that follows it, findings and the studies that report them are first ordered in terms of whether they relate to changes in pedagogical practice, changes in teacher attitudes towards pupils or, implications for professional development. Each of these categories are then further subdivided.

Table 4.7: Summary of findings reported within the synthesis

Research question for review	Category	Finding	Warrant
Changes in pedagogical practice	Teacher questioning	Teachers ask more questions and a higher proportion of these are open-ended.	Donnelly *et al.* (1999), Koufetta-Menicou and Scaife, (2000), McGregor and Gunter (2001), Wilks and Emery (1998)
		Asking more open-ended questions was linked to increasingly focused questions.	Ferretti *et al*. (2001)
		Teachers facilitated more pupil questioning.	Naisbett (1997)
	Grouping of pupils	Used mixed ability grouping more	McGregor and Gunter (2001)
		Gave more consideration to optimum group size	McGregor and Gunter (2001)
	Changes in planning and assessment	Increased flexibility and more adjustment to long term planning to accommodate time spent on building on pupil responses and improve progression	Hojnacki and Grover (1992), McGregor and Gunter (2001)
		Refocusing of priorities so that more attention is paid to underlying concepts and processes rather than factual content and subsequent shifts in assessment practices	Hojnacki and Grover (1992), Koufetta-Menicou and Scaife (2000), McGregor and Gunter (2001)

Research question for review	Category	Finding	Warrant
Changes in attitudes towards pupils	Changes in perceptions of pupil ability	Improved feedback from pupils enabled teachers to become aware of pupil capabilities and so judge their ability more accurately.	Naisbett (1997), Wilks and Emery (1998), McGregor and Gunter (2001)
	Facilitation of greater pupil responsibility and autonomy	The interventions brought about a shift in teacher attention so that they were able to trust pupils and feel that their classrooms were a positive learning environment and supportive of change.	Fennema *et al.* (1996), Zohar (1999), Ferretti *et al.* (2001)
	Access to pupil learning	Improved feedback from pupils and monitoring of classroom conversation raised teacher motivation and self-esteem as well as that of pupils.	Wilks and Emery (1998), Zohar (1999), Franke *et al.* (1998), Hojnacki and Grover (1992)
		Teachers were able to use the classroom conversations to monitor learning.	Ferretti *et al*. (2001)
Implications for professional development	Practical tools	Teachers need accessible means of support in reflecting on their classroom practice, such as video- and audio-recording, learning logs and teacher diaries.	Taverner (2001), Franke *et al*. (1998), Naisbett (1997), Wilks and Emery (1998)
	Collaborative CPD	Joint planning and team teaching enables teachers to develop thinking skills approaches in practice.	Crump *et al.* (1988), Donnelly *et al.* (1999), Ferretti MacArthur and Okolo (2001), Zohar (1999)
		Teachers value opportunities to compare and contrast their experiences with those of their peers.	Hojnacki and Grover (1992), Wilks and Emery (1997), Zohar (1999), Taverner (2001)
	Partnership with researchers as co-inquirers and critical friends	Shared, practical inquiry enables the implementation of thinking skills to be embedded in practice and lead to self-sustaining generative change.	Fennema *et al*. (1996), Franke *et al*. (1998), Hojnacki and Grover (1992), Zohar (1999), Ritchie and Edwards (1996)

4.3.1 Changes in pedagogical practice

Teacher questioning

Wilks and Emery (1997) in their study of implementing the Philosophical Inquiry approach in art lessons, report a change in the patterns of classroom interactions post-intervention with an increase in student initiated discussion and a reduction in lower level responses, and in the interviews the teachers commented on the changes in their questioning styles. Donnelly *et al*. (1999) found that the model of inservice support provided in a programme of cognitive training in PE enabled teachers to display quantitative and qualitative changes in behaviours or the manner in which they structured the learning environment and framed the learning tasks. Some changes were easier to achieve than others and teacher questioning was one aspect that was amenable to change. Koufetta-Menicou and Scaife (2000) focus explicitly on the impact of a thinking skills intervention on teachers' questioning. In their comparison of science lessons where the intervention CASE was being used and those where it was not, they found that, in the former, more time was spent in whole-class discussions and the teachers asked more questions. However, the increased quantity of teacher questions was not equally distributed across the nine categories identified in the study. Teachers who asked 'how' questions were more successful in promoting metacognition in their pupils and there was some evidence of the transfer of questioning style by teachers to non-CASE lessons. In both CASE and non-CASE lessons, the proportion of higher order questions asked by teachers was low and the lower-order questions were not positively connected to any kind of desired learning outcome. McGregor and Gunter (2001) suggest that in-service training (INSET) supporting the implementation of CASE enriches the views of learning held by teachers and impacts on their pedagogical practice so that they become mediators of learning. One specific aspect of pedagogical change noted in the study is a change in the style of teacher questioning so that it facilitates more extended pupil responses.

Ferretti *et al*. (2001) report that in their study teachers implementing strategy supported project based learning (SSPBL) adapted the pace of discussions and used more focused questions and examples from pupils' daily lives in their teaching. Naisbett (1997) found that teachers implementing a Philosophical Inquiry programme were facilitating more pupil questions and that, over time, these questions became more complex.

Those studies that report on teacher questioning, with the exception of Ferretti *et al*. (2001), are all rated medium in terms of overall weight of evidence. In terms of the weighting for the trustworthiness and quality of the study (WoE A), Donnelly *et al*. (1999) is rated high and so the findings as reported can be taken to be valid and reliable. Four studies have a high rating for the relevance of the focus and the appropriateness of the research design for this review. However, it should be noted that the study by Koufetta-Menicou and Scaife (2000) was rated low in terms of WoE A due to the lack of detail in the reporting of the study regarding the coding and analysis of the data. Ferretti *et al*. (2001) is rated medium for the quality of the study but low in terms of design and topic relevance for this review and therefore carries a low overall weight.

Given the agreement across the studies that thinking skills interventions change the way in which teachers question, this finding can be taken as being of consequence and significant in the context of research into the key role of teacher questioning in learning.

Grouping of pupils

McGregor and Gunter (2001) explore how the use of CASE in the classroom, supported by an in-service programme, enabled the teachers to promote thinking through dialogue by managing the composition in terms of ensuring a mix of ability and the size of groups more proactively. Although the WoE A for this study is rated low, this is due to limitations in the reporting of the study and may not be an indication that it was poorly executed. The overall rating is medium because of the close relationship between the focus and the research design and this review.

Planning and assessment

Hojnacki and Grover (1992) report that the teachers involved in the implementation of the Thinking Maths programme had by the midyear survey made adjustments to their teaching timelines (90%) and had altered their grading and/or assessment practices (65%); the majority of teachers (80%) had changed their use of textbooks. McGregor and Gunter (2001) found that teachers reported that they were applying the psychological principles of CASE to the arrangements of activities in lessons, and the order in which they used materials and resources in the teaching of a topic when planning schemes of work. Some schools had been stimulated to review their Key Stage 3 (KS3) schemes of work, to try to build in more progression and one teacher noted that they tended to concentrate more on the concept behind the lesson. Koufetta-Menicou and Scaife (2000) note that the shift in the pattern and focus of teacher questioning in CASE lessons leads to greater emphasis on the underlying scientific concepts and that this transfers to non-CASE lessons. This aspect of change in pedagogical practice tends to be cited in the studies as an indication of the impact of the intervention rather than as a main finding. Consequently, the references appear almost incidental and the supporting evidence is not fully explained or justified in most cases. The cited studies all have a medium rating for the overall weight of evidence.

4.3.2 Changes in attitudes towards pupils

Perceptions of pupil ability

Naisbett (1997), reporting on the findings from her own action research into Philosophical Inquiry states that there was a shift in her identification of the abilities of students, with two girls previously identified as more able not appearing to be exceptional but two boys and two girls not previously identified as gifted and talented showing considerable ability when the thinking skills approach was being used. She reports that, when the approach was disseminated to other teachers in the school, they also commented in their feedback that one of the unexpected and surprising results wsd the high level responses of students not previously identified as able learners. Wilks and Emery (1998) found that the anticipated shift in the patterns of classroom interaction when the philosophical inquiry approach was in use led to teachers being more aware of the capacity of their pupils to contribute extended and sophisticated responses. McGregor and Gunter (2001) also report similar findings with the CASE intervention. The studies have a medium rating for the overall weight of evidence.

Facilitation of greater pupil responsibility and autonomy

Fennema *et al*. (1996) identify four levels of instructional practice and beliefs in the teachers involved in the implementation of Cognitively Guided Instruction in

mathematics. They report that, by the end of the study, over half of the teachers were categorised at Level 4 and this meant that they fully accepted the idea that children can solve problems without direct instruction and that the teacher's role is to support autonomy by structuring the learning environment to build on what each child already knows. Ferretti *et al*. (2001) state that the teachers in their study of strategy-supported project-based learning (SSPBL) had successfully created a classroom climate in which all students felt safe to participate and in which they believed that their contributions were valued. Zohar (1999) refers to reports from teachers who were implementing a Thinking in Science programme that suggested that they were now teaching in a more creative way: as an example of this, they now encourage pupils to design their own experiments in science rather than simply copy what the teacher had demonstrated to the class. The three studies cited span the range in terms of evaluations of the weight of evidence; the precision of the levels identified by Fennema *et al*. (1996), combined with the rigour of the study in all the key element of this review, lends weight to this finding regarding the impact of thinking skills on teachers. Differences in weighting between the studies are due to limitations in the reporting.

