Research for Teachers

Improving learning through cognitive intervention

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For this TLA research summary we selected, appraised and summarised a research and development study which has given teachers real insights into raising standards through teaching thinking skills. The study summarised here is widely known as 'CASE' (Cognitive Acceleration through Science Education).
The questions have been devised to bring out those aspects of the study we think are most useful to teachers. We have also included examples from other studies to illustrate the key characteristics of this work.
Adey, Philip and Michael Shayer. *Really Raising Standards: Cognitive Intervention and Academic Achievement*. London: Routledge, 1994.

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Overview

Why is the issue important?
With the current concern to raise standards, there is a growing interest in thinking skills approaches. It is important that teachers are aware of how thinking skills interventions enable children to develop to higher ability levels and transfer their learning across the curriculum.

What did the research show?
Compared with control groups, all classes of pupils who had been through the Cognitive Acceleration in Science Education (CASE) programme while they were in Years 7 and 8 showed average gains of one grade in science, and slightly smaller gains in mathematics and English at GCSE. This was evidence for both the accelerating effect of the strategy in science, and for the transfer of thinking skills into other curriculum areas.

How was this achieved?

The key characteristics of CASE are:

- concrete preparation, to ensure pupils understand the initial problem
- cognitive conflict - setting up and managing situations in which pupils make observations which are puzzling or in tension with previous experience
- social construction - pupils working together on the challenging activity to construct new joint understandings
- metacognition, in which pupils are helped to articulate their own reasoning in order to understand and internalise it for use later
- bridging - the conscious transfer of a reasoning pattern from its initial context to a new context, which when successful, produces both a generalisation and a consolidation of the reasoning pattern, leading to far-transfer effects.

How was the research designed to be trustworthy?
The CASE team analysed the examination results of around 4,500 pupils who had been taught using the CASE approach in 1991 and 1992 using 'value-added' statistical methodology. Data from a further eleven schools were analysed in 1999, including the GCSE results of children who had begun their CASE lessons in 1994.

What are the implications?
The study shows the value of:

- using a greater range of questioning techniques, displaying key questions and vocabulary to focus the work, and giving students more opportunities to demonstrate their thinking, through mind maps, audio tapes or thinking logs
- professional development for teachers to help prepare them for implementing thinking skills interventions
- teachers using video, peer observation and feedback to support each other to develop teaching strategies in the context of cognitive intervention
- looking to local higher education institutions who are able to provide expert knowledge and initial coaching in the CASE processes

What do the case studies illustrate?
The case studies show:

- the cross-curricular application of thinking skills approaches
- how teachers have developed some of the CASE principles (such as metacognition and bridging)
- the use of video as a tool for investigating teachers' ability to teach thinking skills lessons
- how one school put building blocks in place for creating a whole-school approach to thinking skills
- thinking skills as a strategy for school improvement.

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Study

What did this project set out to do?
The CASE project set out to intervene actively at key points in pupils' cognitive development, thereby 'accelerating' their levels of thinking. Adey and Shayer, who initiated and designed the project and evaluated its outcomes, believe that "It is not what pupils learn, but how they learn it that matters. How they learn depends on their cognitive processing capability, and intervention in the process by which this capability develops is the route to fundamentally improved life chances in the population of learners".

In *Really raising standards*, the authors describe how they went about designing and implementing their cognitive intervention strategy and evaluating its outcomes. They also explore the psychological theory underlying methods of intervention in cognitive development. Their goal was to accelerate pupils' thinking to

a higher level so that they could better attain the objectives of the national curriculum. Adey and Shayer hypothesised that accelerated intellectual development and long-term improvements in achievement can be brought about by a "deliberate policy of challenging learners to transcend their present level of thinking". The book gives examples of the aims and content of lessons that challenged learners in this way and led to gains in their levels of attainment.

What were the main findings?
The study reported in *Really raising standards* provides empirical evidence from 12 classes of pupils in nine schools in support of the CASE strategy.

Immediate tests following the two-year programme, in 1986, showed some improvements in the pupils' performance, but the most striking effects were on the GCSE grades for those pupils later on, in 1989. Compared with control groups, all classes of pupils who had been through the CASE programme while they were in Years Seven and Eight showed average gains of one grade in science, and slightly smaller gains in mathematics and English at GCSE. This was evidence for both the accelerating effect of the strategy in science, and for the transfer of thinking skills into other curriculum areas.

Since 1989, the CASE project has developed into an extensive pedagogic programme, which has become part of the framework for teaching and learning for many children. This continuing process has made it possible for longer-term evaluations to be carried out. These evaluations were conducted by the CASE team themselves using assessments of pupil outcomes derived from national assessment frameworks (GCSEs). Case studies other than those of Adey and Shayer contain additional checks and data sources that point in very similar directions.

Was there other evidence of gains in pupils' attainment?
In 1996, using 'value-added' statistical methodology, the CASE team analysed the examination results of about 4,500 pupils. The analysis showed that for pupils who had been taught using the CASE approach in 1991 and 1992 there were increases of 10-20 per cent in the number of those achieving grade C or above in science, mathematics and English GCSEs, compared to control groups. In the Key Stage 3 national tests in 1996, the results showed even higher rates of improved attainment, being equivalent to a raising of the national average performance at level 6 or above from 25 per cent to 68 per cent.

