Review of Individual Studies from Systematic Research Reviews:

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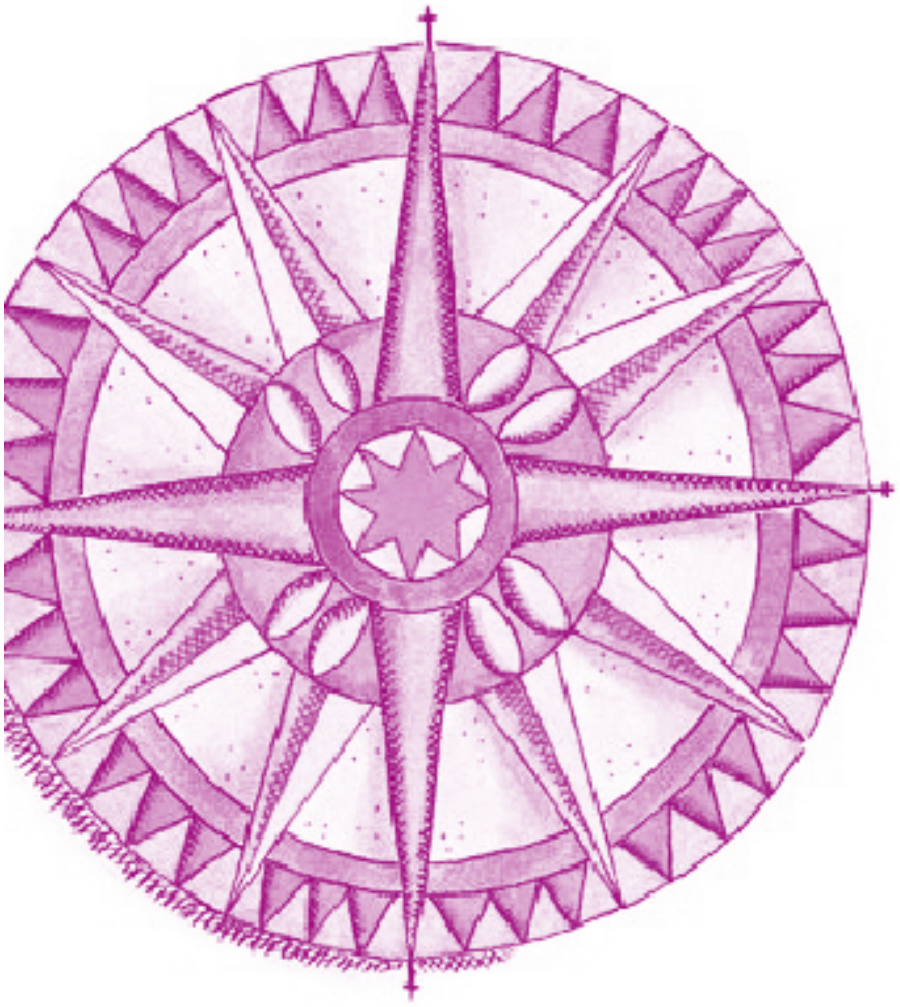

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QCA
Qualifications and Curriculum Authority

QCA Building the Evidence Base

Review of individual studies from Systematic Research Reviews

Contents

Background

CUREE's first foray into mapping evidence relevant to QCA's new and wide ranging curriculum framework took the form of a map of existing reviews of research1. The results have enabled us to start to identify:

- the range and types of curriculum related research
- significant gaps in the research base
- emerging trends in research findings

63 research reviews were included in the map. Three main types of review were identified which were classified as

- systematic – ie using a comprehensive search strategy, transparent inclusion criteria and a rigorous weighting of the evidence from which to synthesise across the studies
- interpretive – ie using expert knowledge to identify studies, without a rigorous and transparent weighting of the evidence but with a synthesis
- descriptive – ie an account of the research and the relative weight of evidence but with no synthesis

The overall findings from the review of reviews represented syntheses of research in several key areas whilst at the same time pointing to significant gaps in the evidence base.

Evidence from a number of diverse review topics, including a number of science and maths based reviews, coalesced around six key areas:

- the effectiveness of learning that is "context based" (dealing with ideas and phenomena in real or simulated practical situations) most notably in reviews of studies in science and maths)

- the importance of connecting the curriculum with young people's experiences of home and community and the related, but also distinctive theme of parental involvement in children's learning in the home

- the impact on pupil motivation and learning of structured dialogue in group work and of collaborative learning

- the need to create opportunities to identify and build on pupils' existing conceptual understandings – again, notably in science and maths. Several reviewers also found evidence of unexplored poor understanding or misunderstandings arising from "teaching to the test."

- the need to remove rigidity in the approach to the curriculum –to allow time and space for conceptual development, to encourage integration of cross-curricular learning.

- the need for excellence and professional development in subject knowledge – without which teachers would be unable to seize opportunities for curriculum innovation, particularly in relation to context-based learning.

- However there was very little data in many of the reviews about strong findings or processes emerging from the individual studies.

QCA Claims

QCA has made a number of claims in relation to (a) the purposes and premises of the secondary curriculum reform programme and (b) the curriculum model on which it is based. The claims in relation to (a) relate mainly to problems and assumptions about the current English national curriculum. The claims in relation to (b) relate to elements of a curriculum model for which it should be possible to uncover an international evidence base.

CUREE explored each of the claims to see whether or not it was feasible to include them in the review. In some cases it was possible to link the claims to the original six map findings and to construct questions with which to interrogate the study data which are capable of yielding evidence about both the claim and the map finding:

- question 1 is linked to the inference (claim 1) that the new curriculum needs better to reflect the world that young people are growing up in and is based on the map finding of the effectiveness of learning that is "context based"
- question 2 is linked to the inference (claim 3) that the new curriculum model needs to be more than a revision to the subject programmes of study and is based on the map finding about the importance of connecting the curriculum with home and community based learning
- question 4 is linked to the inference (claim 4) that the curriculum needs to enable progression and is based on the map finding that teaching needs to build on existing understanding
- question 5 is linked to claim 15 about contexts for learning and is based on the map finding that the curriculum needs to be flexible and to enable cross curricular learning
- questions 7-11 are derived exclusively from the QCA claims

Aims of the Review

Given the relative lack of illustrative detail in the map findings, we explored a sample of individual studies with the aim of adding depth and understanding to the six main map findings. The second aim of the review was to explore the findings from the sample of individual studies to see what (if any) evidence they yielded for those QCA claims which it has been possible to include in the review.

Review Questions

In order to add depth and understanding to the headline map findings and (where possible) the QCA claims the six map findings and those QCA claims which were included in the review were reformulated as questions.

In contexts where there is evidence of effective progress in learning:

1. What is the evidence about content, learning and teaching when learning is related to real world contexts?

2. What is the evidence about content, learning and teaching when connections between the curriculum and learning in the pupil's home and community?

3. What is the evidence about content, teaching and learning when collaborative learning and structured dialogue in group work take place?

4. What is the evidence about content, learning and teaching when practitioners build incrementally on pupils' existing understanding?

5. What is the evidence about content, learning and teaching when the curriculum is flexible and cross curricular learning takes place?

6. What is the evidence about connections between teachers' excellent subject knowledge and content, teaching and learning?

7. What is the connection between the aims and values of the school and the curriculum and teaching and learning processes?

8. What is the evidence about emphasising key concepts as a means of enabling subject teachers to develop more flexible, inclusive and appropriate learning experiences?

9. What is the evidence about key subject-based processes which need to be mastered?

10. What is the evidence about interdependencies between content, teaching and learning? What distinctions are there in different learning domains?

11. What is the evidence of the teaching and learning processes involved in personalising learning?

Note: Question 11 deals with a wide-ranging and complex concept. To ensure that data are extracted consistently and to enable cross comparison we have 'chunked' personalisation into six component parts:

- Paying close attention to learners' knowledge, skills, understanding and attitudes
- Using both formative and summative assessment to find out what learners know, can do and might be capable of
- Teachers and learners using techniques such as open questioning, sharing learning objectives and success criteria
- Giving learners sufficient time to reflect on what they are doing
- Teachers supporting learners in monitoring their own progress
- Learners working with their peers to review what they have learnt and to develop their understanding further

Methodology

Sample of studies

Several thousand studies were covered by the 64 research reviews included in the map. This was too large a number for the current review. To arrive at a manageable sample of studies it was agreed with QCA to focus on those reviews from which the six main findings were derived. Within this group, the review focused on systematic reviews which clearly identified and fully referenced those studies from which the review findings were synthesised.

In 13 of the systematic reviews, the researchers identified those studies on which they had based their in-depth review findings. One study (Anthony & Walshaw, 2007) had not identified the key studies in this way. The project co-ordinator contacted the author who kindly provided an annotated bibliography of the 50 studies on which the review findings had been principally based.

The number of studies in the sample was therefore 233.

Filtering studies for relevance to the review questions

The 233 studies were initially filtered via the abstract. This initial filter excluded:

- unpublished theses
- studies published in a foreign language
- think pieces. (i.e. theoretical discussions of non-empirical research.)