Access to pupil learning

Wilks and Emery (1998), in their study of the impact of using the philosophical inquiry approach in art lessons, comment on the importance to teachers of the insight into student's thinking through the open-ended discussions. Zohar (1999) is concerned with the development of metacognitive knowledge of teaching thinking in teachers but also reports on the impact of awareness of students' capabilities as revealed in the practice of thinking skills activities in science on teachers. Teachers report that they realise that students are capable of more independent learning than they had previously assumed. Franke *et al*. (1998) investigate the role of a thinking skills programme, cognitively guided instruction (CGI), in the development of self-sustaining generative change in teachers. In the study, they provide transcripts of teacher reflections in which the role of feedback from pupils in changing their perspectives on learning is exemplified. Hojnacki and Grover (1992) describe a virtuous circle within their study of the Thinking Maths programme, whereby teacher enthusiasm and empowerment is intrinsically linked with pupil enthusiasm and empowerment. They report that 59% of responses cite pupil factors as the main drive in their own development, 'It's exciting to see the "light bulb" go on' (Hojnacki and Grover, 1992, p 8).

Ferretti *et al*. (2001) refer to teachers being able to use the classroom conversations of pupils in their SSPBL thinking skills lessons to monitor learning more effectively. This study has a low rating in terms of its orientation towards the specific review questions but the quality of the study has medium rating, as a result of the interpretation of key findings rather than for any major deficiencies in the design and execution. Where a finding does contribute to evidence from other studies, it can be regarded as trustworthy in those respects.

The role of pupil feedback in causing changes in pedagogical practice, while tending to not be a central focus of these studies, was reported as an important aspect. Apart from Ferretti *et al*. (2001), the studies cited are all of medium, or in one instance high, weighting overall and so this finding can be viewed as having some merit but would benefit from further investigation in future studies.

4.3.3 Implications for professional development

Practical tools

In his study of the CASE thinking skills programme, Taverner (2001) focuses on the role of the teacher diary in supporting a teacher through the process of embedding teaching thinking in his practice, particularly by helping him to identify the key incidents that have helped to move him on. Franke *et al*. (1998), in their study of cognitively guided instruction, report that explicit support in making sense of students' responses is crucial in promoting self-generative change in teachers; the interventions can function as tools in this way by providing enhanced opportunities for student feedback as does the study of transcripts of student dialogue. Naisbett's (1997) study of Philosophical Inquiry also refers to the teacher diary as an important tool in encouraging reflection and heightened awareness of changes in student responses. Wilks and Emery (1998)'s study of a similar kind of programme also refers to the role of the discussion with teachers of the transcripts of audiotaped lessons in promoting reflection and supporting professional development.

The tools were usually instruments designed to assist in the gathering of data in the evaluation of the intervention; however, they proved to be valuable aids in supporting teacher reflection. The studies have at least medium, and in one case high, degrees of reliability overall and are rated high for their relevance and high/medium for appropriateness for this review.

Collaborative CPD

The role of joint-planning and team teaching is referred to in the findings of a number of the studies and specifically mentioned as an important aspect in four (Crump *et al*., 1988; Donnelly *et al*., 1999; Zohar, 1999; Ferretti *et al*., 2001). While ratings for the individual studies vary across all the items, the cumulative weight reading across the studies is persuasive and can be further supported from other EPPI-Centre reviews on teachers' professional development (Cordingley *et al*., 2003).

Partnership with researchers as co-inquirers and critical friends

Two high-rated, related studies cite the importance of inquiry supported by researchers as critical friends in not only promoting the professional development for teachers using thinking skills approaches but also in achieving maximum effect in terms of pupil gains (Fennema *et al*., 1996; Franke *et al*., 1998). Two other studies also explicitly highlight the importance of research and development in partnership with colleagues in higher education (Hojnacki and Grover, 1992; Zohar, 1999) in terms of establishing both better theoretical understanding and a more sustained model of classroom practice. Ritchie and Edwards (1996) provide a counter example of this in their study of a Cognitive Research Trust (CoRT) thinking skills programme in which the teachers were not involved closely with the researchers and in which there was little impact on their professional development; questions are raised regarding the long-term, sustainable impact of the thinking skills intervention.

This aspect of the impact on teachers is well documented in studies considered to have a high rating in terms of weight of evidence and so can be regarded as having considerable importance for this review.

4.4 In-depth review: quality-assurance results

Reviewers considered that, for most of the 13 studies reviewed in-depth, judgments on the weight of evidence reflected inadequacies in the reporting of the study, which prevented the reviewer from being confident about the robustness of the research. As in the first review, the process of the systematic review of the evidence highlighted the need for studies to be accessed directly rather than solely through journal articles as is usually the case in education research.

As described in section 2.3.3, ratings of high in the overall ranking (WoE D) were dependent on high ratings for WoE B and C (which focus on the appropriateness of the design and relevance of the study for our review) and a high rating for the quality of the execution of the study judged on its own terms (WoE A). One study (Fennema *et al*., 1996) secured an overall 'high' rating and another, related, study (Franke *et al*., 1998) also came out as high even though the WoE A was initially medium because the reviewers judged that their decision on this aspect was borderline and the reservations relatively minor, given the overall quality of the study.

One of the issues that frequently arose in the moderation process was the tendency to import reservations regarding the quality of the study (WoE A) into the judgement of the review-specific criteria; in some instances, studies rated low in the first category tended to be ascribed low ratings in WoE B and WoE C. In some instances, studies rated low on WoE A were also ascribed low ratings in the second and third categories, when, on closer inspection, this was seen to be unwarranted as the focus and design were appropriate for the review question. As has already been stated, in many instances it is likely that poor quality of reporting rather than of actual execution of the study may account for judgements in WoE A. It was a particular problem for this review that reporting of qualitative research was often lacking in important detail regarding the analysis of the findings. The reviewers consider that inclusion of a study with an overall rating of low in the synthesis is justified because of this issue; the reporting of the study by Ferretti *et al*. (2001) was stronger on the quantitative aspect of the research than it was on the qualitative and this resulted in a rating of medium in the WoE A. This problem impeded the reviewers in making secure judgements in WoE B and WoE C because of the way in which the study was reported. However, some of the insights offered within the study were considered to be of sufficient interest for it to remain in the review and contribute to the overall findings.

4.5 Nature of actual involvement of users in the review and its impact

Users were fully integrated into the Review Group and participated at each stage in the review by offering advice and comments, principally by email as there were fewer meetings given the demands on colleagues' time and the fact that the training had been completed for the first review. The data-extraction of the studies in the review was carried out by two HEI members of the group, one of whom had only recently joined the university from an advisory teacher post in a local LEA, and one practitioner.

5. FINDINGS AND IMPLICATIONS

5.1 Summary of principal findings

5.1.1 Nature of studies selected for in-depth review

The impact of thinking skills on teachers is explored in the work of a number of researchers who have included the dimension of professional development in their investigations of thinking skills interventions. The evidence discussed here is drawn from 13 empirical, classroom-focused studies covering all phases of compulsory education (five primary focused, eight secondary focused) and across a range of curriculum subjects. The synthesis of evidence from the studies does not indicate any significant differences regarding the phase of education. One of the studies (Crump *et al*., 1988) includes an examination of the applicability of an approach used successfully in elementary (primary) schools in a secondary context. The conclusion reached is that, although there are some differences in teacher responses – notably in their attitude to the usefulness of some of the training in enabling them to integrate particular thinking skills into their subject teaching and in the frequency with which they use particular thinking skills – the impact on teachers and students in both phases is comparable and positive. The systematic review was restricted to studies published in English and, of the 13 included, six are from the US, four from the UK, two from Australia and one from Israel. Data on the impact of the thinking skills approaches on teachers were gathered using a range of methods, the most commonly being observations of teacher behaviours and teacher-pupil interactions in lessons through the analysis of transcripts of audio- or videotapes. Impact was measured in terms of those aspects of classroom interaction known to support conceptual understanding in learners such as the quantity and quality of pupil talk, pupil to pupil mediation and types of teacher questions (Newton and Newton, 2000). Teacher self-reporting also featured in the form of diaries or logs, self-rating questionnaires and semi-structured interviews in order to probe teacher responses to the intervention, and the effect on their attitudes and beliefs about teaching and learning. All the studies included used more than one measure of teacher impact as well as data on impact on student achievement so that links could be made between improvements in students' learning and changes in teachers' practice. The studies also had mundane realism (Coolican, 1996) in that they are carried out with teachers working with their usual classes in normal school settings.

5.1.2 Synthesis of findings from studies in in-depth review

The studies report that the ability of teachers to develop a classroom climate in which students' contributions in discussion are encouraged and valued is increased when using a thinking skills approach. The inclusive climate created benefits for pupils with learning difficulties (Ferretti *et al*., 2001) and the gifted and talented (Naisbett, 1997), and can address the needs of both in the same classroom setting. One key factor in the change in classroom dialogue reported in studies is the impact of teaching thinking skills on teachers' questioning. Teachers tend to ask more questions when using a thinking skills approach and a higher proportion of the questions used are open-ended (Wilks and Emery, 1998; Donnelly *et al*., 1999; Koufetta-Menicou and Scaife, 2000; McGregor and Gunter,

2001). Studies frequently report impact on questioning as one of the first tangible changes in practice and one that occurs early in the use of a thinking skills approach. This is an example of how the structure of thinking skills approaches to teaching and learning supports changes in practice; the nature of the activities means that the teacher is not able to predict outcomes as the situation is more ambiguous and so the context changes the kinds of questions that can sensibly be asked. By legitimising higher-order questions in their practice, teachers establish a framework for dialogue in which students are encouraged to probe the underlying reasons, the 'why' behind the answer, to make judgements and justify their conclusions. Asking more open-ended questions was also linked to increasingly focused questions (Ferretti *et al*., 2001), allowing more time for students to think before answering and encouraging them to extend and develop responses. Teachers also facilitated more pupil questioning (Naisbett, 1997). In some instances, changes in patterns of classroom dialogue were accompanied by changes in how the students were grouped with greater use of mixed ability groupings and more consideration being given to the optimum group size for a particular activity (McGregor and Gunter, 2001).