Data from a further 11 schools were analysed in 1999, comprising the GCSE results of children who had begun their CASE lessons in 1994. In the three key subjects, ex-CASE pupils had improved by up to one whole grade more than those in the control groups.

The authors were able to conclude that:

- there is a long-term effect, three years after the end of the intervention
- there is a transfer effect from science into other subjects.

What is 'cognitive intervention' and how do you recognise it?

CASE is one kind of initiative that has been developed in the field of cognitive intervention. There are six key elements of CASE, which many teachers have subsequently adopted or adapted in designing similar intervention strategies in their own classrooms. The authors emphasise the importance of:

- duration and density, to ensure there is sufficient material for a period of time which is long enough for developments at the mental level to occur, two years being chosen for the CASE project
- concrete preparation, to establish familiarity with the vocabulary, apparatus and framework in which problems will be set
- cognitive conflict, which refers to setting up and managing situations in which pupils make observations which are puzzling or discordant in the light of previous experience, a central aspect of the CASE approach

- social construction, when pupils work together on the challenging activity to construct new joint understandings. ("construction zone activity")
- metacognition, in which pupils are helped to become conscious of their own reasoning in order to understand and internalise it for use later
- bridging, which is the conscious transfer of a reasoning pattern from its initial context to a new context, and which, when successful, produces both a generalisation and a consolidation of the reasoning pattern, leading to what the authors' term "far-transfer effects invisible to the learner (perhaps we should say 'developer') him/herself".

Examples of core features of CASE
Here are some examples of what these elements might mean in practice.

Concrete preparation
Concrete preparation is an essential preliminary stage to ensure the pupils understand the initial problem. Unless the terms have a real meaning for pupils, a problem may not be seen as a problem. "To someone who has never seen a hat or a rabbit, it is not interesting to see a rabbit pulled out of a hat. For all s/he knows, hats are precisely the place where rabbits live."

Cognitive conflict
A core feature of CASE is maintaining what Adey and Shayer refer to as 'cognitive conflict'. What they mean by this is maintaining in pupils' minds a range of possible explanations for causes and effects that may interact in complex ways with each other. In one example, a pupil investigated the effects of the variables (length, width and material) on the note produced when you blow across the top of a tube. The conflict here is about which variable was the key factor.

Social construction
This is the process that Shayer and Adey emphasise in order to help pupils reach a more complete understanding of the task. Construction is evident when, for example, pupils understand together that it is not just the amount of sugar that determines how fast fermentation using yeast occurs. Pupils in a group gradually clarify the part other factors, such as temperature, could play and propose a way of testing their ideas. Although the teacher asks probing questions to focus debate, pupils do most of the thinking.

Metacognition
Shayer and Adey also emphasise the role of what they call 'metacognition' in putting pupils in charge of their own learning. Here they refer to the importance of enabling pupils to articulate their own thinking and learning processes. For example, in carrying out an investigation into the balance beam (see-saw), a pupil remarked that a lesser weight on one side had to be moved further outwards along the beam, relative to a greater weight on the other side. "If it's half the weight we must move it twice the distance" she said, adding "I didn't even know that until I said it!"

What are the key components in CASE activities?
The theoretical foundations of the CASE project are based on the earlier work of the psychologists Piaget, Vygotsky and Feuerstein. Adey and Shayer introduced the principle of active intervention at key points in pupils' cognitive development within a given subject, in this case science, thereby "accelerating" them from concrete to what they describe as "formal levels of thinking". Others have developed and implemented different approaches to cognitive intervention.

Adey and Shayer described the reasoning patterns of formal operations for science as follows:

- controlling variables
- understanding and using proportionality
- using probability to evaluate evidence
- using compensation and equilibrium to analyse process
- using correlation to interpret results

- selecting criteria for classification
- using formal models
- understanding compound variables.

Thinking Science, which is the title of the published CASE teaching pack, consists of 30 activities, which take the pupils up the 'levels' on the scale of cognitive development. Each activity addresses one of the formal operational reasoning patterns highlighted by CASE and is designed to occupy 60-70 minutes. All activities were extensively tested.

What does a CASE lesson look like?
A report on a CASE lesson called "Roller ball", which investigates variables.

The lesson began with a demonstration using apparatus consisting of a ramp and balls made of glass, steel or brass, which are of different sizes. The teacher asked pupils what they thought they were about to investigate. The pupils said: "time and distance balls go". During the ensuing discussion, the teacher intervened to make the language more precise. The teacher presented a glass marble as a target and asked pupils to choose a roller ball. She released a steel ball from the highest position so that it struck the marble that was lower down the track. The marble was knocked right off the end of the track.

This was the concrete preparation stage.

The teacher then released the glass marble from a lower position at a brass target ball, so deliberately changing the variables randomly. The target ball did not move as far this time. The pupils were quick to comment ".....you dropped them from different positions!", "not a fair test!" The pupils agreed that no conclusions could be drawn so far. A conflict was set up in the pupils' mind over whether the different effects on the target ball were caused by the height of drop or the mass of the target ball.

This was aimed at 'cognitive conflict'.