In order to qualify for inclusion in the review, studies needed to have evidence of student impact and relate to at least one of the 11 review questions. For this review, acceptable measures of student impact included:

Test by comparing pre-test and post-test results for specified tasks
Test against a control group/s
Measured via observation by neutral party

Exclusions:

- Student impact that was measured solely by teacher questionnaire or observation was excluded.

Given the variable reliability of the abstracts, reviewers screened them inclusively. In other words, where the abstracts provided sparse information, the studies were kept in the review at this stage of the filter process. 38 studies failed at the abstract filtering stage, leaving 195 studies, of which 168 were retrieved. Unfortunately, 27 studies were not publicly available. The same filtering process was then applied to the full-text of the studies.

For studies which passed the second stage of filtering, reviewers identified one or more of the review questions for which the study was likely to yield evidence. 68 studies passed the full-text filtering and went forward for detailed data extraction. During the data extraction phase, a further 5 studies were excluded from the review, either because they did not relate to any of the review questions or because on closer inspection there was no or insufficient student impact data. The aim was to only include studies that reported student impact as described in the above criteria. Hence the review findings in relation to each of the 11 questions are based on the evidence from the 63 remaining studies.

Characteristics of the Research

Table 1: Breakdown by date

Year	No of Studies
1982	1
1984	1
1988	1
1989	1
1990	1
1992	2

1993	4
1994	1
1995	5
1996	5
1997	5
1998	2
1999	8
2000	8
2001	4
2002	5
2003	4
2004	1
2005	3

The breakdown by year shows that the studies were fairly evenly spread over a period 10 of years (1995-2005).

Table 2: Breakdown by Country

Country	No of Studies
Australia	1
Belgium	2
Canada	1
China	3
Finland	1
Israel	2
Latvia	1
Netherlands	4
Romania	1
UK	11
USA	35
Not indicated	1

The analysis by country shows that over half of the total originated in the USA. The next largest group was from the UK.

Table 3: Breakdown by Sample Size

1-50	7
51-100	7
101-250	20
251-500	7
501-1000	4
1000+	3
Not Stated	15

Table 4: Breakdown by Phase

Primary	24
Secondary	23
Primary and Secondary	3
Post-16/Higher	6

Education	
Not Stated	7

In the study descriptions in this review we have used the researchers' own terminology in respect of 'students' or 'pupils' and in respect of grades and levels of schooling. As there are a substantial number of US studies included in the review, Appendix 1 sets out the equivalent levels and ages of students in both countries

Table 5: Breakdown by Method

Control group	32
Pre- and post test	26
Post test	11
Interviews	16
Questionnaires & Surveys	22
Classroom Observation	7
Analysis of learner data	6
Longitudinal study	2
Discourse analysis	1

Table 6: Curriculum focus in relation to each review question

Question	1	2	3	4	5	6	7	8	9	10	11	Totals
No Stated Subject	3	3		1		3	1	1		1	3	16
Cross-curricular	4	1	4	1	3	1					1	15
ICT			3							1	2	6
Science	8		7	4		5		3	4	1		32
Maths	2	3	3	3		2		1	1			15
History	1								1			2
MFL	2		1	3					3	2		11
Citizenship	4	1					2					7
English			1			2			2			5
Totals	24	8	19	12	3	13	3	5	11	5	6	

Table 6 shows the spread of the curriculum areas in which the interventions in the studies were based. The dominance of science in relation to (1) context-based learning and (3) collaborative learning and structured group work is notable. Teachers' subject knowledge (6) also features strongly in relation to both science and maths.

Adding depth and understanding: an exploration of the individual systematic review studies

Our aim in exploring the studies in more detail was to offer QCA a range of illustrative examples of successful (i.e. in providing evidence of impact on students) curriculum interventions related to previous findings and (where possible) QCA claims. Previous findings related to questions about 'what works?' For the purposes of this review, the processes we have adopted means that the answers to 'what works' are taken as given. They are used to interrogate the studies in order to answer the practical question ' how and in what ways was the intervention tackled?' The majority of the studies in this review involved more than one school and made use of control groups. As is the case with so many reports of research

studies, the amount of information with regard to the intervention processes varied a great deal from study to study.

For the most part the review process identified many more studies which illustrated the original map findings (ie questions/sections 1-6) than the QCA claims. This is hardly surprising as we retrieved studies synthesised in reviews from which the map findings were drawn.

In some cases, studies spanned more than one of our questions. In each case the information has been selected and separately reported as it relates to the individual question. However it is clear that many of the interventions made use of a mixture of pedagogical processes rather than just one.

What is the evidence about content, learning and teaching when learning is related to real world contexts?

(Or: How can we make the curriculum context based?)

Context based teaching explores phenomena in real or simulated situations and, we know from the reviews, can be effective across the curriculum. Such approaches help to include all students because they draw on contexts with which the students – particularly those from minority groups – are familiar.

The review found a wide range of approaches to context-based learning: from active in-the-field community-based or 'service' learning to connecting language learning with students' real life experience. We also found considerable overlap between context-based learning, extending the curriculum to home and community, working collaboratively and building on what students know and can do already. The following studies offer examples of interventions which employed context based learning in different curriculum areas.

Eight of the seventeen studies which evaluated interventions which related learning to real world contexts were concerned with science teaching and learning.

Context based learning in Science.

Using a play: 745 students from 11 high and 2 upper middle schools in this study were introduced to genetics and genome mapping though a science theatre play. Students found the play useful for learning because it was based on real life and on everyday settings and use of language. They found conflict between the characters to be a useful way of bringing to life the ethical dilemmas. The play made more real, visible and audible the complex issue of mapping human genes and effectively linked ethical and scientific issues. The proportion of students who could describe and explain the pros and cons of genetic mapping rose significantly (Black & Goldowsky, 1999).

Physics and everyday life: The Dutch Physics Curriculum Development project (PLON) has run from 1972 with the aim of modernising physics teaching in secondary schools. Pupils on PLON learn physics within the context of nature and technology and from questions taken from daily life and society. The PLON's real-life context is reflected in the course title. For example: Traffic and safety; Energy at home etc. In this evaluation PLON classes gained higher levels of cognitive achievement than control classes (Wierstra, 1984)

Physics and everyday life:

The study explored the effect of a new physics curriculum unit based on basic concepts and skills set in everyday contexts. For example: working with water, traffic, weather changes and music.
There was no significant difference between the secondary programme experimental students (209) and the controls (355) in terms of cognitive outcomes. Although students perceived the lessons as more reality based they did not appreciate them as better learning environments (Wierstra & Wubbels, 1994).

Interestingly the intervention in this study was similar to that in the PLON programme. Measurements were similar too. The differences might be explainable in terms of the length of time the students were immersed in the new physics curriculum (PLON) and the fact that it was a whole programme as opposed to just one unit.

Integrating reasoning: This study examined the outcomes of a learning unit that integrated teaching of reasoning (argumentation) into the teaching of a specific science topic (human genetics.) As part of the students' preparation for argument (ie giving an answer and justifying it with a relevant piece of information) they discussed moral problems (such as the case for and against abortion) from everyday life and the importance of honesty in dealing with them. Results showed big increases in the experimental group's use of effective argument. Test results also showed that students were able to transfer argument strategies used in everyday contexts into the scientific ones of genetic dilemmas. The frequency with which students used correct biological knowledge in constructing arguments also increased. The study involved 99 (experimental) and 87 (control) 9th grade students in Israel (Zohar & Nemet, 2002).

Integration of real societal issues into science classes: This case study examined how students engaged and achieved in a science programme which integrated science topics with an exploration of societal and moral issues. A modular curriculum structure included content for chemistry, physics, biology, technology and society. For example, a learning unit called the Fat and the Slim covered topics such as digestion, structure of fats and sugars and metabolic rates as well as anorexia and obesity. Students' test results increased by over 10% (Huppert, 1992).

Coaching exploratory talk: This comparative study of two groups of 9-10 year old children explored the concept of general thinking skills and group talk which could be used across the curriculum. It involved the use of case studies set in a 'real' situation: eg children role-played scientists aiming to help a friend with the local flower show. They used simulation software which showed how plant growth was affected by temperature and amounts of heat and light. The approach led to improved group problem-solving and improved scores in reasoning tests. The researchers used off-computer lessons followed by on-computer lessons using specially designed educational software. Their findings support the effective use of computers in supporting exploratory talk amongst children and directing this towards curriculum ends (Wegerif, 1996).

Using the lives of scientists for African American students
The study investigated the effects of a science learning programme on African American students in two rural high schools. It involved students in applying the methods of science in the context of the real lives of African American scientists. The experimental groups showed significantly greater gains in cognitive abilities and (especially for males) in self concept development (Faubert *et al*, 1996).

Examples of context based learning in other curriculum areas

Seven further studies covered a wide range of curriculum areas and used distinctive approaches to context based learning. These were:

- Community service linked to behavioural change
- Developing critical thinking taking an integrated approach to the curriculum
- Developing mathematical modelling based on real world activities
- Understanding citizenship using experimental civic texts based on participatory democracy
- Using Socratic dialogue and real world issues to develop reasoning and other skills
- Using familiar material in language learning for second language learners
- Developing practical intelligence by drawing on life outside school

Service Learning

In this largescale (17 middle and high schools and c. 1,000 students) Learn and Serve America programme, students worked in a range of voluntary contexts, including as tutors, nursing aides, with disabled children, helping to manage city Food Banks. The research found positive short term impacts on a range of civic and educational attitudes and behaviours – (eg towards cultural diversity and service leadership) but that these appeared to fade over time. Follow up study showed that there is little evidence that one-time participation in a service learning programme produced substantial long-term benefits. This suggests that such programmes may need to be sustained over time.