The change in practice reflects the shift in focus for the lessons as the emphasis is on exploring the processes of learning and developing underlying concepts and this requires the teacher to be a facilitator rather than an instructor. The tensions this shift in role can create and the threat to existing competence are also explored in the studies and eloquently expressed by the following teacher who becomes 'stuck' when trying to plan a 'thinking skills' lesson on a topic she has taught many times before:

> Now I am thinking that before each lesson I must think what is my purpose in each question I intend to ask (Zohar, 1999, p 425).

However, the benefits are also clearly articulated by the teachers in a number of studies:

> I've learned a lot just from listening to some of these kids. I'm thinking, WOW, I never figured it out that way (Franke *et al*., 1998, p 78).

> It's exciting to see the 'light bulb' go on (Hojnacki and Grover, 1992, p 8).

Access to the students' thinking and positive feedback on the lessons was powerful in promoting teachers' self-esteem as well as that of the students (Wilks and Emery, 1998; Zohar, 1999). Teachers were able to use the classroom conversations to monitor learning (Ferretti *et al*., 2001). Consequently, they were able to identify the relative abilities of the students in their classes more accurately and this led to some unexpected and surprising results as students demonstrated abilities previously undetected; or, in some cases, students labelled as gifted and talented appeared to be unexceptional (Naisbett, 1997; Wilks and Emery, 1998; McGregor and Gunter, 2001). Other changes mentioned in the studies include the following:

- increased flexibility and adjustments to the long-term planning to accommodate spending more time on building on the students' responses (Hojnacki and Grover, 1992) and to secure better progression (McGregor and Gunter, 2001)

- a refocusing of priorities so that more attention is paid to the underlying concepts and processes rather than factual content and shifts in

assessment practices (Hojnacki and Grover, 1992; Koufetta-Menicou and Scaife, 2000; McGregor and Gunter, 2001).

One common thread running through all the studies is the way in which teaching using a thinking skills approach brings about a shift in the teachers' attention so that they focus on different aspects of the teaching and learning process. They are able to learn more from their students and describe the classroom as a positive environment in which they are able to respond and develop their practice to facilitate greater student responsibility and autonomy (Fennema *et al*., 1996; Zohar, 1999; Ferretti *et al*., 2001). The importance of the teacher being a learner in the context of the classroom is stressed and, in one study, they talk of the teachers developing greater empathy with their students (McGregor and Gunter, 2001). What appears to be particularly powerful is the combination of positive reinforcement for teachers from the enthusiastic response of their students, combined with a degree of cognitive dissonance as their perceptions of the capabilities of their students are subverted.

While there is evidence that teaching using a thinking skills approach is beneficial in promoting teacher inquiry and promoting changes in pedagogy, the process can be demanding and not all teachers benefit to the same degree. A longitudinal set of studies of teachers using an approach called cognitively guided instruction (CGI) to teach mathematics in elementary schools in the US found that not all teachers followed the same trajectory of inquiry and change even though they implemented the CGI approach in their classrooms (Fennema *et al*., 1996; Franke *et al*., 1998). For some teachers, it seemed to be enough to try out the approach and confirm that it worked in their classroom; this did not then lead on to further inquiry about how and why the approach was effective. So that, while CGI with its focus on students' mathematical thinking has the potential to engage teachers in inquiry, the authors suggest that the experiences may not be sufficient as it is the meaning that the teacher constructs that acts as a stimulus for what they term 'self-sustaining generative change' (Franke *et al*., 1998).

The studies highlight the need for support for teachers in extending and deepening their reflections on experience and grounding this in an emergent pedagogy by having access to a wider critical community. The importance of practical tools, such as the use of video- and audio-recording of classroom interactions to enable teacher reflection on their practice, is emphasised (Wilks and Emery, 1998; Franke *et al*., 1998). The use of student learning logs was another method of providing structured feedback on the teaching and learning process that helped teachers to construct new mental models to guide their pedagogy (Naisbett, 1997). The keeping of teacher diaries noting the progress of the intervention is also mentioned as a useful tool for supporting pedagogical inquiry (Crump *et al*., 1988; Taverner, 2001). Highlighted across the studies is the importance of close and sustained collaboration between the teachers and the researchers who have designed the approaches and/or are responsible for the in-service training. Joint-planning of lessons and team-teaching feature in a number of the studies (Crump *et al*., 1988; Donnelly *et al*., 1999; Ferretti *et al*., 2001) as does the need to engage teachers actively in discussion about the impact of the approaches during the project so that they have the opportunity to compare and contrast their experiences with those of their peers (Hojnacki and Grover, 1992; Wilks and Emery, 1998; Zohar, 1999; Taverner, 2001).

Two studies focusing on mathematics – cognitively guided instruction (Fennema *et al*., 1996; Franke *et al*., 1998) and the Thinking Mathematics Project (Hojnacki and Grover, 1992) – have a highly developed understanding of the relationship

between the researchers and the teachers, and argue for the importance of collaboration to promote inquiry in order to create and share knowledge about teaching and learning. The researchers working on the CGI approach in mathematics develop their model of self-sustaining generative change through the promotion of 'practical inquiry', which they define as inquiry conducted by practitioners to help them to understand their contexts, practices and, in the case of teachers, their students (Franke *et al*., 1998). The catalyst is the explicit focus on the analysis of students' thinking and the construction in workshops of opportunities to challenge the notions of both the teachers and the researchers about how that thinking develops. The partnership is described as one of mutual respect for different but complementary areas of expertise: 'We tried to communicate that they had certain unique knowledge and so did we' (Fennema *et al*., 1996). The CGI model enabled the classroom to become a 'learning laboratory' in which knowledge about teaching and learning was dynamic rather than static but which was also firmly grounded in the teaching of mathematics; in fact, the study suggests that this can only happen within a subject discipline and in a classroom setting (Fennema *et al*., 1996).

The Thinking Mathematics Project is a thinking skills approach developed in the US, and was founded on the principle of developing a practitioner-researcher collaboration to develop an instructional approach based on current research findings interpreted by the, 'clinical wisdom of classroom teachers' (Hojnacki and Grover, 1992). The primary objective of the collaboration was to develop more efficient means of disseminating new knowledge about mathematics education and to address the three factors identified as inhibitors of change:

- lack of personal experience of the new approaches to learning mathematics
- insufficient institutional support to take the risks inherent in an experimental approach to pedagogy
- lack of conviction about the validity of the proposed reforms

The study identifies substantive interaction with researchers and evidence of a programme's effectiveness in actual classrooms with actual students as the remedy and is able to report significant impact on pedagogy within one semester and sustained change in approaches to teaching and learning after one year. Again, it is the impact of student feedback on the teachers that proves to be a trigger but it is the support for professional development and collegiality that support more profound change. The indications are that thinking skills approaches facilitate an initial and significant shift in teacher behaviour in the classroom, but may not in themselves lead to a more considered reorientation of a teacher's approach to pedagogy without encouragement to question how and why the new approaches are working.

Finally, a study of a Thinking in Science intervention in Israeli schools (Zohar, 1999) affirms the importance of collaboration, particularly the opportunity for joint planning and review with fellow teachers and with the researchers, while also highlighting the role of professional development workshops in enabling the teachers to move from implementation to analysis of the function of thinking skills in the classroom. The researchers describe the implementation aspect as pedagogical knowledge of thinking skills, as opposed to a more analytical metacognitive declarative knowledge of thinking skills. While this use of pedagogy seems too narrow and much of what is said about metacognitive declarative

knowledge would be adequately covered by definitions of pedagogical content knowledge (Schulman, 1986), the substantive point that teachers require support in moving from using to analysing the impact of thinking skills in the classroom is endorsed.

Studies which have sought to investigate the link between thinking skills and professional development point to the significance of such approaches in stimulating pedagogical inquiry. Caution still needs to be exercised, given the relatively narrow range of studies and the fact that the teachers participating were largely volunteers who already had an interest in teaching thinking. Questions remain about the dynamics and uniqueness of the relationship between thinking skills, pedagogical inquiry and professional development.

There also needs to be caution as a result of uncertainty introduced by limitations in the reporting of most of the studies included in this review. As with the first review, this one has highlighted the need to report studies in a more rigorous and transparent manner so that all the detail necessary to judge the relevance and utility of a piece of research is evident to a range of potential users (including researchers). The fact that most research is reported via education journals, where the genre invites persuasion and argument rather than straightforward reporting, is an issue. We feel that guidelines for journals should specify more clearly the components that should be included (as is the case in journals in other disciplines) and also that studies should be disseminated in a range of formats (as has been recommended by the British Educational Research Association (BERA).

In addition, this review highlighted a tendency for qualitative research to be less rigorous in its reporting, if not in its execution, particularly in terms of providing detail regarding procedures for establishing the reliability and validity of the instruments and the methods of analysis of data. The studies that used a combination of qualitative and quantitative data did not always apply the same rigour to both aspects of the study.