Next, the pupils tackled tasks leading them to investigate the effects of height, mass, etc. Working in groups of between three and five, one pupil had the responsibility to ensure that the others understood the tasks. The teacher circulated, asking probing questions. In one group, the pupils dropped two different balls from different heights, so changing two variables at the same time, the effects of which they clearly thought would cancel out. When asked "What do you think you will observe?", one replied "The target will move about the same distance." The teacher then asked "What will that tell you about the effect of height?", and so on. By discussion and by trial and error the pupils arrived at a strategy for testing each variable independently.

There followed feedback and discussion in which pupils reflected on, justified and refined their strategies. One group said, about the effect of brass and steel roller balls, "You should release them from the same position." When asked why, they explained "Otherwise you don't know whether it's the height or the ... whether its brass or steel that makes the difference."

This was construction zone activity.

The teacher asked pupils to think about what had happened during the lesson. "Did you make any mistakes?; Tell me something you did wrong? What did you think then? ... What do you think now? ... What happened to make you change?"

This was aimed at metacognition.

The teacher continued the investigation with pupil help. The teacher reminded pupils of another lesson in which they had had to plan an investigation into conditions for growing seeds. She brought out the similar strategy of controlling variables.

This was aimed at bridging.

How does the CASE project contribute and relate to thinking skills approaches?
The idea of cognitive intervention has been around since the 1950's (Feuerstein). Approaches to intervention in learning were given a major impetus by the work of Adey and Shayer in the mid 1980s and 1990s. They, along with other researchers, have continued work in this area and there are now several acceleration strategies being used in schools and researched in universities. The descriptive term given to the whole range of approaches designed to accelerate cognitive development in children is 'thinking skills.'

Researchers in the field continue to debate the different approaches to thinking skills. Some approaches involve explicit and dedicated thinking skills courses. Another group, including CASE, see specific subjects as offering a vehicle for the delivery of general thinking skills. In addition to CASE, CAME (mathematics) and CATE (technology) fall into this category. A third group emphasises the infusion or spreading of thinking skills across the curriculum.

All these approaches share the same general characteristics for developing thinking skills, such as: making thinking skills explicit, teacher intervention to create cognitive challenge or conflict, metacognition, construction, and bridging to other tasks. It is central to all thinking skills approaches that activity takes place collaboratively so that pupils construct a more holistic understanding from their separate insights, make their thinking explicit and learn from and to work with others.

Some examples of thinking skills approaches applied in the classroom
To illustrate some of the approaches taken by teachers in their classrooms a number of case studies have been included in this 'Research for Teachers'. This is a small selection but it does give a snapshot of what is happening in many schools.

Case studies showing application of one or more of the principles of CASE are:

- an example of CASE in a Hertfordshire Secondary school
- encouraging metacognition, an activity from "More thinking through geography", for secondary pupils, which shares some principles from CASE
- training children to ask questions, an exercise from "More thinking through geography"
- a study of a thinking skills approach to history teaching and learning from Northumberland
- playing "Taboo" to teach geography terms; an exercise in construction(
- using "debriefing" to stimulate metacognition.

Two other case studies illustrate:

- a thinking strategy in a Primary school
- thinking skills as a strategy for school improvement.

Both of which exemplify a combination of CASE type and infusion methods across the curriculum.

Two more case studies have been selected to show how thinking skills approaches can be supported on a whole school level and how the use of video can help teachers develop their abilities to teach thinking skills.

Can cognitive intervention be used at any Key Stage?

The CASE programme was designed for use at Key Stage 3. This was because it was aimed at intervening at the crucial age 11-12 period during which, studies in cognitive psychology indicated, childrens' brains seemed genetically receptive to accelerating from concrete to formal operational thinking. Nonetheless, Adey and Shayer considered that, based on existing research material, activities could be developed which were appropriate for five to six year olds. Specifically these were:

- quantitative - relation (conservation, measurement, number)
- qualitative - analytic (classification and ordering)
- imaginal - spatial (imagery, mental rotation, perspective).

These are all features of concrete operational thinking. At post-16 level, the authors are rather more pessimistic and feel that genuine intervention is unlikely to happen. The reason for this is that it is probably too late to take advantage of the growth of the neural network in the brain at an earlier age. They suggest that cognitive intervention could be applied more narrowly at this phase, centred on cognitive strategies within a particular context, eg, a commerce problem in which students have to assess the problem of ordering stockroom items and then to write a plan.

What are the implications for training and professional development?
All proponents stress that in thinking skills interventions there is a radical departure from normal teaching practice. In describing their approach to the training of teachers in the CASE approach, Adey and Shayer stress that if you really want to change teaching practice, some process of teacher induction is needed, followed by a longer period of coaching.

Teachers in schools proposing to adopt CASE need coaching by someone who is already proficient in the CASE approach. King's College, London, runs programmes for CASE trainers. Teachers are given a thorough grounding in CASE through a programme of INSET days combined with four or five coaching sessions based in schools. During the visits, it is usual for the coach to teach part or all of a CASE lesson while the teacher observes. The roles can be reversed if the observer wishes to propose an alternative way of doing something. The authors highlight the importance of some form of peer coaching to continue spreading the CASE pedagogy.

What conditions are needed for developing a successful CASE cognitive programme?
From observation of the way CASE was developed in a number of schools, Adey and Shayer concluded that the key was to include the whole department. It was also important to identify senior management support. This could be made practical by asking one of its members to make a thorough costing of:

- staff time required for training
- outside visitors
- materials.