Developing critical thinking: Facing History and Ourselves was an interdisciplinary, moral education programme based on the Holocaust and WW2 to develop middle and high school students' critical thinking abilities. The programme aimed to make connections between historical events and current issues. The study involved 64 students from 2 8th grade classes from a predominantly African-American, public school. One class received the programme, the other was a control. The programme was implemented by six teachers in language arts, history, French, mathematics, science art and music. Teachers met with the facing History co-ordinator and developed plans for implementation. The experimental group showed significantly greater gains in historical knowledge of the period, greater increase in reasoning about human relationships and implications of one's actions.

Developing a culture of more realistic mathematical modelling: Three classes of boys aged 10-12 in Belgium were involved in this study, with two classes acting as control groups. The experimental class was immersed into a classroom culture in which word problems were conceived as exercises in mathematical modelling to elicit real-world responses, discussion and understanding of maths in order to test the hypothesis that it is possible to develop a cluture of more realistic mathematical modelling. Five teaching/learning units of about 2.5 hours each were spread over two and a half weeks. The experimental class was given word problems to ground the maths in a real world context. For example, solving number problems relating to collecting comics. This class made significantly higher gains in post tests than two control classes. Hence understanding improved through the application of real world scenarios in mathematics (Verschaffel & De Corte, 1997).

Real-world participatory characteristics of citizenship:

Researchers investigated the impact of the use of experimental civic texts in 109 7th and 8th grade students from four schools in Romania. The experimental group used these civic texts instead of the official ministry textbooks used by the control group. The study was conducted in 1994/5 while Romania was undergoing a transition from totalitarian to a democratic country. The study confirmed that civic education is deeply rooted in the

country's political and historical context, with challenges for civic education for countries in transition. Students in the experimental group demonstrated gain in rating the participatory characteristics of citizenship. There were no significant gains in this category for the control group. Students in both treatment and control groups rated very highly the importance of obeying the law and honouring one's country (Tibbitts, 1999).

Using Socratic dialogue/philosophy approaches to explore impact on a range of student outcomes:
The study explored the effectiveness of dialogue/philosophy approaches to learning on 123 7-8 year olds, using real world contexts. The main focus of the discussions was "Our responsibilities to our environment." The children explored, for example, the rights and wrongs of cutting down tress in terms of the possible effect on humans as well as discussing whether trees had value in their own right. The experimental group made significant gains over the control children in reasoning, motivation/self image, and playground behaviour but there was no significant difference in reading ability and fluency or written English (Fields, 1995).

The role of familiar material in language learning for second language learners:
This study explored the role of schemata in language learning for second language learners (188 Spanish learners of English at a US university.) The researchers explored the effect on listening comprehension of material familiar to listeners in their own culture. Students listened to one familiar (a well known rock band) and one unfamiliar (a gold rush) topic of equal length. They produced more correct responses about the familiar topic showing that they drew on background knowledge as well as linguistic knowledge (Long, 1990).

Context based development of practical intelligence:
This study evaluated a two year metacognitive intervention programme aimed at developing practical intelligence for 514 US middle school students in reading, writing, homework and test taking. Lessons drew in students' experiences from their lives outside school. For example in a discussion about the purpose of tests students were asked about the kinds of tests they might undergo outside school. Skill-building was based on students' own experiences and inclinations. Experimental students' gains were significantly greater than controls on practical intelligence (skills) development – that is, reading, homework, writing and testing. There were also significant gains in 'academic intelligence' for the experimental groups in reading, writing and academic summarising (Williams *et al*, 2002).

What is the evidence about content, learning and teaching when connections are made between the curriculum and learning in the pupils' home and community?

(Or: How can we connect the curriculum with parental involvement and the community?)

The initial review found that inclusive, context based teaching and learning and citizenship education that connects with the students' community beyond the school can make a difference to student learning. The review also highlighted the effectiveness of connecting the curriculum to students' learning in the home and of involving parents in their children's learning. The research highlights strategies for promoting conversations between children and their parents at home, through, for example, setting interactive homework activities specifically designed to involve parents.

There are overlaps here with studies in the context based learning section above. For example, the Learn and Serve America programme: to help young people develop as

responsible citizens, improve academically and develop as individuals through integrating service learning into school programmes. Students were involved in a wide range of community activities, as teachers' aides, nursing aides etc. The positive short term impacts mostly faded over time and there was little evidence that one-time participation produced substantial long-term benefits. This suggests that further research into home and community extended learning activities probably needs to be extended over time and that such activities themselves need to be sustained rather than one-off.

A further study involving service learning found that the Community Connection programme in Texas was having a positive impact on students with regards to achievement levels, attendance and behaviour. The programme provides opportunities for students to form ties with the community through service and students were reported to have gained a sense of the ethic of service, and feel a sense of accomplishment (Garcia-Obregon *et al*, 2000).

Mathematics featured strongly in this section as researchers and schools developed a number of strategies for involving parents in their children's mathematics learning with positive results. But it was interesting to note the successful involvement of parents in school improvement planning and in developing inclusivity, alongside the more commonly found attempts to involve parents in supporting reading and maths learning.

Mathematics 1:
Parental involvement and reciprocal peer tutoring:
Three groups were set up in this study involving 72 4th and 5th grade students who were experiencing difficulties in mathematics:

- home based parental involvement plus reciprocal peer tutoring; (PI plus PT)
- parental involvement (PI)
- control.

Parental involvement took the form of regular home-school communication that emphasised students' achievements; parent-student celebrations of students' school efforts that included parent-student conversations about the students' mathematics work at school. PI by itself did not lead to gains in mathematics achievement in solving problems but it did lead to significant gains in self esteem. The PI plus Peer Tutoring group achieved higher assessment scores in mathematics as well as higher self-concept (Fantuzzo *et al*, 1995).

Mathematics 2: family and community involvement activities:
This study investigated whether eight specific mathematics related family and community involvement activities affected students' achievement. Ten elementary and eight middle and high schools from seven US states participated.

Mathematics partnership practices included:

- daytime and evening parenting workshops (on their maths skills and expectations);
- individual meetings with parents whose children were at risk of failing maths;
- requesting parents or community volunteer tutors for the students;
- inviting parents and community to assemblies for student awards for excellence in maths ;
- offering parents and students mathematics game packs to use at home;
- assigning students maths homework that required them to show and/or discuss with a family member;
- offering students and families maths activities on Saturdays;

- organising presentations for students on how mathematics is being used by business, government and industry.

Researchers found that family and community involvement activities improved students' learning and achievement – particularly learning at home that encouraged parent child interactions. It also found that parents' beliefs and expectations could influence their children's achievement in elementary and middle schools. Students whose parents met with a math teacher to discuss ways of helping their children at home achieved more in mathematics than the students whose parents did not receive such training.

'Interactive' homework which was designed to involve parent-child activities enabled families to communicate more easily about homework assignments. The researchers found that it also resulted in increased homework completion.

The effects of Partnership Practices in the schools in almost all instances were rated positively. There were dramatic differences in student achievement between the schools that did and did not conduct workshops during school hours and the schools that did and did not assign interactive homework involving children and their parents.

The analyses indicated that 'learning at home activities' consistently related to improvements in students' performance on mathematics achievement tests.

Mathematics 3: Cultural practices out of school in relation to mathematics
(It is worth pointing out that this is study different in kind – partly because it introduces another variable – culture. It is thus focused specifically on the needs of particular groups of students.)

This study examines the relationship between ethnicity, out of school activities and arithmetical achievements in Latin American and Korean American children in 1st to 3rd grades. The research found a strong association between children's performances at school, their ethnicity and their engagement in out of school activities. The researcher's starting point was the theory that children's mathematical practices reflect the values and practices of their communities. Activities with money are most common uses of mathematics outside the school. The Korean children had not been exposed to money at home whereas this had been encouraged by the Latin American community. LA children correctly solved more mathematical tasks using money and Korean children correctly solved more tasks with denominational chips (Guberman, 2004).

Other foci for interventions in the illustrative studies below were:

- increasing intervention in reading skills;
- inclusivity: Involving parents in developing incllusivity;
- parental Involvement as a means of raising achievement for disadvantaged groups;
- The National Partnerships for Change Programme;

Increasing intervention in reading skills:
This study involved six schools in Haringey and 400-500 6-9 year old students. The researchers set up a comparative study of pupil groups: one with targeted parental involvement, one with extra teacher help and one acting as a control. In the parental control group parents were asked to listen to their children reading several times a week. This was followed up with visits to the child's home several times a year. Researchers developed relationships with the teachers and parents. They met them at parents' evenings, at home

and at the school gate and occasionally helped parents in the process where necessary. Both the parental involvement group and the extra teacher help group showed a marked improvement in the quality of their understanding. However this was stronger in the parental involvement group (Tizard, 1982).