5.2 Strengths and limitations of this systematic review

Strengths

- The review builds on and refines the first review undertaken by this group and so is based on an extensive search of the literature on thinking skills programmes and approaches, and their impact on teaching and learning.
- As with the first review, members of the group have been fully involved in all stages of the process and this has ensured the link between research, the interpretation of that research and the development of practice in schools is maintained.
- The review not only builds on the previous work of the Thinking Skills Review Group but also demonstrates a high level of agreement with the findings of the CPD Review Group and so provides consolidation of evidence of effective practice in CPD.

- The focus of the review is particularly relevant, given the widespread use of thinking skills approaches and programmes in schools, and the position of thinking skills in key government frameworks and strategies in both primary and secondary schools in the UK. Schools are looking for ways to support teachers in developing innovative pedagogy and also to promote their professional development.

Limitations

- The studies included were only those written in English.
- The searches were conducted in 2002 and, unfortunately, it was not possible to do more given the limitations of time and resources.
- There was poor quality of reporting of studies, particularly of qualitative data. Judgements were based on the study as reported and, in some instances, this may have resulted in exclusion of studies that might in fact have rich sources of data – in which case, exclusion is an artefact of the conventions of reporting research in education rather than of the quality of the study itself.

5.3 Implications

5.3.1 Policy

- The evidence from this review suggests that delivery models of implementation will not only reduce the professional involvement of teachers but may also reduce the effectiveness of the interventions in terms of pupil impact.
- Thinking skills interventions appear to have potential to support and encourage teachers to develop pedagogy that enables students to achieve greater understanding, engagement and higher achievement, but it is a process that requires close partnerships and sustained involvement of teachers working together within and across schools, as well as links with critical friends; this has resource implications.

5.3.2 Practice

- Joint planning and peer observation are effective means of supporting innovative pedagogy.
- The impact of teaching thinking on teachers is to provide greater insight into pupils' learning and assists in the meeting of the requirements for assessment for learning as well as promoting higher order thinking.
- Tools designed to assist the research/evaluation process in an intervention can also be useful in improving the range and quality of feedback to pupils.

5.3.3 Research

- The quality of reporting of studies needs to be improved so that judgements can be made more easily regarding the reliability and validity of findings and conclusions. In some cases, the reports of the study do not include sufficient detail regarding the collection and analysis of data, or indicate whether there were any changes in the sample during the life of the project. It may be advisable for education journals to draw up criteria regarding reporting, as is the case in psychology, or encourage authors to indicate more explicitly where such technical information could be found.

- More research in which the rigour of the qualitative research and quantitative research are matched and the sample sizes are greater would enable the findings from these studies to be tested and firmer conclusions to be drawn.

- This review, considered alongside the first review on impact on learners, shows where the gaps in existing research lie and there is a need to provide more comprehensive evidence drawn from a wider range of contexts. For example, there is not an even distribution across the subjects in the curriculum and this should be addressed, given the recommendations to infuse thinking skills into all subject areas. We need to know more about the impact of subject discipline on the ability of teachers to adopt and develop thinking skills approaches in their teaching. Currently, we have some key studies in Mathematics and Science, with only limited coverage of the arts and humanities. We also need to tease out the different factors involved in the professional development of teachers. To what extent is the implementation of thinking skills approaches a necessary or sufficient tool in effecting changes in practice as distinct from the benefits of being involved in research.

6. REFERENCES

6.1 Studies included in the in-depth review

Crump WD, Schlichter CL, Palk BE (1988) Teaching HOTS in the middle and high school: a district-level initiative in developing higher order thinking skills. *Roeper Review* **10:** 205–211.

Donnelly FC, Helion J, Fry F (1999) Modifying teacher behaviors to promote critical thinking in K–12 physical education. *Journal of Teaching in Physical Education* **18:** 199–215.

Fennema E, Carpenter T, Franke ML, Levi L, Empson SB (1996) A longitudinal study of learning to use children's thinking in Mathematics instruction. *Journal for Research in Mathematics Education* **27:** 403–434.

Ferretti RP, MacArthur CD, Okolo CM (2001) Teaching for historical understanding in inclusive classrooms. *Learning Disability Quarterly* **24**: 59–71.

Franke ML, Fennema E, Carpenter T, Ansell E, Behrend J (1998) Understanding teachers' self-sustaining, generative change in the context of professional development. *Teaching and Teacher Education* **14:** 67–80.

Hojnacki SK, Grover BW (1992) Thinking mathematics: what's in it for the students? Paper presented at the Annual Meeting of the American Educational Research Association. San Francisco, CA: April 21.

Koufetta-Menicou C, Scaife JA (2000) Teachers' questions types and significance in science education. *School Science Review* **81:** 79–84.

McGregor D, Gunter B (2001) Changing pedagogy of secondary science teachers: the impact of a two-year professional development programme. *Teacher Development* **5:** 59–74.

Naisbett A (1997) Policy and provision for more able pupils: the Nunthorpe experience. *Support for Learning* **12:** 83–89.

Ritchie SM, Edwards J (1996) Creative thinking instruction for aboriginal children. *Learning and Instruction* **6:** 59–75.

Taverner S (2001) A case study of the professional development of a main scale teacher of mathematics. *Mathematics Education Review* **13:** 1–9.

Wilks S, Emery L (1998) Aesthetics and critical thinking in visual arts education. *Australian Art Education* **21:** 61–70.

Zohar A (1999) Teachers' metacognitive knowledge and the instruction of higher order thinking. *Teaching and Teacher Education* **15:** 413–429.

6.2 Other references used in the text of the report

Adey PS, Shayer M (1994) *Really Raising Standards*. London: Routledge.

Adey PS, Shayer M, Yates C (1995) *Thinking Science: The Curriculum Materials of the CASE Project* London: Thomas Nelson and Sons.

Baumfield VM, Oberski IO (1998) What do teachers think about thinking skills? *Quality Assurance in Education* **6**: 44–51.

Blagg N, Ballinger M, Gardner R (1988) *Somerset Thinking Skills Course Handbook* Oxford: Basil Blackwell.

Bloom BS (Ed.) (1956) *Taxonomy of Educational Objectives, the Classification of Educational Goals – Handbook I: Cognitive Domain*. New York: McKay.

Coolican H (1996) *Introduction to Research Methods and Statistics in Psychology*. London: Hodder and Stoughton.

Cordingley P, Bell M, Rundell B, Evans D (2003) The impact of collaborative CPD on classroom teaching and learning. In: *Research Evidence in Education Library.* London: EPPI-Centre, Social Science Research Unit, Institute of Education.

Csapó B (1992) Improving operational abilities in children. In: Demetriou A, Shayer M, Efklides A (eds) *Neo-Piagetian Theories of Cognitive Development: Implications and Applications For Education.* London: Routledge, pages 144–159.

Dawes L, Mercer N, Wegerif R (2000) *Thinking Together: A Programme of Activities for Developing Thinking Skills at KS2.* Birmingham: Questions Publishing.

De Bono E (1970) *Lateral Thinking.* London: Penguin.

De Bono E (1992) *Teach Your Child to Think.* London: Penguin.

Dweck C (1999) *Self Theories: Their Role in Motivation, Personality and Development.* Hove, Sussex: Psychology Press.

Edwards A, Westgate D (1987) *Investigating Classroom Talk.* London: Falmer Press.

EPPI-Centre (2002) *EPPI-Centre Core Keywording Strategy: Data Collection for a Register of Educational Research. Version 0.9.5.* London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

EPPI-Centre (2003) *Review Guidelines for Extracting Data and Quality Assessing Primary Studies in Educational Research. Version 0.9.7*. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Feuerstein R, Rand Y, Hoffman MB, Miller R (1980) *Instrumental Enrichment: An Intervention Programme for Cognitive Modifiability.* Baltimore: University Park Press

Fisher R (1996) *Stories for Thinking.* Oxford: Nash Pollock.

Fisher R (1998) *Teaching Thinking: Philosophical Enquiry in the Classroom.* London: Cassell.

Galton G, Hargreaves L, Comber C, Pell A (1999) *Inside the Primary Classroom 20 Years On*. London: Routledge.

Garnham A, Oakhill J (1994) *Thinking and Reasoning.* Oxford: Blackwell.

Hamers JHM, Van Luit JEH, Csapo B (eds) (1999) *Teaching and Learning Thinking Skills*. Lisse: Swets and Zeitlinger.

Higgins S (2001) *Thinking Through Primary Teaching.* Cambridge, Chris Kington Publishing.

Higgins S, Baumfield V, Lin M, Moseley D, Butterworth M, Downey G, Gregson M, Oberski I, Rockett M, Thacker D (2004) Thinking skills approaches to effective teaching and learning: what is the evidence for impact on learners? In: *Research Evidence in Education Library.* London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Higgins S, Leat D (1997) Horses for courses or courses for horses: what is effective teacher development? *British Journal of In-Service Education* **23**: 303–314.

Higgins SE, Moseley DV (2001) Teachers' thinking about ICT and learning: beliefs and outcomes *Teacher Development* **5**: 191–210.

Lake M, Needham M (1993) *Top Ten Thinking Tactics.* Birmingham: Questions Publishing Company.

Leat D, Higgins S (2002) The role of powerful pedagogical strategies in curriculum development. *The Curriculum Journal* **13:** 71–85.

Leat D, Lin M (2003) Developing a pedagogy of metacognition and transfer: some signposts for the generation and use of knowledge and the creation of research partnerships. *British Education Research Journal* **29**: 383–415.