Within departments, they observed that it was important that CASE was part of department policy and not attached to particular individuals. The department needed to have a CASE coordinator, who attended each INSET workshop organised by the CASE centre and a second teacher - different each time - who accompanied the co-ordinator. The authors believed it to be essential that the department had an efficient communication policy so that good practice could be shared. In the best examples departmental in-service training became normal practice.

Can we classify stages in cognitive development?
The underlying model of cognitive development in this study embodies a central proposition that some kind of general processing mechanism of the mind controls all comprehension. Following Piaget, Adey and Shayer found it useful to categorise the stages in the development of this mechanism.

In 1974, the Concepts in Secondary Maths and Science (CSMS) programme used a battery of Piaget reasoning tests on a large population of school children. From this study, they were able to create a scale of cognitive development levels. This is the one Adey and Shayer used:

Stage/level	Symbol	Type of thinking
Early concrete	2A	Here the thinking is of the cause and effect kind where the interactions understood rules. The situations involved contain two variables. Obser explained based on links between two variables.
Mid concrete	2A/B	
Mature concrete	2B	
Concrete generalisation	2B*	
Early formal	3A	These concern situations in which there are three or more variables an of abstraction. Models become more prominent.
Mature formal	3A/B	
Formal generalisation	3B	

Why should we intervene in cognitive development?
At its most general, cognitive intervention is about enabling children to develop to higher ability levels. The whole field of cognitive intervention was given a major stimulus by the assessment work of the CSMS team. They found that fewer than 30 per cent of 16 year olds reached level 3A. Another startling finding was that among Year Seven pupils the gap between pupils at the highest and lowest stages of cognitive development could be as wide as 12 years.

When the original national curriculum was designed, the Government's public target figure was that 50 per cent of pupils should reach level six or above by age 14. From the CSMS survey conducted in the 1970s, it could be predicted that only 20 per cent would be at the appropriate stage of development (ie, 3A) to cope with the higher level questions. The first results from national tests in May 1992 for London, show only 14 per cent reaching level six or above. Later national tests confirmed this picture. Hence, Adey and Shayer's programme for cognitive intervention was both timely and provided the impetus for the spread of development work around cognitive intervention strategies in UK schools.

What else did the study discover?
In addition to the main findings about pupil performance, Adey and Shayer highlight some other issues that will help teachers in their planning for teaching and learning:

- Is CASE of equal benefit to both boys and girls?

- What is the optimum age of pupils for applying CASE?
- Does CASE raise the attainment of very able pupils?
- Is CASE of equal benefit to both boys and girls?

The analysis of the tests pupils sat one year after the intervention, ie, at the end of Year Nine showed improvements particularly for girls who started the programme at age 11+ and boys who started at 12+. This effect was replicated at GCSE level two years later, when, again, the 11+ girls and 12+ boys did significantly better than the control groups and the 12+ girls and 11+ boys. Similar, although weaker, effects were noted in mathematics and English.

These observations led the authors to suggest that there may be a critical period for the development of formal operational thinking. The earlier maturation of girls may lie behind the different performances. Another possibility was that the type of organisation of Year Seven classes might have suited girls more than boys, although this factor would only occur in a proportion of schools.

What is the optimum age for applying CASE?
There is evidence from developmental psychology that there is a major brain growth spurt around the age of 11. This is supported by the CSMS survey data, which also suggests a brain growth spurt at approximately age five to six. In the opinion of Adey and Shayer, these changes in children's brains make it possible for the development of concrete operational thinking at the age five to six, and for formal operational thinking at age ten to eleven. Adey and Shayer also conclude that because of their earlier maturation, girls who have not transferred to formal operational thinking by the age of 14 may miss the opportunity to complete the last stage of their cognitive development; the same presumably applies to boys a year later.

Does CASE raise the attainment of very able pupils?
In a more recent study (Adey and Shayer, 1999) of GCSE results, data from 11 schools were analysed. In the earlier study, the CASE project was undertaken in schools that were representative of the mainstream of the secondary sector in the UK. The 1999 sample included evidence from two selective schools, which showed large gains in GCSE grades in science, maths and English.

What are the implications for teachers and school leaders?
Whilst preparing this summary, the RfT team became aware of a number of implications of the research findings for teachers - particularly subject leaders - and school leaders.

Teachers and subject leaders might like to consider the following implications of the research:

- the CASE intervention needed specific materials for teachers and students to work with. Would it be helpful to see how far your current resources would allow you to go in developing CASE type activities? Is there scope for pooling resources and developing materials for use across the curriculum, but tailored to specific subjects as appropriate?
- in Shayer and Adey's programme, the development of teachers was a key part of preparation for implementing the intervention. What professional development would teachers in your school or department need in order to participate in such a programme? Do you have colleagues who use cognitive strategies in their teaching who could coach others in their use?
- the case studies show how some teachers have used video and peer observation and feedback to support each other through professional development. Are these activities which you might find helpful in developing the teaching strategies described in the context of cognitive intervention?
- the research shows that for cognitive strategies to be sustained, the methods have to become owned by all the department or group of teachers implementing the work. Would you find it helpful to discuss with colleagues in your department how to embed and sustain the strategies - for example, through more shared planning and by designating a co-ordinator to facilitate the pooling of ideas and practices?
- would you find it helpful to use some of the strategies discussed in the research without taking on board the complete programme? (For example, using a greater range of questioning techniques, displaying key questions and vocabulary to focus the work, or giving students more opportunities to demonstrate their thinking, through mind maps, audio tapes or thinking logs etc).