Inclusivity: Involving parents in developing inclusivity:
In this US school focus group research was used to investigate the alignment of inclusive education with other reforms. Parents and staff worked in focus groups with pupils of all abilities to build up a shared consensus from which to embark on a unified school reform programme. Parents were regarded as part of the reform programme, and were asked about their participation in school activities. Of the 347 students, 40% were Latin American, 29% African American, 15% European American and 7% Asian American. 50% qualified for free school lunch. The school offered bilingual education to 8-9 year old native Spanish speakers and provided education for students with severe disabilities. Reforms were targeted at integration.

Disabled pupils experienced greater competency and self esteem, and achieved better academically and developed socially. All students who took part developed cross-cultural respect (Hunt *et al*, 2000).

Inclusivity 2: Parental Involvement as a means of raising achievement for disadvantaged groups
This meta analysis of 41 US studies examined the relationship between parental involvement and the academic achievement of urban elementary school children focusing on :

- the degree of association of parental involvement with levels of school achievement;
- the influence of parental involvement programmes;
- different aspects of parental involvement;
- the relationship between parental involvement and academic achievement across ethnic minority and disadvantaged students.

The results indicate a strong relationship between parental involvement and academic outcomes for urban students. The PI intervention included communication between home and school about student progress, parental involvement in homework, sharing expectations about student achievement, helping with reading, and encouraging regular attendance and participation in school activities. It was particularly associated with higher achievement for students of racial minority and disadvantaged students (Jeynes, 2005).

National Institute for Urban School Improvement
85 schools are involved in the partnerships for change programme within the National Institute for Urban School Improvement in the USA. School, parents and community are linked through health services, enrichment opportunities and other community based programmes. There were positive gains for students' learning from the common vision and goals. Many programmes and field trips included parents and encouraged family participation. As well as becoming an important part of the community, it reduced the number of students performing below the basic level and maintained high attendance rates. Researchers conclude that successful and sustainable change is more likely in schools where everyone shares a common vision and goals and where all contribute their individual talents and enthusiasm to the change efforts of the community (Ferguson & Blumberg, 2001).

What is the evidence about content, learning and teaching when collaborative learning and structured dialogue in group work take place?

(Or: What do we know about structured dialogue in group work and collaborative learning?)

We know from a particularly strong research base in this area that collaborative learning and structured challenge in group work are effective learning strategies. What these and other studies demonstrate that it is only when teachers provide clear guidance for groups to follow, tasks to undertake and activities that help students develop the skills they need to work collaboratively that collaboration and group work have benefits for pupils.

In groups where learning is not collaborative there may be no specific requirement that students work together; they often work individually, albeit side by side, on tasks for their own ends. The studies in this section show how the teacher can make group work collaborative by structuring activities that generate effective patterns of discussion.

Again there is considerable overlap in this section with the one on context based learning, as well as some which employed strategies for home and community involvement and building on students' current understandings. In other words, many interventions made connected use of multiple strands of research evidence about 'what works'.

The contexts for foci for collaboration

Science features strongly as a subject vehicle for interventions based on collaborative pedagogies. The development of problem-solving and reasoning skills also featured strongly in their own right, in some cases aided or supported by guided use of ICT. There is an interesting study of parent/student/teacher collaboration in a whole school reform project and one study introduces the notion of parents collaborating with their children in their learning: a different perspective on the area of parental involvement.

Three studies involved the use of ICT in collaborative group work; seven were science based and three were mathematics based. It is particularly interesting here to note the different types of tasks and activities which can be used to generate collaboration for learning. They range from setting very clear ground rules for the collaboration itself, to the use of Socratic dialogue, assigning roles such as 'explainer' and 'summariser' and structuring the tasks themselves to ensure maximum collaboration. In some cases students were required to reach a group consensus; in one case the teacher used open questions and positive encouragement to scaffold talk and ensure full participation in discussion. In another, students were equipped with the skills and protocols to act as mentors.

The foci for the studies described below are:

- **ICT:** TRAC (Talk, Reasoning and Computers)
- Collaborative computer based work
- Using ICT for metacognitive training
- **Science:** Applying a thinking skills programme to chemistry learning
- Understanding physics concepts through group discussion
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- Comparing whole class and group work interactions
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- The impact of philosophy approaches (x2)
- **MFL**: Developing students listening comprehension in German

ICT

ICT: TRAC (Talk, Reasoning and Computers).

This study involved 60 children aged 9-10 years and their teachers. The programme developed children's reasoning and collaboration skills by developing their awareness of language use and promoting 'ground rules' for talking together for learning. The teachers undertook appropriate CPD and took the children through a series of lessons to show how the rules work. The rules are based on evidence about building exploratory talk, in which partners engage critically but constructively with each others ideas. Statements and suggestions are offered for joint consideration. These may be challenged and counter challenged but challenges are justified and alternative hypotheses are offered. Using experimental and control groups and pre and post tests, researchers found that children's use of language and problem solving scores increased (Mercer *et al*, 1999).

ICT: Collaborative computer based work

This study begins with the researcher's premise that due to lack of resources in many classrooms working in pairs is common and sometimes unavoidable but that suitable programs for small group work are rarely available. Students in the study were engaged in collaborative computer based work, taking on roles such as the explainer, the summariser and the listener in mixed ability dyads. Some worked with verbal instruction cues. The results showed that students with these cues performed better and with less off-task behaviour. The children's ability to interact with the computer and with each other improved, as did their summarising skills (Sherman & Klein, 1995).

Using ICT for metacognitive training

This study investigated the effects on students' problem-solving of metacognitive training implemented within a Logo environment (computer software that can be used to represent and display quantities and graphs). Sixty-eight 12-14 year old students took part. Both groups used Logo but the experimental group had input from teachers designed to develop metacognitive awareness and the control group did not. The experimental group worked collaboratively in pairs on structured tasks. They decided what to investigate (eg gender differences in buying swimsuits) they collected data from companies and discussed which type of graph would best fit the data. All students were pre and postested on a graph construction test. Students were also interviewed. The treatment group constructed better graphs and could talk in more detail about both the mathematics and the reasoning they had used (Kramarski & Mevarech, 1995).

Science

Science: Applying a thinking skills programme to chemistry learning

This experimental study looked at the application of a thinking skills programme – Feurstein's Instrumental Enrichment – to the teaching of chemistry to 14 year olds. 21 students were split into two groups, a control group of 10 and experimental group of 11. The experimental group was taught a chemistry module designed to compensate for cognitive deficiencies displayed in interviews. Discussion was followed by experimental work and then further group discussion in which every student was encouraged to participate and each was given continual positive support by the teacher acting as facilitator. The teacher questioned students to facilitate and scaffold discussion but did not provide answers. Mean post test score for the experimental group was 58.8% compared with 38.1% for the control group which had been taught the module normally (Strang & Shayer, 1993).

Science: Understanding physics concepts through group discussion
The study examined whether understanding of underlying physics concepts can be developed by confronting groups of students with varying views. Pupils worked collaboratively on three problems by considering and confronting each other's ideas. In a feedback session they considered multiple solutions for each problem and compared the answers with their own solutions. Pupils were required to reflect together not only on the specific problems and problem solving strategies but also on their approach to learning physics in general. Pretest and post test scores and interviews showed that pupils' understanding increased and problem solving skills improved. Pupils were also enabled to see things differently: that there are several problem solving strategies for the same problem; and that there are different learning approaches for physics (Tao, 2003).

Science: Cognitive Acceleration in Science Education
The study assesses the impact of CASE on the cognitive development of children in Yr 1 (5-6 year olds) in primary classes in an inner city area. 300 children were involved in the experimental group and 170 as matched controls. The experimental group showed gains in tests over the control group with girls making the greatest gains. Children in the experimental classes experienced 29 activities aimed at promoting cognitive conflict and promoting social construction of knowledge and understanding. The pupils are given introductory lessons to prepare them for: listening to others, respecting others' views, disagreeing constructively and building shared understanding. During the activities the children talk about new ideas, ask each other for explanations and justifications, build on each other's explanations, seek to reach an agreed answer to a problem (Adey *et al*, 2002).

Science: Learning through group discussion in biology.
The study explores the effects of including a prediction/discussion phase in students' learning cycles in biology. 250 high school students were involved with five teacher-researchers. Peer group discussion following hypothetico-deductive reasoning was used to help make students aware of other students' views, stimulate argument and enhance students' abilities to reflect on and support their own views. (Hypothetico-deductive reasoning is the capacity to think of all possible factors that might affect the outcome of a problem and test them in an orderly fashion.)
The experimental students made significantly larger gains in conceptual understanding, process skills and logical thinking. They used more higher level thinking, exposed more misconceptions and asked more questions (Lavoie, 1999).

Science: Peer and self assessment in physics learning
This study evaluated the effects of a cognitive learning programme on:

- students scientific inquiry expertise;
- their physics knowledge;

- their attitudes to learning science.