Lipman M (1991) *Thinking in Education* (1st edition). Cambridge: Cambridge University Press.

McGuinness C (1999) *From Thinking Skills to Thinking Classrooms: A Review and Evaluation of Approaches for Developing Pupils' Thinking*. Nottingham: DfEE Publications.

McGuinness C, Wylie J, Greer B, Sheehy NAF (1995) Developing children's thinking: a tale of three projects. *Irish Journal of Psychology* **16:** 378–388.

McNamara D (1991) Vernacular pedagogy. *British Journal of Educational Studies* **39**: 297–310.

Mercer N (1995) *The Guided Construction of Knowledge: Talk Amongst Teachers and Learners.* Clevedon: Multilingual Matters.

Moseley D, Baumfield V, Higgins S, Lin M , Miller J, Newton D, Robson S, Elliott J, Gregson M (2004) *Thinking Skill Frameworks for Post-16 Learners: An*

Evaluation. A Research Report for the Learning and Skills Research Centre. Trowbridge: Cromwell Press.

Murris K, Haynes J (2001) *Storywise: Thinking Through Stories.* Dialogue Works: Newport.

Newton D, Newton LD (2000) Do teachers support causal understanding through their discourse when teaching Primary Science? *British Educational Research Journal* **26**: 599–613.

Nickerson R, Perkins D, Smith E (1985) *The Teaching of Thinking*. London: Lawrence Earlbaum Associates.

Nisbet J, Davies P (1990) The curriculum redefined: learning to think - thinking to learn. *Research Papers in Education* **5(1)**: 49–92.

Palincsar A, Brown A (1984) Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction* **1:** 117–175.

Schulman LS (1986) Those who understand: knowledge growth in teaching. *Educational Researcher* **15**: 4–14.

Shavelson RJ, Stern P (1981) Research on teachers' pedagogical thoughts, judgments, decisions and behavior. *Review of Educational Research* **51**: 455–498.

Shayer M, Adey P (2002) *Learning Intelligence.* Buckingham: Open University Press.

Watkins C, Mortimore P (1999) Pedagogy: what do we know? In: Mortimore P (Ed.) *Understanding Pedagogy and its Impact on Learning.* London: Paul Chapman Publishing, pages 1–19.

Webb N, Farivar S (1994) Promoting helping behaviour in cooperative small groups in middle school mathematics. *American Educational Research Journal* **31:** 369–396.

White R, Gunstone R (1992) *Probing Understanding.* London: Falmer Press.

Wood D, Wood H (1996) Vygotsky, tutoring and learning. *Oxford Review of Education* **22:** 5–16.

Appendix 1.1: Advisory Group membership

Jane Brooke	LEA Adviser, Cheshire
Sue Eagle	Primary School Headteacher, Norfolk,
Dr Carol McGuinness	Professor of Educational Psychology Queen's University, Belfast
Dr Iddo Oberski	Lecturer in Education, Stirling University
Dr Carolyn Tan	Senior Lecturer in Early Years Education, NIE, Nanyang Technological University (NTU), Singapore
David Thacker	Secondary Headteacher (retired)
Dr William Wu	Co-Director of the Thinking Qualities Initiative at the Centre for Educational Development, Hong Kong Baptist University

Appendix 2.1: Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
We will include studies which:	*We will exclude studies which:*
1. Are set in a school or schools and are concerned with any section of the school population (including pupils with special needs)	1. Are not set in a school or schools
2. Evaluate the impact of the implementation of thinking skills interventions on teaching and/or learning ***Thinking skills interventions are defined as approaches or programmes which require learners to articulate and evaluate learning strategies and/or which identify specific thinking processes that are amenable to instruction in order to improve teaching and/or learning.*** These interventions may be taught as separate programmes or infused into curriculum teaching. Impact includes, for example, pupil and/or teacher motivation and engagement, and/or patterns of classroom interaction, and/or self-regulation and/or metacognitive monitoring and/or pupil attainment.	2. Do not evaluate the impact of the implementation of thinking skills interventions on teaching and/or learning Do not evaluate programmes or approaches which require the learners to articulate and evaluate the learning strategies that they are using and/or which do not identify specific thinking processes that are amenable to instruction in order to improve teaching and/or learning Describe pupils' thinking or learning without any evaluation of a thinking skills intervention, strategy or approach Do not evaluate the impact of thinking skills programmes and/or approaches
3. Are concerned with the phases of compulsory schooling (5–16)	3. Are about pre-school, further and higher education, sixth form (A-level or equivalent)
4. Contain empirical classroom research with data or evidence (pupil outcomes, classroom processes, teacher role)	4. Are editorials, book reviews, policy documents, resources, guides, manuals, bibliographies, theoretical papers, philosophical papers, unevaluated interventions
5. Are written in English, as it is beyond the funding of the review to translate papers in other languages	5. Are not written in English

Inclusion / exclusion criteria for the in-depth review

6. Studies should contain data on impact on pupils.

7. Studies must contain quantitative or qualitative data of the impact of thinking skills approaches on teachers.

8. The studies will need to include sufficient detail regarding the role and training of the teachers involved to enable conclusions to be drawn that are relevant to practitioners.

Appendix 2.2: Search strategy for electronic databases

The last date on which searches were run was 27 May 2002 and the cut-off date for retrieval was 16 September 2002.

Via BIDS

- British Education Index (from 1986)
- ERIC (Educational Resources Information Center) (from 1985)
- IBSS (International Bibliography of the Social Sciences) (from 1980)
- Ingenta Journals (full text of a large number of journals)
- PsycINFO (extensive catalogue of psychology related publications)

Via Web of Science

- Social Sciences Citation Index (SSCI) (from 1981)

Via FirstSearch

Article1st	Articles and tables of contents of journals in all subjects
Dissertations	Dissertation Abstracts, theses in all subjects
ECO	(Electronic Collections Online)
EducationAbs	Education Abstracts
PapersFirst	Conference papers in all subjects
Proceedings	Conference proceedings in all subjects
SIRS Researcher	Social Sciences
SocialSciAbs	Social sciences
WorldCat	Books and other materials on all subjects

Education-line	Conference papers and studies

Key search terms applied to each database were as follows:

- thinking, thinking skills, thinking skills program(me), thinking strategies
- critical thinking, critical thinking skills
- creative thinking skills
- higher order thinking skills (HOTS)
- metacognition, metacognitive, meta-cognitive/ition
- community of inquiry/enquiry/learners
- transfer, near-transfer, far-transfer, bridging, teaching for transfer
- reasoning, argument
- Socratic questioning
- mediated learning

The names of specific thinking skills programmes and approaches and their authors were also applied:

- Instrumental Enrichment / Feuerstein
- Somerset Thinking Skills / Blagg
- Top Ten Thinking Tactics / Lake
- Cognitive Acceleration in Science/Maths/Technology Education (CASE/CAME/CATE) Adey, Shayer, Adhami
- Philosophy for/with Children (P4C) / Lipman
- Thinking Actively in a Social Context (TASC) / Wallace
- Activating Children's Thinking Skills (ACTS) / McGuinness

CoRT (Cognitive Research Trust), Six Thinking Hats / de Bono
Storywise, Philosophy with Picture Books / Murris
Reason!Able / van Gelder

Appendix 2.3: EPPI-Centre keyword sheet, including review-specific keywords

V0.9.7 *Bibliographic details and/or unique identifier*

A1. Identification of report
Citation
Contact
Handsearch
Unknown
Electronic database
(Please specify.) .....

A2. Status
Published
In press
Unpublished

A3. Linked reports
Is this report linked to one or more other reports in such a way that they also report the same study?

Not linked
Linked (Please provide bibliographical details and/or unique identifier.)
.....
.....
.....
.....

A4. Language (Please specify.)
.....

A5. In which country/countries was the study carried out? (Please specify.)
.....
.....
.....

A6. What is/are the topic focus/foci of the study?
Assessment
Classroom management
Curriculum*
Equal opportunities
Methodology
Organisation and management
Policy
Teacher careers
Teaching and learning
Other (Please specify.).....

A7. Curriculum
Art
Business studies
Citizenship
Cross-curricular
Design and technology
Environment
General
Geography
Hidden
History
ICT
Literacy – first language
Literacy further languages
Literature
Maths
Music
PSE
Physical education
Religious education
Science
Vocational
Other (Please specify.).....

A8. Programme name (Please specify.)
.....

A9. What is/are the population focus/foci of the study?
Learners
Senior management
Teaching staff
Non-teaching staff
Other education practitioners
Government
Local education authority officers
Parents
Governors
Other (Please specify.).....

A10. Age of learners (years)
0–4
5–10
11–16
17–20
21 and over

A11. Sex of learners
Female only
Male only
Mixed sex

A12. What is/are the educational setting(s) of the study?
Community centre
Correctional institution
Government department
Higher education institution
Home
Independent school
Local education authority
Nursery school
Post-compulsory education institution
Primary school
Pupil referral unit
Residential school
Secondary school
Special needs school
Workplace
Other educational setting (Please specify.).....