The research highlighted the key role of school leaders in creating the optimum conditions for developing and implementing cognitive intervention strategies. School leaders might wish to consider the following issues:

- Would it be possible to offer teachers time to work together to plan cognitive intervention strategies, to embark on relevant professional development and to spread good practice within and also beyond their own department, through peer coaching?
- A core feature of the research was the involvement of researchers from higher educational institutes (HEI) who provided stimulus and support for the teachers involved in the initiative. Are there people in your local HEI who might be able to provide expert knowledge and initial coaching in the process?

Case studies
A number of case studies illustrating key aspects of this research are available in the case study section.

Your feedback
Have you found this study to be useful? Have you used any aspect of this research in your own classroom teaching practice? We would like to hear your feedback on this study. To share your views with us please email: research@gtce.org.uk

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Case studies

There is a large and growing body of literature on the subject of thinking skills. The following ten case studies offer a flavour of some of this work, which ranges from subject specific planned interventions to strategies for infusing thinking skills across the curriculum in a large secondary school. Each case study is summarised and the reference to the complete paper is given at the end for interested readers.

The first case study features a straightforward application of CASE in a secondary school. The next five case studies come from the Newcastle work of David Leat and his colleagues, which shares some CASE principles such as metacognition and bridging. These studies exemplify the how approaches similar to CASE have been developed by teachers, in different ways. They have been included to illustrate the diversity of theory and practice under the general rubric of thinking skills as well as to highlight specific examples of core CASE concepts in action. Case studies 7 and 8 refer to the work of Robert Fisher of the Centre for Thinking Skills at Brunel University and derive from the 'philosophy for children' approach that lays emphasis on the development and use of questioning skills among pupils. The final two case studies deal with strategies for developing practice amongst teachers who are exploring or implementing thinking skills approaches in their work.

CASE in a Hertfordshire secondary school

This case study offers an example of how CASE methods were applied in a secondary school and how the pupils benefited.

The continuing popularity of CASE is illustrated by this study of science teaching in Years 7 and 8. It shows that in the hands of an enthusiastic and experienced practitioner, the simple question "Why do you think that?" can become a strategy for promoting metacognition, or 'thinking about thinking'. Pupils were challenged to demonstrate their experiment to their classmates, explaining what they had learned from it. On other occasions pupils had to prepare overhead transparencies to illustrate and explain their thinking.

Teacher and pupils found the CASE approach to be quite different from their usual styles of teaching and learning, but the gains for pupils offered tangible complementary evidence for the validity of the CASE

method.

For the full paper see: *Teaching Thinking 1*, A Raw, Spring 2000.

History teaching and learning in a Northumberland primary school

This is a study of a thinking skills approach to history teaching and learning from Northumberland, showing the cross-curricular applications of thinking skills approaches.

The teacher decided to make history lessons much more stimulating by building a thinking skills approach into the planning of her lessons. The theme of the topic was the Saxon occupancy of a hill fort. Like CASE the strategies sought to make thinking explicit by constructing cognitive challenges which the teacher then guided to promote metacognition.

The activities included:

- the use of mystery to encourage the children to think of questions like "Why would people dress like this?", for themselves
- the use of story, in this case Beowulf, to stimulate discussion about issues like good and evil
- the use of group discussion to help children keep on track in debate and to respond directly to others in a group situation.

During the unit of work, displays of key questions reminded the children about the purpose of the activities. Vocabulary was also displayed. Children were encouraged to use a variety of ways to demonstrate their understanding of the topic including making an audio tape with narration and sound effects, making a timeline, drawing a comic strip to tell the story, etc. These methods helped to make the children's understanding explicit.

For the full report see: *Report of the development of thinking Skills using the Northumberland National Park's education pack on Ad Gefrin (Yeavering)* in *Thinking for learning*, published by Northumberland County Council (2000).

How can research be effectively implemented in a school?

In this report, we see how one school has begun to put in place the building blocks for creating a whole-school approach to thinking skills and to identify the essential elements of a whole-school programme.

This paper maps the progress of one school in the North East of England, which is researching the process of infusing thinking skills across the curriculum. It is also researching the engagement of teachers with and in research. Six teachers were involved in the initial stages of the project, which now involves 25 teachers spread across seven departments.

The report shows the leadership needed to support changes in practice, highlights some of the experiences and opportunities that had the greatest impact on the professional development of the staff and explains what was learned about supporting change and developing partnership.

The role of the school research co-ordinator is explained in the context of the school's thinking skills initiative and the report stresses the value of senior level involvement in the processes. Resources to support supply cover and residential development sessions were also crucial.

The engagement in research meant data and information gathering. Lesson and video observation stimulated valuable continuing professional development. Analysis of these observations also encouraged reflective practitioners to change their practice as did pupil comment monitored through pupil learning logs. Despite a lack of quantitative data at the pilot stage, the qualitative analyses of the process and findings offered

persuasive evidence for teachers who had seldom analysed their own pedagogy in quite so direct a fashion.