The study involved three teachers and 12 classes in grades 7-9. The basis of the learning was collaboration among students using peer and self assessment. Students were enabled to construct new ideas and explanations. Peer and self assessment activities were introduced by teachers to give students the opportunity to check what they were doing and to scaffold their learning. Programme students achieved better than matched control students, especially the case for low achievers. They also outperformed older students on a series of physics questions (White & Frederiksen, 1998).

Science: PLON
The Dutch Physics Curriculum Development project (PLON) has run from 1972 with the aim of modernising physics teaching in secondary schools. Pupils on PLON learn physics within the context of nature and technology and from questions taken from daily life and society. The PLON evaluation showed that the more inquiry-based the classroom environment, the more favourable the pupils' attitude to physics, and the greater the cognitive achievement. PLON lessons are often split into 3 parts: an orientation on the theme; investigations (often in small groups in which groups may choose their own topic of enquiry, including planning and carrying out experiments) and integrations and evaluation (Wierstra, 1984).

Science: Peer mentoring in science
The study investigated the effects of a science learning programme on African American students in 2 rural high schools – the students had low SES backgrounds. There were two experimental and two comparison groups. In the experimental groups students learned science in the collaborative role of helping a peer. 10th grade students were trained to coach 9th grade students in scientific methods of investigating a research topic. Graduate students acted as assistants. The students took on roles as scientists and mentors. The experimental groups demonstrated significantly greater gains in cognitive abilities, especially for males, and for self-concept development (Faubert *et al*, 1996).

Mathematics
Maths: Reciprocal peer tutoring in mathematics
The study examines three types of intervention: home based parental involvement plus reciprocal peer tutoring; parental involvement and control. The first group (PI plus PT) achieved higher assessment scores in mathematics although both the PI groups showed higher self esteem. The collaborative element here was that students were randomly put into pairs and trained in the intervention processes which included taking on alternating roles as teacher and student in tackling computational problems. Students who took on being the teacher had to keep their students on task, give prompts and provide praise and encouragement. They had to observe their peers working and coach them to try better strategies (Fantuzzo *et al*, 1995).

Maths: Using collaboration for developing real-world mathematical modelling
This study involved three classes of students: one experimental and two control groups. Mixed ability groups of maths students aged 10-12 were given individual real-world problems and asked for an agreed common response. They were then asked reflective questions such as 'on what points did you disagree?' Followed by whole-class discussion in which answers, problem solving steps and additional comments were compared and evaluated. The aim was to test the hypothesis that it is possible to develop a culture of more realistic mathematical modelling. Each group was then given new worksheets with four or five problems with or without the same underlying difficulty as the opening problem, which

was also followed by a class discussion. This was followed by individual work on similar problems. Results from the pre and post tests were measured in terms of realistic reactions from the students. The control classes increased from 20-34% and the experimental increased from 7% to 51% (Verschaffel & De Corte, 1997).

Maths: Student-student and student-parent collaboration
The study used three groups: one with Parental Involvement (PI) plus reciprocal peer tutoring (RPT), one with just just RPT and one as a control. 84 African-American fourth and fifth grade students (average age: 9.9) showing poor performance in maths were selected and randomly split into three groups. One group received reciprocal peer tutoring (RPT) and parental involvement (PI), one received just RPT and the third was control. Each intervention session was 45 minutes long and occurred twice weekly. Following an initial diagnostic test students were split into three groups based on ability levels. Curriculum-based computational tests were then administered to each group based on skill level, and with a strict time limit to measure both ability and speed of calculation. These were measured against a Standard Diagnostic Mathematics test (SDMT, p 520). Students were then measured against a Teacher-Child Rating Scale (T-CRS, p 521) to determine behavioural and emotional factors, and a Child Rating Scale (CRS, p 521) to determine the effect of socioeconomic background.
At the conclusion of the intervention the PI and RPT group showed the highest rate of accurate computations on a curriculum based measure. But students who received RPT were more socially confident than the control group (Heller & Fantuzzo, 1993).

The development of thinking skills and other outcomes of collaborative working

Developing students listening comprehension in German. Fifty college students of intermediate German classes took part: 23 in experimental groups and 17 in the control group. The experimental classes used video and audio 'illustrations' for brainstorming sessions for vocabulary. Students worked in small groups answering quiz questions and collaboratively competing a 10 item cloze procedure based on the text. The teachers gave the students access to video and audio tapes and they were encouraged to make use of them as often as they wished. They asked pupils to discuss the passages and engage in role plays and other interactive activities. Post test scores showed that the experimental groups had more significant gains than the control group. They demonstrated significant improvement in listening ability (Teichert, 1996).

Collaboration as a means to whole school reform
This project involved the use of focus group research to align inclusive education with other reforms at a targeted urban school. Teachers, parents and students were involved in discussion and in jointly setting the direction for reform. However the nature of the task and the collaborative processes through which agreements and outcomes were achieved, were linked with many benefits for participants. Students who took part in the unified programme gained knowledge and direct experience of a second language and culture. Through that process, they developed cross-cultural respect. All pupils learned to work through differences to complete tasks. Disabled students experienced feelings of competency and self esteem, achieved academically and developed socially. Teachers and parents described how students in inclusive classrooms or during mixed language groups learned to work together to plan and complete interactive educational tasks despite the fact that members of the group might speak different languages, represent various cultures or present varying levels of academic ability (Hunt *et al*, 2000).

Comparing whole class and group work interactions
This study compares the interactions between teachers and pupils in whole class and group work situations during literacy hour (part of the NLS.) Researchers wanted to see whether interactive whole class teaching promotes higher levels of interaction and cognitive engagement in pupils. Researchers analysed the lessons of 70 teachers. They found that teachers used more explaining, reading and repeating and used more open and uptake questions during whole class teaching. Teachers used more direction and more teacher answers during group work. Teachers tended to use a larger number of lower cognitive interactions with fewer challenging questions and sustained interactions when working with smaller groups. Thus the smaller group work tended not to promote higher levels of pupil interaction and cognitive engagement (Hardman & Smith, 2003).

Developing thinking skills through group talk
This study explored how the development of thinking skills through group talk could be used across the curriculum. The experimental group of 33 mixed ability children aged 9-10 worked in groups of three as well as in a whole class setting. In two lessons they made use of especially designed educational software. They were trained in effective listening, giving information and co-operating in a group. They were also given ground rules for talk. The study found that coaching for exploratory talk leads to improved group problem-solving, can improve test scores in reasoning and that computers can be used to support exploratory talk amongst groups of children and to direct this towards curriculum ends (Wegerif, 1996).

Group work: a comparison between effects for SEN and mixed ability children
The study investigated the impact of a technology supported historical investigation for 28 grade 5 students with learning disabilities against a comparison group of 59 mixed ability grade 5 students who received the same intervention. Most activities were conducted in collaborative groups, including analysis and interpretation of historical evidence and construction of multimedia projects. Group work was structured to promote constructive conversation where students' questions and interpretations could be addressed. The SEN students did not benefit as much as the comparison group in relation to knowledge and understanding but they benefited equally in terms of self-efficacy (i.e. their belief that they had the capacity to learn and achieve) (Ferretti, 2001).

The impact of philosophy approaches
This case study evaluation explored the effectiveness of Socratic dialogue/philosophy approaches on 123 7-8 year olds from a private school and a state school. Impact was measured using achievement tests, reasoning tests taped discussions and observations. The experimental group made significant gains over control children in reasoning tasks, improved behaviour and self image. They also engaged in dialogue that produced both a breadth and depth of insight. There was no difference in reading ability or written English. Children worked collaboratively using books from Philosophy for Children and other sources. Teachers used the books, passages of music, pictures and TV to stimulate discussion (Fields, 1995).

Group discussion and joint problem solving
This study evaluated the Socratic seminar method of group discussion and joint problem solving. (The Socratic method of teaching is based on Socrates' theory that it is more important to enable students to think for themselves than to merely fill their heads with "right" answers. Therefore, he regularly engaged his pupils in dialogues by responding to their questions with questions, instead of answers. This process encourages divergent thinking rather than convergent.

Students are given opportunities to examine a common piece of text, whether it is in the form of a novel, poem, art print, or piece of music. After reading the common open-ended questions are posed. Open-ended questions allow students to think critically, analyse multiple meanings in text, and express ideas with clarity and confidence. Dialogue is exploratory and involves the suspension of biases and prejudices. By contrast discussion/debate is a transfer of information designed to win an argument and bring closure. The theory is that once teachers and students learn to use dialogue, they find that the ability to ask meaningful questions that stimulate thoughtful interchanges of ideas is more important than "the answer."

Participants in a Socratic Seminar respond to one another with respect by carefully listening instead of interrupting. Students are encouraged to "paraphrase" essential elements of another's ideas before responding, either in support of or in disagreement. Members of the dialogue look each other in the eye and use each other's names. This simple act of socialisation is intended to reinforce appropriate behaviours and promote team building.)

The study suggests that the Socratic seminar method can have an impact on skills both for teachers and for students. Though some teachers were not particularly interested in the method, some supported it due to an increase in team spirit, general understanding of school activity and an increase in planning skills. Students were found to have increased skills as well, particularly in the field of conflict resolution. The method was effective in promoting conflict resolution skills and encouraging students to pursue a 'win win' approach to disagreement as well as improving metacognitive and higher order thinking skills (Polite & Adams, 1997).