A13. Which type(s) of study does this report describe?
A. Description
B. Exploration of relationships
C. Evaluation
   a. naturally-occurring
   b. researcher-manipulated
D. Development of methodology
E. Review
   a. Systematic review
   b. Other review

REVIEW-SPECIFIC KEYWORDS

11. Pupil ages ***How old were the pupils?*** 5-6 11-12 6-7 12-13 7-8 13-14 8-9 14-15 9-10 15-16 10-11 **12. Teaching grouping** ***How were the pupils grouped for teaching?*** *Usual class* *Set / Banded* *Mixed attainment/ability* *Not specified* *Special group* 13. Teaching group size ***(NB: This might not be the same as Q15.)*** *Less than 15* *16-25* *26+* *Not recorded* **14. Teacher** ***Who was the teacher?*** Usual teacher Specialist/Expert Researcher as teacher (HEI staff) Teacher as researcher (school staff) (Please specify.) _____ **15. The research sample** How many schools were involved? _____ How many classes? _____ How many teachers involved? _____ How many pupils? ___.*(Intervention/Control)*	**16. Does the study sample focus on a particular group of learners?** All Special group Gifted and Talented EAL Low attainers Other (Please specify.) _____ **17. Thinking skills terms** *Mark up to 3 categories for the main focus.* Argumentation Community of enquiry/learners Co-operative learning Creative Thinking Critical thinking Decision making Discussion Enquiry based learning Higher order thinking Logical thinking Mediation/mediated learning Metacognition Problem solving Reflection Scaffolding Self-regulation Socratic questioning Systems thinking Transfer **Others (Please specify.)** _____ **18. Thinking skills approach** Infused Enrichment	**19. Type of data** *(Mark all that apply.)* Quantitative Qualitative Interactions Non-verbal behaviours Classroom talk/discourse Pupil attainment Pupil attitude/beliefs/dispositions Teacher attitude/beliefs/dispositions Other (Please specify.)_____ **20. Length of intervention** *(teaching time)* _____ lessons/hours (Delete as applicable.) Not recorded **21. Duration of intervention** *(from first lesson to last)* _____ weeks/months (Delete as applicable.) Not recorded **22. Method of data-collection** (Mark all that apply.) Observation Video Audio recording Test *(standardised, criterion referenced, SAT, GCSE, etc*) Questionnaire/Survey/Rating scale Interview Document analysis Other (Please specify.)_____	**Notes** v 0.1.1

Appendix 4.1: Details of studies included in the in-depth review

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Crump *et al.* (1988) USA	Researcher-manipulated prospective evaluation	To describe a school district initiative in addressing thinking skills instruction at the secondary level through inservice education To compare middle and high school teachers' responses to the thinking skills programme To evaluate the impact of the programme on pupils' higher order thinking skills	**Sample** All middle and high school teachers of key subjects in middle and high schools in one School District (87 in total); 42 middle school students and 60 high school students **Intervention** Higher order thinking skills (HOTS) programme 'Talents Unlimited' **Measurement** Teacher ratings of inservice provision, their readiness to teach using the programme and the frequency of use of items in the programme Pupils' pre- and post-intervention scores on a published test criterion reference test of talents (CRT)	All teachers of major academic disciplines in middle and high schools in a school district received training in the Talents Unlimited programme. The teachers made self-assessments of their understanding pre- and post-implementation of the programme and also of how useful they found the INSET workshops. Post intervention self-assessment by teachers explored the ease with which they had been able to implement the programme and the frequency of use of the different aspects composing the programme. The teacher self-ratings were scored and analysed statistically. Pre- and post-intervention tests were administered to two randomly selected pupil groups to assess the impact on their higher order thinking skills.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Donnelly *et al.* (1999) USA	Researcher-manipulated prospective evaluation	To examine the teaching behaviours exemplified by four PE teachers before and after an intervention designed to enable them to use a critical thinking in PE (CT-PE) approach in their teaching.	**Sample** Four volunteer PE teachers: two from the primary phase, one from a middle school and one from a high school **Intervention** McBride's schema for Critical Thinking in PE **Measurement** Quantity and type of instructional behaviours deployed pre- and post-intervention	In three phases over 3 x 15-week semesters. In phase 1 (pre-training in intervention), videotapes made of teachers' PE lessons. In phase 2, there were workshops and team teaching sessions using the intervention. In phase 3, teachers were again videotaped and their behaviours analysed for comparison with phase 1. The coding of the teacher behaviours in phases 1 and 3 was according to McBride's schema and results analysed statistically. Verbal statements from the teachers were also examined. Inductive analysis of coded teacher behaviours and accompanying verbal statements generated categories to represent the teaching behaviours which promoted CT-PE: Replication and modification Questions Facilitating movement products The distribution across the categories was then plotted for each of the four teachers.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Fennema *et al.* (1996) USA	Exploration of relationships	To understand the relationship between teacher participation in the cognitively guided instruction intervention (and its parallel professional development programme) and the development of a capacity for self-sustained generative change; the link between a pedagogy designed to stimulate pupil inquiry and teachers' own capacity for professional inquiry	**Sample** 21 first, second and third grade teachers **Intervention** cognitively guided instruction (CGI) in the context of primary mathematics **Measurement** Changes in teachers' beliefs about teaching and learning; changes in their knowledge about pupils' mathematical thinking and changes in teaching practice	Interviews and observations were carried out at the start of the project. During the project, teachers were given professional development support in the use of the approach and were interviewed at the end of each year and also within two days of an observation. Observations were carried out over two days at five different points in time. All the data were analysed using a coding scheme elaborating teacher change within cognitively guided instruction (CGI). Grounded theory was used to generate codes and the emerging categories discussed with participants. Data were analysed and reanalysed throughout the project.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Ferretti *et al.* (2001) USA	Naturally occurring prospective evaluation	Reporting on the degree to which the implementation of strategy-supported project-based learning (SSPBL) promoted improvements in students' knowledge of the history of US Westward expansion, understanding of historical content and historical inquiry and their self-efficacy of learners Interested in evaluating whether the approach was inclusive of pupils with 'mild disabilities' in mainstream classrooms	**Sample** Four fifth-grade classes in two schools, which employed an inclusive approach called Team Approach to Mastery (TAM) but later three classes as it was decided that staffing issues in one class meant that it was no longer a naturally occurring evaluation. Number of teachers providing data is not specified. **Intervention** Strategy-supported project-based learning (SSPBL) integrated into a history topic studied in the fifth grade **Measurement** Pre- and post-intervention tests of pupil knowledge, understanding of historical inquiry and attitudes; triangulated with pupil interview and classroom observations	Pre- and post-testing of pupils and comparison between those with mild disabilities and their peers in each classroom Pre- and post-tests and attitude scale were analysed statistically and comparisons made between pupils with and without mild disabilities. Pupil interviews were analysed using a scoring guide agreed between the researchers. The tests were supplemented with interviews and weekly observations, and meetings with the class teachers. The observations and field notes were analysed to explore two key themes: (i) challenges encountered by the teachers and pupils, and (ii) the opportunities provided.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Franke *et al.* (1998) USA	Exploration of relationships	To understand the relationship between teacher participation in the cognitively guided instruction (CGI) intervention (and its parallel professional development programme) and the development of a capacity for self-sustained generative change; the link between a pedagogy designed to stimulate pupil inquiry and teachers' own capacity for professional inquiry	**Sample** Three teachers were selected from the study reported in Fennema *et al*., because they represented particular points on a developmental trajectory. **Intervention** Cognitively guided instruction (CGI) in the context of primary mathematics **Measurement** Changes in teachers' beliefs about teaching and learning; changes in their knowledge about pupils' mathematical thinking and changes in teaching practice. Interviews and observations were used at key points throughout the four-year project.	Interviews and observations were carried out at the start of the project. During the project, teachers were given professional development support in the use of the approach and were interviewed at the end of each year and also within two days of an observation. The interviews were of two types to explore general beliefs and reflections post observation. All the data were analysed using a coding scheme elaborating teacher change within CGI. Grounded theory was used to generate codes and the emerging categories discussed with participants. Data were analysed and reanalysed throughout the project.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Hojnacki *et al.* (1992) USA	Researcher-manipulated prospective evaluation	To evaluate an approach to disseminating new knowledge about mathematics instruction and learning using a thinking maths (TM) intervention, and intensive teacher and researcher collaboration	**Sample** 64 teachers participated in the pilot of thinking maths (TM). Participation was voluntary and there were 65 classes represented (grade 5 but also one grade 7/8). **Intervention** TM programme and a model of intensive researcher and teacher collaboration for the development and dissemination of the programme **Measurement** Qualitative data on teacher changes in instructional practice, views on being teachers, and student outcome and quantitative data on pupils' attitude, problem-solving abilities and relationships between receiving TM and standardised assessment scores	Described and evaluated preliminary findings of a one-year piloting of a TM programme with 65 classes from six cities participating on a voluntary basis. The study was a practitioner research collaboration. Both qualitative and quantitative data were collected from teachers and pupils. There is little detail of analysis methods. Self-report, survey and discussions were used to provide insights into teachers' perceptions of changes in their instructional practice. Pupils completed tests designed to measure their attitudes to mathematics and their attainment. Further comparisons were made between TM and non-TM classes in terms of attainment in standardised tests; there was no comparison between TM and non-TM teachers.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Koufetta-Menicou and Scaife (2000) UK	Exploration of relationships	To ascertain the types of questions asked by teachers in science lessons and to determine how each type relates to particular teaching approaches and to students' learning; to compare questioning in lessons where the thinking skills approach CASE is used and normal science lessons	**Sample** Science teachers in two schools involved in the CASE project. Number of teachers providing data is not specified. **Intervention** Cognitive acceleration through science education (CASE) **Measurement** Classroom observations were encoded into a format for analysis using SPSS. The statistical analysis included comparisons between CASE and non-CASE science lessons regarding types of questions asked by teachers and their importance for teaching and learning	The two schools were already using CASE in science lessons. The study focused on comparing CASE lessons with science lessons when the CASE programme was not being used. The same teachers were observed twice teaching the same classes – once when implementing the CASE programme and once when teaching a 'normal' (non-CASE) lesson. 19 CASE and 19 regular lessons were observed. Questions were coded using coding frame and learners' responses generated by verbal responses and written responses in the lesson. Statistical analysis used to calculate correlations between the two.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
McGregor *et al.* (2001) UK	Exploration of relationships	Exploration of teacher perspectives on how aspects of their pedagogy had changed through training to support the implementation of the CASE programme in their schools	**Sample** 22 CASE co-ordinators from the full cohort of 11 secondary schools enrolled onto a CASE training programme and a subset from four of the schools selected randomly were interviewed a year later. Number of teachers providing data is not specified. **Intervention** CASE training programme **Measurement** Teacher perceptions of changes in their practice as a result of the inservice training in CASE	The participants were the first cohort to participate in an inservice training course on using CASE. Questionnaires were administered and were formulated to encourage careful reflection on the nature and extent of pedagogical changes. Later a random sample from four of the participating schools was interviewed. Methods of analysis are not reported in detail, although themes relating to the sustaining of any changes and transfer of practice are explored.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Naisbett (1997) UK	Researcher-manipulated prospective evaluation	To develop pupils' questioning and thinking skills within a mixed ability Y10 group and also promote speaking and listening skills by infusing thinking skills into a unit of work in the English curriculum; also, to explore whether practice can be shared with other teachers.	**Sample** Action research by one teacher with her Y10 English class **Intervention** Pupils were encouraged to generate their own questions; longer waiting time was given between questions and answers, and learning journals were kept by pupils throughout a unit of work on the play 'Romeo and Juliet'. **Measurement** Number of pupil questions and level of participation in lessons; attainment in assessments of knowledge and understanding of the unit of work	Practitioner action research developing a thinking skills approach to a unit of work and analysing impact through evaluating responses and also analysing pupil learning logs completed for the duration of the research. Written work was also set and assessed and attainment measured through usual methods of assessing pupil work in that unit. Methods used were shared with colleagues and their feedback on the implementation in their own classrooms gathered. Methods of analysis are not reported in detail.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Ritchie *et al.* (1996) Australia	Researcher-manipulated prospective evaluation	To find out if the teaching of general thinking skills using de Bono's Cognitive Research Trust (CoRT) programme promotes creative thinking and improves the academic performance and internal locus of control of urban Aboriginal children	**Sample** Y7 classes in five schools in which 40 aboriginal students were selected (22 experimental and 18 control classes). Number of teachers providing data is not specified. **Intervention** The delivery of 20 weekly 45-minute CoRT lessons by teachers who were individually trained in two one-hour meetings. The entire introductory CoRT 1 was taught plus five lessons from CoRT 4 (creativity) and five from CoRT 6 (action). **Measurement** Qualitative and quantitative data through lesson observations (to check on the fidelity of CoRT teaching); cognitive ability and creative thinking test results; student questionnaire data; teacher ratings of school achievement; post-intervention interview data were collected from the teacher and student subsample.	Quasi-experimental design, in which the progress of Aboriginal children in three Y7 experimental classes who received 20 lessons from de Bono's CoRT programme was compared with progress made by similar number in three non-intervention control classes. A repeated measures design was used, with pre-testing, mid-point testing and post-testing. There were both pupil and teacher control groups. The post-intervention interviews with the teachers were used to cross-check the student responses. The interviews also highlighted issues regarding the implementation of the programme. Methods of analysis are not reported in detail.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Taverner (2001) UK	Researcher-manipulated retrospective evaluation	To provide an overview of the professional development of a former ITE student through involvement in a research project monitoring the impact of thinking skills on beliefs and practice	**Sample** Case study of one secondary school mathematics teacher **Intervention** The teacher kept a diary during a collaborative research project on the implementation of thinking skills in Mathematics (CAME) **Measurement** Pattern of responses as recorded in the diary over a period of time	Case study of an individual teacher using the entries recorded in his teacher diary that was kept as a research tool during the project. The entries are analysed to detect patterns and any change over time, and this is put into the wider context of professional learning. Methods of analysis are not reported in detail.
Wilks *et al.* (1997) Australia	Naturally occurring prospective evaluation	To ascertain the extent to which training in using philosophical inquiry impacts on teachers' classroom practice	**Sample** Three Art teachers working with Y9 pupils **Intervention** Teachers were using an approach based on Lipman's community of inquiry approach in the Philosophy for Children programme. The content of the training workshops for teachers is not specified **Measurement** Teacher talk and teacher-pupil interactions in classrooms during Art lessons; looking for evidence in an increase in behaviours likely to foster higher order thinking	The researcher became an 'indweller' in six Art teachers' classrooms to get a pre-intervention view of the patterns of interaction. Three of these teachers agreed to be observed on a regular basis during the intervention phase and the lessons were audiotaped. The teachers were interviewed after the first observation and again after the training workshop. Transcripts of lessons were analysed using an adaptation of Flanders Interaction Analysis Categories.