Other crucial aspects involved in the process of infusing a thinking skills approach were:

- integrating and involving other teachers
  coaching
- maintaining regular contact through large and small group meetings.

For the full report see: Summary produced for the TTA/DfEE Teacher Research Conference, 7 March 2001, adapted from an article *Learning to think: thinking skills for teachers*, prepared for *Professional Development Today*.

Improving pupils' thinking in the primary school

The following study offers an example of how different thinking skills strategies were applied in a primary school. A more recent study than CASE, and identifying closely with the five thinking skills of the national curriculum 2000, the project aimed to help schools construct a whole school strategy towards developing the thinking skills of pupils.

This study aimed to develop effective thinking strategies drawn from recent research into teaching thinking and accelerated learning. The strategies included:

- using thinking logs in which children recorded questions, ideas, mind maps and personal reflections
- reading and discussing stories and poems designed to infuse philosophical discussion and higher order thinking into the literacy hour
- introducing maths discussion aimed at metacognition into the numeracy hour
- applying 'Thinking science' strategies including pupil questioning, mind mapping and conceptual thinking
- promoting discussion to develop thinking skills in PSHE/citizenship
- applying 'Thinking through art' to develop visual literacy and creative thinking
- infusing thinking skills strategies into the planning of all lessons.

Findings from this research project indicated that it had a positive effect in the following skills:

- listening
- questioning and enquiry
- creative thinking
- communicating ideas
- self-expression
- verbal reasoning
- concept-building and mapping
- critical reading
- co-operative discussion.

The study also reported that the approach improved teachers' professional confidence and self-esteem, boosted children's achievement, raised children's self-esteem and self-concept and made pupils more aware of citizenship issues.

For the full report see: *The Queen's Beacon School thinking skills project*, R Fisher, Summary paper for the TTA/DfEE Teacher Research Conference, March 2001.

Playing 'Taboo' to learn geography

This example shows how the game 'Taboo' became part of a thinking skills strategy for teaching geography terms.

To help pupils understand the meaning of geographical terms and not just to define them, teachers used the game of 'Taboo' to improve examination technique for a top set Year Eight class. (In the game 'Taboo', participants gain points by describing words without using the most obvious explanations). During a game called 'Hydrological Cycle Taboo', the teacher challenged the children to describe the term 'evaporation' without using words such as 'water', 'vapour', 'gas', etc.

The activity was aimed at bridging the gap between what the pupils knew and what they could know, given help in getting there. At the end of the activity pupils wrote in their learning logs:

"We learnt how to improvise, using other means to explain things to people and we learnt how to use examples to explain things."

"I learned how to describe things and how to make other people understand what I was saying. It improved my knowledge of geography and English."

For the full paper see: *Raising achievement by teaching thinking skills*, summary paper for the TTA/DfEE Teacher Research Conference, J McGrane, March 2001.

School improvement through thinking schools

The following study provides an example of how one type of thinking skills approach, with local authority, headteacher and HEI support, can be implemented across a group of schools. The approach stresses the value of 'thinking time' and seeks to promote pupil questioning, open-ended enquiry and problem solving.

This study reported on the School improvement through thinking skills project carried out in primary schools by the Hammersmith and Fulham LEA in 1996 and 1997.

In the author's words: "The project was seeking whole school commitment and changes in teachers' practice to achieve long-term gains from a 'thinking skills' approach to teaching and learning."

The strategy deployed a combination of a thinking skills programme and the infusion of teaching for thinking across the curriculum. The project was aimed at achieving measurable gains in literacy and maths - improving pupils' ability to reflect on their own learning and on developing pupils' self-esteem, motivation and willingness to learn.

Some of the comments from children who had gone through the programme were:

"When I'm older I might have to teach other children: it will be easier for me because I have already done it."

"It makes me think more than I used to."

"I never used to share my thinking and I used to keep it inside me like normally, I can just take it out now."

Teachers noted signs of improved self-esteem and confidence among pupils. All schools reported improved literacy and several recorded gains in national tests. In conclusion, the author listed the sorts of evidence one could expect from a 'thinking school', including, among other things, explicit reference to thinking skills at several levels, an appropriate range of strategies, and high-quality pupil-teacher interaction to promote metacognition.

For the full report see: *Thinking schools*, R Fisher, *Professional Development Today*, July issue, 1999.

The role of video in improving teaching and learning

This study has been selected to show what sorts of strategies can help teachers to adapt their teaching to take account of thinking skills approaches.

This ongoing study is investigating the use of video as a tool for investigating teachers' ability to teach thinking skills lessons.

It involves 22 teachers and 9 departments in a large secondary school. The focus of the project is concerned with how thinking skills can be introduced effectively to a school and the impact this has on teachers and pupils and their learning. Teachers use diaries to record their perceptions of the thinking skills lessons they have taught; pupil learning logs to gain the pupils' impressions of the same lesson; and video recordings of the actual lesson.