What is the evidence about content, learning and teaching when practitioners build incrementally on pupils' existing understanding?

Research, particularly in science and mathematics,[2] has shown that pupils often start with conceptual misunderstandings which, if they are not addressed, may inhibit achievement. Many of the studies already described in the context of the first three sections focused on structuring group discussions to focus and build on students' existing concepts and understandings as an important foundation for progression. The particular aspects of interventions that help teachers build increasingly on pupils' existing beliefs and understanding are identified here. It was interesting to note the emphasis on prior knowledge and understanding in language learning.

The studies described below focus on:

- metacognition in science;
- building incrementally on chemistry concepts;
- building on students' existing knowledge in language learning (German);
- building on students' existing knowledge in language learning (EFL) (x 2).
- building on students' existing knowledge in language learning (French);
- building on prior knowledge in language learning;

[2] Ann Dowker (2004) What works for children with mathematical difficulties? DfES Research Report 554 www.dfes.gov.uk/research

Millar R. & Gill J.S. (1996). School students' understanding of processes involving radioactive substances and ionizing radiation. Physics Education. 31 (1). pp27-33

- using past experiences in a metacognitive programme;
- understanding children's mathematical thinking;
- durable understanding of scientific concepts;
- assessing and building on children's skills and knowledge on entry and transfer;
- building on prior knowledge in physics;
- building on prior experiences in mathematics;
- understanding children's thinking in mathematics.

Metacognition in science
The study explores the effect of including a metacognitive element (building in structured opportunities for students to reflect on their thinking) in their science learning. Two classes of 7th grade students were involved. One group received an intervention targeted at both metacognition and content intervention, the other their normal curriculum. In the intervention class the students were asked to indicate what their prior knowledge was about a theme in the ecology unit and say how helpful they thought their prior knowledge was. They were presented with new data that challenged their existing views. There was evidence that beliefs students brought in from everyday life were difficult to shake even when scientifically accurate data were presented to them. There was initially no significant difference in ecological understanding across the two groups. But delayed post tests showed significant gains for the treatment group. Students were observed to be much more critical, requiring justifications for teachers' views; and discussion was livelier, they listened to each other more and were more engaged (Blank, 2000).

Building incrementally on chemistry concepts
The study explored the application of Feuerstein's Instrumental Enrichment programme to the teaching of chemistry to 14 year olds. Teachers build up students' understanding of concepts and ideas before they can fully understand what is being taught. The protocol involved 3 stages. Initially the students carry out the chemical reactions (enactive representation – ie they do the work and go through the process.) They then should be encouraged to form a concrete model to represent the atoms and molecules of the chemical reactions (iconic representation.) Finally they should use this to develop symbolic representation of chemical reactions in the form of chemical equations (symbolic representations.) The process is based on the premise that students will not be able to formulate symbolic representations without a foundation of concrete images on which to draw. The mean post test score for the experimental group was 58.8 compared with 38.1 for the control group (Strang & Shayer, 1993).

Building on students' existing knowledge in language learning (German)
This study was an evaluation of a project to improve students' listening comprehension in German. The research was based on the theory that foreign language learners must relate the incoming message to existing background knowledge. Experimental classes used audio and video illustrations for brainstorming sessions for vocabulary. Students worked in small groups answering quiz questions and collaboratively completing a 10 item cloze procedure based on the text. Posttest scores showed that the experimental groups had more significant gains than the control group. They demonstrated significant improvement in listening ability (Teichert, 1996).

Building on students' existing knowledge in language learning (EFL)
This study explored two cognitive processes in listening comprehension in large scale EFL tests for secondary Hong Kong students over a period of seven years. The researchers found that processing strategies underlying effective listening and reading have much in common;

- In both listening and reading comprehension, listeners and readers need to use their pre-existing knowledge to interpret the text and to create expectations of what they are about to hear/read. That was referred as 'top-down' processing;
- 'Bottom-up' processing involves a rapid decoding of lexical and grammar forms (is text based) and is considered less important.

According to this view, skilled readers are able to use their pre-existing knowledge to make predictions about the text, while poor readers are word-bound and unable to use context when they are reading. Another view is that the most efficient text processing would involve both 'top-down' and 'bottom-up'. This research suggests that skilled readers shift constantly between the two processes according to demands of the text they are reading (Tsui & Fullilove, 1998).

Building on students' existing knowledge in language learning (EFL)
The study explored the listening comprehension of 388 high and low proficiency Chinese Naval Academy students of English as a foreign language. It investigated two input factors: modification that included redundancies and elaboration; familiar or unfamiliar content (ie prior knowledge).

The study findings support the view that prior knowledge of a topic in their own culture (in this case Confucius and his teaching) helps listeners' comprehension as well as their reading comprehension. Prior knowledge provides learners with schema (categories) for assimilating and organising new information (Williams *et al*, 2002).

Building on students' existing knowledge in language learning (French)
The study explores the impact of narrow listening in French language learning. Narrow listening is when you listen to or watch different programs or speakers on the same topic. Each story or program will talk about the same things, using very similar vocabulary. By using narrow listening in this way, you can hear the same words used over and over again, and have more opportunities to understand and acquire them. Students' data were collected to find out the impact of narrow listening on their language development. The topics selected were based on students' prior learning from first language textbooks. Most students reported that they found narrow listening helpful for improving listening comprehension, fluency and developing vocabulary (Dupuy, 1999).

Using past experiences in a metacognitive programme
The study evaluates a 2 year metacognitive intervention programme aimed at developing practical intelligence for US middle school students in reading, writing homework and test taking. The study involved 514 9-13 year olds. The content of the learning is practical knowledge about being able to study and learn effectively in school. It is implemented throughout the four key activity areas reading, writing, homework, and testing (These are called PIFS - Practical Intelligence for School). Pupils are engaged in thinking about what they are already familiar with such as in the Knowing Why module they tackle questions like 'How is the writing they do inside of school like the writing they do for other reasons?' 'Why do they go to school?' 'Why are tests used in school?' Also for example the Knowing Self module involves pupils in assessing their own work and their personal strengths and weaknesses

The experimental-group teachers approached the teaching of PIFS project lessons as though these lessons were a normal part of the curriculum. They began the PIFS curriculum by working through the lessons in the introductory booklet and then were encouraged to use

subsequent booklets (and lessons within the booklets) in the order that best met the needs of their students and their standard curriculum. The teachers had considerable flexibility in what they emphasised. For example, one teacher felt that her students needed first to develop the organisational skills addressed in the homework booklet and so began by leading her class through all six lessons of that booklet. Another teacher wanted her students to practice note taking and reading skills as they carried out a social studies project. She began with a mix of lessons from the reading and testing booklets. Through weekly meetings with and observations with teachers and classes, the researchers ensured that the PIFS curriculum was being taught appropriately by all teachers, although allowing for individual teachers' customisation of the lessons to meet their own and their students' needs.

Experimental students showed significant gains in what the researchers call practical intelligence: reading, homework, writing and testing and in 'academic intelligence': reading, writing and academic summarising (Williams *et al*, 2002).

Understanding children's mathematical thinking
The study examines changes in beliefs and instruction of 21 primary teachers over a 4 year participation in a Cognitively Guided Instruction teacher development programme. Researchers gathered baseline data about teachers and their students and for three years led a CPD programme which focused on children's thinking. The aim of the programme is to help teachers understand their students' mathematical thinking and how this can form the basis for the development of more advanced mathematical ideas. Gains in students' concept development and problem solving appeared to be directly related to changes in teachers' instruction. Teachers ascertained what their students knew by questioning or reading descriptions of what the child had written and based decisions for learning progression on these. There was a consistent pattern of gains in student achievement for all the teachers participating in the study (Fennema, 1996).

Durable understanding of scientific concepts
This study explored the transfer of scientific skills and concepts and the durability of newly acquired scientific concepts. The study suggests that conceptual durability is important in teaching and learning: conceptual change requires the understanding of Concept A before Concept B (which is an extension or reinterpretation of concept A) The experimental group scored consistently higher than the control group on a sustained basis (Georghiades, 2000).

Assessing and building on children's skills and knowledge on entry and transfer
This is a longitudinal study of 202 students known to be entering one of four elementary schools from preschool to second grade. 44 poor learners were selected from this group. Phonological awareness was assessed in pre-school non readers. Listening comprehension was assessed in preschool and in first grade using comparative text series. Metacognitive processes and motivational orientation were also measured. The study shows that poor learners often have task-orientation and higher motivational vulnerability than other students. The students were helped to build an overall goal for their activities and to develop a concrete, holistic vision of skilled learning. Text comprehension strategies were explained, modelled and practiced. The post tests showed that the intervention pupils gained higher control over their cognition although they experienced difficulties with complex tasks and needed external prompts to carry out tasks successfully (Vauras *et al*, 1999).