Author, date and country	Study type	Aim	What was studied?	How was it studied?
Zohar (1999) Israel	Naturally occurring prospective evaluation	To investigate teachers' declarative metacognitive knowledge of higher order thinking skills in the context of a project designed to foster higher order thinking in junior high school science classes	**Sample** Teachers attending an inservice course on developing pupils' thinking skills through science. The exact details of the sample, including number of teachers and from how many cycles of the course they were drawn is not stated or unclear. **Intervention** The classroom programme is Thinking in Science (TSC) and the workshops for teachers provide basic instruction in the principles of the programme and learning theory along with a series of creative workshops. Lessons and reflective workshops are planned and activities devised by the teachers. **Measurement** Evidence of teachers engaging in metacognition and being able to make metacognitive processes explicit from audiotapes and written reports from teachers and instructors	Qualitative study using a grounded theory approach conducted during inservice courses preparing teachers to implement the TSC learning activities. Workshop sessions were audiotaped and notes were taken by course leaders to record what they regarded as significant events analysed. Methods of analysis are not reported in detail. Teachers' written work for the course was also analysed as were their written reflections. Two cycles of training were included in the study and this enabled the effect of adjustments made in the training to be evaluated as well.

Appendix 4.2: Results and findings of studies in the in-depth review

Item	What are the results of the study as reported by authors?	What do the author(s) conclude about the findings of the study?
Crump *et al*. (1988)	(1) Teachers appear to understand the purpose of the intervention but experience greater difficulty in translating the model to classroom practice than they anticipated from the initial workshop. (2) Both groups (middle and high school teachers) were similar in gaining increased understanding of the skills of a talent but high school teachers apparently encounter greater difficulty in integrating the talents within the disciplines they teach. (3) There were significant differences between the ratings of middle school and high school teachers on implementation strategies; middle school teachers again rated more highly their preparation to introduce students to the thinking skills model and their understanding and skill in developing specific thinking skills lessons. (4) There were significant differences in favour of middle school teachers on the ratings of frequency of teaching all thinking skills clusters except the communication skill. Data from logs on actual number of thinking skills activities taught:for both middle and high school teachers, productive thinking lessons were taught most frequently, and planning and forecasting were taught least frequently. On average, middle school teachers reported teaching slightly more thinking skills lessons overall than high school teachers. (5) For both groups (middle and high school) integrating higher order thinking skills into the curriculum was successful and had an impact on student performance.	'Generally, the workshop ratings by teachers in this study suggest that the Talents Unlimited staff development component is effective in enhancing the understandings, skills, and attitudes related to implementing this thinking skills model for secondary teachers.' 'Data from student performance on the CRT showed statistically significant increases on 11 of the 14 comparisons of pretest and posttest scores for the middle school and high school samples. These results provide substantial evidence for the impact of the teacher inservice education program on improving higher order thinking skills among middle school and high school students.'
Donnelly *et al*. (1999)	Overall the results of this study substantiate Ennis' assertion that teachers need inservice training to promote thinking in PE. Also findings confirm what other studies have shown about teachers of subjects, such as Science.	The study supports the value of using McBride's schema of CT-PE as a foundation for developing a pedagogy for critical thinking. Inservice training is vital for providing teachers with the skills to modify teaching behaviours.

Item	What are the results of the study as reported by authors?	What do the author(s) conclude about the findings of the study?
Fennema *et al*. (1996)	17 of the 21 teachers came to believe more strongly that children could solve problems without being shown procedures for solving them and that solving many carefully selected problems enabled children to learn mathematics. This belief changed their perception of their role as teachers. They came to believe that their role was not to tell children how to think, but to provide an environment in which children's knowledge could develop as the children engaged in problem-solving experiences and reported on solution strategies. The teachers perceived their role to be active: leading children to more mature problem-solving by providing appropriate problems and by sensitively questioning children as they discussed their problem solutions. Sometimes a teacher's beliefs changed before her instruction and at other times instruction changed first; it is not clear why some teachers changed more than others. The problem-solving and understanding of concepts of learners increased and was directly related to changes in teachers' instruction and the shift to understanding rather than drilling in skills did not have an adverse effect on computational skills.	Research-based model (CGI) served as a catalyst between teachers' intuitive knowledge and principled knowledge of their own students' thinking, which the teachers developed as they taught. The initial learning of the model permitted the class to become a 'learning laboratory'. In the minds of the teachers, the research-based model became a useful, dynamic, principled body of knowledge that helped them understand their students' thinking. This study provides evidence that knowledge of children's thinking is a powerful tool that enables teachers to transform this knowledge and use it to change instruction. This knowledge is not static and acquired outside classrooms in workshops but dynamic and ever growing and can probably only be acquired in the context of teaching Mathematics. Confirms the need identified by Simon (1995) for teachers to create psychological models as a basis for pedagogical decisions and, while he did not see research-based models as essential for this, the study has shown how in practice a robust model can impact on teachers.
Ferretti *et al*. (2001)	Teachers adapted the pace of discussions and used more focused questions and examples from pupils' daily lives. Immediacy and responsiveness of the classroom discussions seemed important in promoting the learning of all students. Teachers had successfully created a classroom climate in which all students feel safe to participate and in which they believed their contributions were valued.	We observed a number of instructional challenges, a variety of teaching practices that were implemented by the teachers, and some genuine instructional opportunities that were afforded by the implementation of a SSPBL unit.