They have found that watching videos of themselves teaching thinking skills is the most significant factor in helping them improve their practice. Video allows specific aspects of a lesson to be highlighted and analysed in isolation, for example the de-briefing process, or post-activity discussion. Video has been used as part of triangulated data for the project's research into the impact of thinking skills on pupils' learning; as a tool of self-reflection to develop a teacher's own practice; in coaching and for dissemination.

When teachers watched themselves teaching, their attention initially was on teacher behaviour. For example, classroom issues, gestures and mannerisms or the length of time spent talking to the pupils. Alternatively, it can be related to thinking skills, such as the management of the de-brief, the number of open questions asked or the length of each stage of the lesson.

Later, the focus was more concerned with the pupils. So, for example a teacher would be interested to know whether the pupils' responses were longer in the thinking skills lesson, how the group work dynamics helped or hindered the activity and if metacognition (talking about their thought processes) was taking place in the de-brief.

By the third stage, after a number of videos have been watched, the focus is returned to the teacher. This time the concern is with how the actions of the teacher impacted on the pupils. For example, how did the teacher generate the post-activity discussion? What techniques were used to encourage the pupils to critique each other? How did the teacher's change in practice influence the pupils?

For the full report see: Summary of a report produced for the TTA/DfEE Teacher Research Conference, 7 March 2001, Patricia Hopkins, St Thomas Moore School.

Using 'debriefing' in a North East secondary school

This study shows how debriefing was used with secondary school pupils to stimulate metacognition.

Debriefing was a strategy used to get pupils to talk about their solutions to geography tasks and to explain how they carried out the tasks. The activity was aimed at metacognition and was designed for pupils of Years 7 to 10.

One pupil commented on its usefulness for her literacy skills: "For writing essays and stuff, you have the reasons, the background and the trigger reasons, it can help you...arrange an essay and write it."

The features of the debriefing activity were:

- the high number of open questions asked by the teacher

- the frequent references made by the teacher to learning skills (pupils commented: "We learnt how to group things together and see what might affect other things" and "like one thing starts another")
- many pupils gave lengthy responses to questions, in some cases with the teacher prompting
- the teacher made connections between learning outcomes and other contexts (bridging) offering analogies from pupils' everyday lives (a pupil said, "It's like we're relearning things that we've done in the past that we've been learning over two years" while another commented, "and if you're going to college you can use it")
- evaluative feedback was given to pupils by the teacher and other pupils (when asked, "You don't mind your friends correcting you?" a pupil responded, "No ...I'm not bothered.....if you don't (listen) you just do it wrong next time")
- discussion was usually animated
- the teacher made the point of the lesson explicit (when asked if she thought this helped, one pupil said, "Yeah because then we understand what we're doing and why we're doing it").

For the full paper see: *De-briefing: pupils' learning and teacher planning*, TTA, Teacher Research Grant (TRG) summary 70/8-99, E Evans, D Kinninment, J McGrane and A Riches.

Five Ws (or what? where? who? when? why?)

This study offers an example of training children to ask questions, an exercise from *More thinking through geography*.

The study describes how pupils were encouraged to ask questions and to consider the underlying logic of asking particular kinds of questions, in particular ways and in a particular order. One exercise, aimed at stimulating metacognition among pupils was based on the San Francisco earthquake of 1989 and undertaken by an able Year Nine class.

During the exercise, the pupils brainstormed examples of words from their own experience that indicated that a question was being asked, before arriving at the list of 'five Ws' in the heading. Imagining that they were newspaper reporters assigned to report on an earthquake in San Francisco, they were challenged to think of as many questions as they could of the type that would be most effective in providing a reader with an understanding of the event. The pupils suggested questions like:

- When did it happen?
- What was the damage?
- Who was affected?

For example, by circulating among groups the teacher monitored and supported pupils, intervened to create debate and to make pupils examine their own thinking.

Debriefing was an essential part of the activity. It allowed pupils to debate the issues, to refine their own thinking, to talk about thinking processes, and to consider if these processes could be transferred to other topics and subjects.

For the full activity, see: *More thinking through geography*, ed. A Nichols, series ed. D Leat, Chris Kington Publishing, Cambridge (2001)

Most likely to ...

This is an activity from *More thinking through geography*, for secondary pupils, which shares some principles from CASE.

The activity was designed for Year Nine pupils and aimed to promote metacognition. It was based on the highly topical subject of 'Tourism in the rainforests'. In learning to decide whether statements such as 'disturb the wildlife of the forests', are characteristics of either 'ecotourism' or of 'mass commercial tourism', pupils

met ambiguities they struggled to resolve. While pupils were engaged with the task the teacher moved among the working groups asking probing questions which challenged pupils' preconceptions, and sought to foster and mould debate.

The exercise provided the opportunity to develop forms of critical thinking in line with the five national curriculum thinking skills. During the activity and through debriefing the teacher explored with the pupils key components of the processes involved in the activity including:

- understanding characteristics
- using classification skills
- testing their understanding of generalisations
- testing hypotheses
- enhancing vocabulary
- visualising context and content.

The debriefing session at the end of the activity was an important part of the exercise. Pupils gave feedback to each other. For example, they debated which kind of holiday would be the more expensive. The arguments went back and forth with different pupils giving their opinions about the features of tourism which affected costs, until at one point a pupil commented, "Yes but when something's unusual and not many people do it or have something, things are more expensive, like, if you wanted a car that nobody else had, it would probably be dead expensive." This type of comment provides a central focus for debriefing.