Building on prior knowledge in physics

The study explored the effects of a new physics curriculum unit based on basic concepts and skills set in every day contexts of physics phenomena. The sample comprised 209 experimental and 355 control students in grade 10 in 24 Belgian school classes. A key first step is 'orientation' in which the teacher identifies and builds on students' prior knowledge through questions and discussion. (eg what factors are important for safety in traffic?).This leads into identified physics content for learning. Students can choose particular areas to study in more detail eg in relation to 'what factors are important for fuel economy in traffic?' groups of students can study friction on bikes, air resistance, fuel consumption of a motorbike. Cognitive outcomes on a standard physics test showed no significant difference between the programme students and the controls, who had followed the usual text book based curriculum. Although students perceived lessons as more reality based they did not appreciate them as better learning environments. (This study is an exception in that the results were neutral as between the two groups, begging questions about the pedagogical variables between this and other similar studies.) (Wierstra & Wubbels, 1999)

Building on prior knowledge in language learning
The study explored the link between the extent of prior study of a lecture topic on the performance of learners in tests based on lectures. It involved students on a university level intensive English programme. The study is based on the idea that learning second language comprehension depends on the interaction of: language input, linguistic knowledge of listener and world knowledge of listener. The key point is that while all learners use schemata (classifications of ideas) more highly skilled learners select more appropriate schemata. This reduces the amount of cognition they have to exert to link what they hear to what is available to them as prior knowledge. However prior familiarity with the material only improved the comprehension of learners in the case of technical lectures (Jensen & Hansen, 1995).

Building on prior experiences in mathematics
This study showed a strong association between children's performances at school, their ethnicity and their prior experiences. It involved two groups of young children from Latin American and Korean American backgrounds. The Korean children had not been exposed to money at home and the Latin American children had. LA children correctly solved more mathematical tasks using money and Korean children correctly solved more tasks with denominational chips (Guberman, 2004).

Understanding children's thinking in mathematics
This study investigated the effects on 40 1st grade teachers and their students of a program designed to provide teachers with knowledge about their students' thinking. Half were assigned to a control group. The study was based on empirical research which showed that children initially solved addition and subtraction problems by directly representing the action in the problems – they did not appear to have learned this through formal instruction. Experimental teachers taught problem solving significantly more and encouraged students to use a variety of problem solving strategies. They believed that instruction should build on the students' existing knowledge more than did the control teachers and they knew more about individual students' problem solving processes. Experimental students exceeded control students in number fact knowledge, problem solving, understanding and confidence in problem solving (Carpenter, 1989).

What is the evidence about content, learning and teaching when the curriculum is flexible and cross-curricular learning takes place?

The review found considerably fewer studies in this area than we had anticipated. The most likely reason for this is that we included only systematic reviews in the studies we retrieved, and in turn only those studies from the systematic reviews which had been included in the synthesis for the actual review question. (ie specific to science, mathematics etc.) This particular Map finding was related to six reviews, three of which were non systematic and therefore excluded. A few studies are described here but we are aware that there is a developing literature on curriculum integration,3 some of it relative to student impact. We therefore suggest that one of the reviews planned for the second year of the Building the Evidence Base project should focus on this area.

Learning across the curriculum

Facing History and Ourselves was an interdisciplinary, moral education programme based on the holocaust and WW2 to develop middle and high school students' critical thinking abilities. It was implemented by six teachers in language arts, history, French, mathematics, science art and music. Teachers met with the facing History co-ordinator and developed plans for implementation. The experimental group showed significantly greater gains in historical knowledge of the period, greater increase in reasoning about human relationships and implications of one's actions (Beyer & Presseisen, 1995).

Drama as a means of learning across the curriculum

The study investigated US high school reactions to a science theatre play. The use of a play as a medium for learning drew together dramatic and content elements. Plays can bring key learning points to life and lend themselves to cross curricular approaches. Science play about genetics and ethical questions. Students found the play useful for learning because it was based on real life and on everyday settings and use of language; the proportion of students who could describe and explain the pros and cons of genetic mapping rose significantly from pre to post test (Black & Goldowsky, 1999).

The Unified Studies programme

The Unified Studies programme involves 16-18 year olds. Subjects covered often involve working outside the classroom, hiking, animal studies, real world science etc. It is run by a pair of teachers with complementary disciplines such as science and art. Subjects such as nature study for example may involve all three of the sciences plus art and environmental study. 96% of pupils agreed that the programme made learning and school more enjoyable; 73% agreed that the programme 'was the most important or valuable part of my high school education.'; 60% said that it was more challenging than they had anticipated and 48% said they learned more from out of school experiences (Williams *et al*, 1995).

What is the evidence about connections between teachers' excellent subject knowledge and content, teaching and learning?

We know from the work of Shulman and others that if teachers are to be effective practitioners they need to have a deep knowledge and understanding of the subject matter

[3] See for eg Kathy Lake: Integrated Curriculum. SIRS series 1994; and Curriculum Integration, a sample of literature
http://k6.boardofstudies.nsw.edu.au/linkages/Curriculum/curriculum_literature.html

in order to be able to support children's learning through the use of appropriate pedagogies. Teachers draw on both their subject knowledge and their experience and knowledge of learning. Many of the studies described earlier are good examples of this, particular in the sciences. The role of professional development was highlighted in many of the studies described below. Two separate studies demonstrated how, with professional development in a particular approach (thinking skills) teachers improved their students' learning. Another showed how a programme of reform in science teaching and learning improved their subject knowledge, changed the way teachers taught science and improved student learning outcomes across a range of measures. We have also included a study of interactive whole class teaching as there were significant pedagogical differences in the approaches of 'effective' and 'average' teachers which might be linked to better literacy expertise in the former.

The studies described below illustrate the importance of teachers' subject knowledge in applying pedagogy in a range of contexts: including five in science, two in literacy, four on thinking skills and two in mathematics.

- Developing language and reasoning skills through structured talk
- Supporting children's reading
- Using real world contexts in physics
- Developing teachers' understanding of thinking skills
- Reforming science teaching and learning
- Interactive whole class teaching
- Using mathematical knowledge in the classroom
- Teacher development on children's thinking
- Cognitive acceleration in science education
- Teaching difficult subject matter in biology
- Teacher expertise in children's thinking in mathematics
- CPD to develop teachers' knowledge of children's thinking

TRAC (Talk, Reasoning and Computers).
This programme developed children's reasoning and collaboration skills by developing their awareness of language use and promoting 'ground rules' for talking together for learning. Children's use of language and problem solving scores increased. The implementation of the programme involved teacher knowledge of children's literacy as well as understanding of the different kinds of talk that children use and how their less effective use of language can be developed.
This intervention involving exploration, concept introduction, concept application and concept assessment depended on
teachers having good science subject knowledge. The approach applied to the intervention group included the obligation for students to reflect on their science ideas at various points and the status of their ideas. Status refers to one of the four conditions under which a learner will construct knowledge. Dissatisfaction, intelligibility (can the student explain to others?); plausibility (does the student think his/her idea fits their and their colleagues' experiences?; fruitfulness (does his/her idea help in solving the problem? Using experimental and control groups and pre and post tests the study found that children's use of language and problem-solving scores increased (Mercer *et al*, 1999).

Supporting children's reading
In this comparative study of pupil groups researchers compared three groups of 6-9 year olds in Haringey. They were divided into two treatment groups: parental involvement, extra teacher help and a third, control group. Both the parental involvement group and the extra

teacher help group showed a marked improvement in the quality of their understanding. This was stronger in the parental involvement group but the group which experienced greater involvement and attention from the teachers in reading also showed a significant though more modest improvement. Researchers visited the children's homes and supported the parents in the process. Parents and teachers were asked to record the reading activities they were undertaking with their children, but only the parents were supported in the delivery of reading support (Tizard, 1982).

Use of enquiry in science using real world physics.
The study explored the effect of a cognitive learning programme on students' scientific inquiry expertise, their physics knowledge, their attitudes to learning science. Two of the teachers in the progamme were subject experts who were also familiar with the pedagogy of teaching physics. Programme students achieved better than matched control students, especially low achievers. Programme students also outperformed older students on a series of physics questions (White & Frederiksen, 1998).

Developing teachers' understanding of thinking skills
The study evaluated a school district initiative addressing thinking skills through inservice education from the Talents Unlimited model.
87 staff were trained in 19 specific skills for 18 hours with another 6 hours spread over the course of the project for the purpose iof writing effective lesson plans. 102 students were selected for testing and lessons were monitored and scored over a year and a half. Comparing the pre and post tests, student performance showed significant increase on 11 of 14 comparisons (Crump *et al*, 1988).

Reforming science teaching and learning
In this project teachers improved in terms of their confidence to teach science as well as in terms of their understanding of basic science and technology. The study was set in Iowa and was part of a worldwide project Scope, Sequence and Co-ordination which aims to promote lasting change in science education. Teachers learnt about constructivist teaching and identified teaching strategies which encourage real learning. Teachers changed key aspects of their teaching, specifically in:

- Establishing goals
- Curriculum design
- Modifying and changing instructional strategies
- Inventing and using new forms of assessment.

Pupils achieved better results on the reform programme than the control group, and improved their learning in process, application, attitude, creativity and world view significantly more than the control students (Yager, 1999).