Item	What are the results of the study as reported by authors?	What do the author(s) conclude about the findings of the study?
Franke *et al*. (1998)	Three teachers had access to similar opportunities for learning, engaged in the same workshop sessions and interacted with project staff, students and colleagues. However, they engaged in different levels of practical inquiry and as a consequence, we see different patterns of change. Teachers need more support in using their emerging knowledge to engage in inquiry more actively – moving beyond verifying impact to questioning how and why the changes are happening. More challenge needs to be built into the process to maximise impact on teachers' professional development. Viewing the classroom as a place for continued teacher learning, and focused inquiry as a way to learn within that environment pushes our conceptions of professional development. The critical questions become how can professional development foster this learning process; and how do different teachers, involved in different professional development opportunities, accomplish self-sustaining, generative change?	They conclude that more investigation is needed into why different teachers are more or less prepared to engage in inquiry at a deep level by problematising and challenging rather than trying and concluding it works. There is a need to focus more and be more explicit regarding the active engagement of teachers in making sense of students' responses, including challenging and problematising the intervention. The implication is that some teachers will acquiesce in seeing that the CGI approach has benefits without pushing it further. The involvement of researchers in the process facilitates critical engagement.
Hojnacki, and Grover (1992)	Teachers' self-report data showed that teachers experienced change that they considered to be empowering, and also perceived changes in the empowerment of their students.	Although the findings reported were preliminary, there were multiple indications that student learning and attitudes were enhanced by their participation in the Thinking Mathematics programme. The collaborative model developed by the Thinking Mathematics project appeared to be beneficial for both teachers and students.

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Koufetta-Menicou and Scaife (2000)	The research revealed that, in CASE lessons, more time was spent in whole-class discussions (in comparison with regular science lessons). This corresponds to a greater total number of questions asked. However those extra questions were not equally distributed across all nine categories and were concentrated on the second category (identification/description). It is also obvious from both types of lessons that questions which require higher mental operations appear in very low frequencies. Correlation of question types/teaching approaches/learning outcomes calculated to 5% significance level showed the following: In CASE lessons, 'how' questions were linked to students' use of metacognitive skills. in CASE lessons, questions seeking for evidence were connected to teachers' guidance towards the appropriate resolutions of cognitive conflicts. Teachers appeared to transfer and use CASE elements (terminology and reasoning patterns) in regular science lessons In CASE lessons, the questions which require lower order mental operations were not positively connected to any kind of desired learning outcome. Teachers who legitimise higher-order questions through their practice tend to establish a communication framework in which students are inclined to think not only how (procedure) but also the underlying reasons, and this is an important step towards metacognition. Stressing the importance of explanations in science means teachers are likely to be aware of the value of evidence in constructing scientific arguments - when students are required to justify their judgements, teachers are likely to have success in promoting conceptual change.	Some kinds of questions make very little contribution to the quality of teaching. It is the type of question that matters and not simply their quantity. With practice, teachers can come to predict the broad nature of students' responses and they can then establish a balance between questions of different degrees of complexity. The teaching of questioning techniques should be an important part of teachers' in-service and pre-service training. Assessment should reflect the kind of thinking teachers' are trying to promote in lessons. Recalling is not productive in terms of developing higher-order thinking.

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McGregor and Gunter (2001)	This study suggests that INSET supporting the implementation of CASE can affect individual professional development of those involved in the training programme. It appears to enrich their views of learning and resultant pedagogical practice (along the lines predicted from experience of other CASE training incidents). There is some evidence of the transfer of effective practice to non-CASE lessons. Change was gradual over the two-year programme.with more impact on personal development (described as impact on teaching generally) than anticipated. Teachers employed more mediation techniques and opportunities for the development of understanding by encouraging more dialogue between peers, and between teacher and students going beyond CASE to develop pedagogy consistent with Vygotskian principles. Increased empathy with students is reported by some teachers and shift in emphasis from assessing outcomes to processes. Many departments had developed peer observation strategies to share practice between teachers. (pp 71–72)	When teachers recognise the generalisable, applicable benefits of aspects of the CASE approach, they are more likely to appropriate them as part of their teaching 'toolkit'. The teacher enculturates these 'new tools' into their normal practice. The explicit discussion of processes and practices in the classroom which was part of the INSET course was instrumental in this process by enabling teachers to overtly recognise, in themselves and others, that they employ certain practices that can be explained by educational theory, complemented by the consideration of why they do what they do effectively, with more expert others appears to be an influential method to employ within professional development programmes.
Naisbett (1997)	The study detects a gradual shift away from simple questions and simple answers to more complex questions and answers, showing evidence of real thought. The collaborative approach to learning employed was enhancing the quality of the notes the students were producing and also the quality of assignments they produced. The students' inferential comprehension skills were enhanced and there was a general feeling that the students were gradually beginning to take responsibility for their own learning and to some extent the learning of others. Dissemination to colleagues was successful. Staff reported that they felt they had acquired strategies which allowed them to challenge their more able learners and these often yielded unexpected and surprising results: for example, students previously not identified as able learners responding at higher levels.	Feedback from the colleagues who had tried some of the successful strategies was extremely encouraging and indicated that basic approaches – such as exploiting the use of questioning, classroom management techniques and the systematic teaching of thinking and study skills – can be used to enhance learning experience and raise the attainment of all pupils as well as extending the more able. Feedback from colleagues reinforces the point that good provision for these pupils does not necessarily entail the purchase of costly material which may date quickly and are frequently rejected by the pupils. Much can be achieved through the careful selection, introduction and extension of specific skills that foster active and independent learning.

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Ritchie and Edwards (1996)	Implementation integrity was satisfactory, although there were some problems in achieving effective group work. The teachers' familiarity and acceptance of the CoRT approach was found wanting in two respects: (i) they felt uneasy about using CoRT skill acronyms and (ii) they did not always demonstrate enthusiasm and confidence. However, students experienced a high level of success in the lessons. The CoRT lessons did not significantly affect cognitive ability, teacher-rated school achievement, self-reported use of CoRT thinking approaches, self-concept as a thinker or internal locus of control as measured by the tests used in the study.	Creative thinking can be taught with CoRT and the decision to capitalise on a perceived area of relative strength in Aboriginal children was supported. However, success in CoRT lessons is not enough to produce more generalised gains. The study suggests that the CoRT approach is not immune to teacher effects and successful implementation may require commitment to the CoRT materials and goals.
Taverner (2001)	Involvement in the research and the keeping of the diary logging critical incidents and feedback from pupils during the thinking skills intervention were important and significant factors in the teacher's professional development but that this was an uneven process.	The use of the diary enabled the teacher to engage critically with the intervention and reflect on its impact, and thereby sustained involvement in the project. The professional development experienced by the case study teacher is seen as having more potential and impact than some current models of INSET.
Wilks and Emery (1998)	There was a marked difference in student-initiated discussion in post-training classroom discussion and there was a shift in the nature of teacher talk within the lessons. Interviews showed that teacher felt that the approach was beneficial to specific students related to the open-ended discussion approach.	The philosophical inquiry approach is effective at improving classroom discussion in the visual arts classroom and enhances the quality of thinking in visual arts discussions.

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Zohar (1999)	Prior to the course, teachers felt that they had no familiarity with metacognitive declarative knowledge of thinking skills but awareness had grown as a result of the workshops and they were more confident as a result. Initially, teachers had difficulty with metacognitive declarative knowledge of thinking skills, although they had been seen using thinking skills successfully on previous occasions. There was a tendency for teachers to plan tasks that bore a surface similarity to Thinking in Science (TSC) materials but which were 'lean in terms of higher order thinking'. This highlights the difficulty of the conscious application and articulation of declarative knowledge of thinking skills. There was some improvement in second year when trainers drew attention to the elements more explicitly in their instruction. There is a discrepancy between teachers' procedural knowledge and their metacognitive declarative knowledge of thinking skills; what they can do requires the former and what they cannot do the latter. The findings also raise a serious question regarding the type of knowledge that is required for instruction. The course supporting TSC did have a positive impact on practice with 42.3% of thinking lessons taught by teachers who participated in the TSC course included at least some discussions with students aimed at metacognition of thinking skills.	The major finding from this study is that teachers' intuitive declarative metacognitive knowledge of thinking skills was found to be unsatisfactory for the purpose of teaching higher-order thinking in science classrooms. A general practical implication from this finding is that courses which prepare teachers for instruction of higher-order thinking should address extensively the issue of declarative metacognitive knowledge of thinking skills. Creative workshops which require teachers explicitly to plan lessons requiring the active use of knowledge of thinking skills can help the transition from procedural to declarative knowledge of thinking skills. The study's findings reverse the usual understanding that declarative knowledge precedes procedural and may provide insight into the process of learning to teach.