The *Thinking through geography* programme consists of a range of challenging resource materials published in a pack of the same name. There is also a more recent teaching pack with the title More thinking through geography that provides more resources. The materials are based on research and development activities carried out co-operatively between Newcastle University and a number of local schools.

For a description of the full activity, see: *More thinking through geography*, ed. A Nichols, series ed. D Leat, Chris Kington Publishing, Cambridge (2001)
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Further reading

Our summary has highlighted key issues in Really raising standards that we thought would be of interest to teachers. For interested teachers, here are some references to pages in which you might like to follow up:
o The Piagetian model of cognitive development: pp. 11 - 31
o Other intervention programmes: pp. 38 - 59
o The development of CASE materials: pp. 79 - 83
o A description of the features of higher order thinking: pp. 16 - 26
o The nature of the mind and of learning pp. 113 - 127.

Two other important papers by Michael Shayer which continue the analysis of the effects of CASE intervention on pupil performance are:

The long-term effects of Cognitive Acceleration on pupils' school achievement, November 1996
GCSE 1999: Added value from schools adopting the CASE intervention.

Both of these papers are published by the Centre for the Advancement of Thinking, King's College, London.

Thinking through geography is a major innovation that shares a number of features of CASE.

Edited by David Leat of the University of Newcastle, it is published by Chris Kington Publishing, Cambridge.

There is now a second resource pack entitled More thinking through geography also published by Chris Kington.

Developed later than CASE but very much along the same lines in the field of mathematics is the Cognitive Acceleration through Maths Education (CAME). It is also based at King's College, London.

The researcher Robert Fisher has also done extensive work on the teaching of thinking skills. His work has been associated with the 'philosophy for children' approach and places great importance on the development and use of questioning skills by pupils. His book Teaching thinking, published by Cassell (1998) contains many interesting ideas and examples.

1. What else might I enjoy reading?

Cognitive Acceleration through Maths Education (CAME)
http://www.kcl.ac.uk/schools/sspp/education/research/projects/came.html

Fisher, R. (1998) Teaching thinking: Philosophical enquiry in the classroom. London: Cassell

2. Where can I find out more online?

Centre for the Advancement of Thinking
http://www.kcl.ac.uk

Cognitive Acceleration through Science Education (CASE)
http://www.kcl.ac.uk/schools/sspp/education/research/projects/case.html

National curriculum site
http://www.nc.uk.net

Newswise site
http://www.dialogueworks.co.uk

Robert Fisher site
http://www.teachingthinking.net

Thinking through geography
The Society for the Advancement of Philosophical Enquiry and Reflection in Education (SAPERE) site:
http://www.sapere.net
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Appraisal

Robustness

This research and development study comes in the form of a book of 208 pages. The aims of the research are clear and the study builds on existing research into the theory and practice of cognitive intervention. The issues are explored systematically and the development of their intervention strategy - the Cognitive Acceleration through Science (CASE) project - is carefully explained. Teachers were involved in extensive trials in the pilot phase. Evidence of the effect on

teaching and learning resulting from the two-year strategy comes from a large empirical base. Assessment data from Key Stage 3 national tests and, for the same cohort, from GCSE results two years later, are used as a measure of its effectiveness. All assertions are backed up by evidence, and the authors, while careful, are emphatic in their conclusions. Although this is obviously not an independent evaluation, other practitioners have developed thinking skills programmes incorporating CASE principles, these contain additional checks, and data sources that corroborate the findings from the main study.

Relevance

At a time when schools are concerned to raise standards, there is a growing national emphasis on, and interest in, thinking skills. This study points the way to a strongly indicative strategy for teachers. The study was stimulated by the authors' concern to boost the level of thinking among pupils at Key Stage 3, and consequently improve their ability to cope with the intellectual demands of the ensuing GCSE curriculum. The schools and pupils in the study were chosen to be representative of the mainstream, and the large empirical base of the evidence gives it credibility. A major conclusion of the study is that thinking skills learned by pupils are transferable across the curriculum, and with some modification, to pupils at Key Stage 2 and post-16. Statistical methods are necessarily used in the treatment of results. It is an example of education research that does explore data about both processes and outcomes. The study encourages strategies supportive of reflection on thinking by pupils. The continued relevance of the CASE project is such that it has featured in the national media, as well as in many educational publications.

Applicability

Teaching and learning are firmly at the core of this book. CASE in action is illustrated by a number of lively examples, which clearly show how the teacher uses the approach in the classroom. The debates that occur between teacher and children are quoted to show the productive effects of the strategy on cognition. Teachers will readily identify with the classroom situations described in the book. CASE is an intervention in the context, not the content, of teaching and learning and can be built into any curriculum, as the authors explain. Conditions required for successful implementation of the CASE approach are described and the implications for training teachers are discussed.

Writing

The book is interesting and highly readable and is free of jargon. It presents what is, in places, difficult subject matter in a lively and accessible form. Teachers of all subjects and phases will find there is something in the book for them. Processes and outcomes are clearly distinguished and presented. Essential statistical evidence is used in a way that will not intimidate the non-specialist and, to avoid diverting readers, details of 'value added' statistics are put in an appendix. Back to top