The impact of interactive whole-class teaching
This study explored the impact of the official endorsement of 'interactive whole class teaching' in the National Literacy Strategy. Teachers classed as average by PIPS asked more closed questions and fewer open questions than highly effective teachers. Average teachers gave slightly more direction. Highly effective teachers used more higher-cognitive interactions than the average teachers. The research found overall that most teacher questions are closed and therefore do not promote higher levels of pupil interaction and cognitive engagement (Hardman & Smith, 2003).

Teacher development on children's thinking in mathematics
This study examined changes in the beliefs and teaching of 21 primary teachers in a four year programme in Cognitively Guided Instruction, which focused on children's thinking. The researchers found that the teachers had informal knowledge about children's mathematical thinking, but seldom related critical problems to children's solutions. The researchers' goal was to help teachers build on and refocus their informal knowledge so that the children's thnking would become central to their instruction. There was a consistent pattern of gains in student achievement for all the teachers participating in the study. These concept and problem-solving gains appeared to be directly related to changes in teachers' instruction (Fennema, 1996).

Teacher expertise in children's thinking in mathematics
The study explored teachers' and grade 2 students' learning of mathematics – symmetry and transformational geometry. Of the four classes involved, two had teachers who had undertaken CPD in geometry and symmetry as well as as arithmetic. The other two teachers had only ad CPD in arithmetic. In the two classes whose teachers were more knowledgeable about pupils' mathematical thinking, pupils made greater gains in knowledge about transformational geometry. The gains were sustained over time. Pupils made triangles they then placed on quilt patterns and using paper triangles and the computer they manipulated the shapes, accompanied by extensive classroom teacher-pupil and pupil-pupil talk. The two teachers who were more knowledgeable about space were also able to orchestrate classroom talk in ways that refined, elaborated and extended their pupils' thinking (Jacobson & Lehrer, 2000).

CPD to develop teachers' knowledge of children's thinking
This study investigated the impact of a program designed to provide teachers with knowledge and understanding about children's thinking. The aim was to improve both teaching and children's achievement. Forty first grade teachers were randomly assigned to a treatment or control group. The experimental teachers participated in a four week summer workshop to familiarise themselves with findings on children's thinking and problem solving skills. The control group participated in a two hour workshop focused on non routine problem solving. Experimental teachers taught problem solving significantly more and encouraged students to use a variety of problem solving strategies. Experimental students exceeded control students in number fact knowledge, problem solving understanding and confidence (Carpenter, 1989).

Using mathematical knowledge in the classroom
This study assessed mathematics knowledge teachers actually used in the classroom rather than their general mathematical knowledge. Researchers collected survey and student achievement data in 115 US elementary schools – 89 in the learning programme and 26 control schools. By mathematics knowledge they included maths content knowledge as well as knowledge of how to teach it. The study found that the mathematical knowledge teachers used was related positively to student achievement. The study highlights the importance of professional development to improve and develop teachers' mathematical knowledge (Hill *et al*, 2005).

Cognitive Acceleration in Science Education
The study assess the impact of CASE on the cognitive development of children in Year 1. 300 chidren in 10 schools were involved in the experimental group and 170 in 5 matched schools as controls. The researchers found that effective delivery of the intervention depends on teachers having a good understanding of the underlying theory and extensive practice in

generating cognitive conflict, encouraging social construction and prompting metacognition as well as good subject knowledge. Teachers participated in CPD as part of the project. The experimental group showed gains over the control group in both direct and transfer tests, with girls making the greatest gains (Adey *et al*, 2002).

Teaching difficult subject matter in biology
The study explores the effects of including a prediction/discussion phase in students' learning cycles in biology. 250 high school students were involved. Peer group discussion following hyothetico-deductive reasoning was used to help make students aware of other students' views, stimulate argument and enhance students' abilities to reflect on and support their own views. The experimental students made significantly larger gains in conceptual understanding, process skills and logical thinking. The focus was on biology subject matter the students found difficult – genetics, homeostasis, ecosystems and natural selection (Lavoie, 1999).

QCA Claims

We included the following questions, based on the QCA claims, in the data extraction processes as a 'fishing' process. Unlike for the map findings, we were not sure what, if any, illustrative material we would find in relation to the claims. In the event the studies which were relevant to these offer a variable and in some cases (for example Question 7 on alignment between curriculum, aims and values) a scant picture of the range of curriculum related research interventions. We would suggest that there is the beginnings of a useful illustrative evidence base here, all of which needs further exploration of the research landscape in relation to specific claims. This is particularly the case in relation to the development of conceptual understanding in science (Question 8) and for the mastery of key subject-based processes (Question 9) where there are a number of illustrative examples

It is also important to note that many of the studies described above are relevant to some of the claims as well as the (often overlapping) map findings. For example Question 10 (regarding interdependencies between content, teaching and learning) is a persistent theme. Taking collaborative learning as one example, many studies show how teachers can use talk as a learning tool which enables students to access the content more effectively and solve problems together.

We also found that nearly all the studies we describe in the review are relevant to Question 11 on personalisation and we have explained this in more detail below.

What is the connection between the aims and values of the school and the curriculum and teaching and learning processes?

The studies described below illustrate the connection between the aims and values of the school and the curriculum and teaching and learning processes

National evaluation of Learn and Serve America
Promoting prosocial pupil behaviour: 2. Secondary school intervention and pupil effects
Prospects for civics education in transitional democracies: results of an impact study in Romanian classrooms

Partnerships for change
85 schools are involved in the partnerships for change programme within the National Institute for Urban School Improvement in the USA. School, parents and community are

linked through health services, enrichment opportunities and other community based programmes. There are positive gains for students from the common vision and goals. Successful and sustainable change was found to be more likely in schools where everyone shared a common vision and goals and where all contributed their individual talents and enthusiasm to the change efforts of the community.

Programmes which connected the school, parents and community promoted pupil learning. Many programmes and field trips included parents and encouraged family participation. As well as becoming an important part of the community, the programme reduced the number of students performing below the basic level and maintained high attendance rates (Ferguson & Blumberg, 2001).

Collaborating on anti-aggression strategies
Seven secondary schools were involved in this 3 year study, all of which had relatively high degrees of pupil aggression. Three matched schools acted as a control group. Teachers collaborated with staff and researchers to increase pupils' participation and responsibility in specifying and controlling behavioural and didactic rules (in the sense of moral teachingL). Working groups of staff were set up on social behaviour and cognitive learning behaviour. The groups then presented information about positive social and cognitive processes and attempted to use this information to create positive methods of teaching and learning. This involved small group work to vary social behaviours The aim of the groups was to promote prosocial behaviour through a reclarification of accepted behaviour and a change to the curriculum processes in the relationship between pupils, teachers, school staff and parents. Positive relationships decreased through years 1 to 3 in both control and experimental schools, but in 3 of the 4 experimental schools pupils perceptions of shared responsibility for class rules by pupils and teachers increased, which, the researchers claimed, let to an increase in involvement and behaviour (Mooji, 2000).

Developing democratic awareness
Researchers investigated the impact of experimental civic texts as opposed to the official ministry textbooks in Romania. The experimental group used the civic texts instead of the official ministry textbooks used by the control group. The experimental civic education texts emphasised dialogue, critical reflection individual and group work and fundamental democratic processes. Romania was left with a particular legacy as schools had been highly ideologised and used to align children to the communist cause.. The experimental classes showed gains in rating in the participatory characteristics of citizenship but there were no gains in this category for the control group. Both groups, however, rated the importance of obeying the law and honouring one's country very highly. The study confirmed a clear link between institutional methodology and the development of participatory values and attitudes (Tibbitts, 1999).

What is the evidence about emphasising key concepts as a means of enabling subject teachers to develop more flexible, inclusive and appropriate learning experiences?

Using CASE Methods to develop conceptual understanding
This study explored the transfer of scientific skills and concepts and the durability of newly acquired scientific concepts. The experimental group, taught by CASE methods, scored consistently higher than the control group. The study suggests that this is because the conceptual understandings developed through the CASE methods for the experimental group were of sufficient quality to allow the students to refer back to what they knew even after a significant amount of time had passed (Georghiades, 2000).

The effects of context-based learning on conceptual development in chemistry
This study explores the effects of a context-based approach on pupils' understanding of some key chemical concepts at 16+. One group of pupils were taught elements, compounds and mixtures, conservation of mass in chemical reactions and chemical change using a context based approach, (Salters GCSE course) the other group was taught conventionally. The study found that both groups of pupils are likely to develop the same level of understanding of ideas and concepts and that both approaches were effective in developing understanding. However students enjoyed and were more engaged in the context-based course. There is some evidence to suggest that a context based approach is more successful in terms of providing pupils with what they perceive as a worthwhile experience (Ramsden, 1997).

Reforming science teaching and learning
his paper reports on a project which aims for reform in science teaching and learning. One of the central ideas is to emphasise concepts to achieve improvements in science teaching and learning. One of the findings was that the programme worked well for low ability and female students which could indicate that the programme encompassed inclusive and appropriate learning experiences. The project emphasises 6 domains for learning and assessment success in science:

- concept domain
- process domain
- creativity domain
- attitudinal domain
- applications and connections domain
- world view domain

Experimental pupils achieved better results than the control group. They improved their learning on process, application, attitude, creativity and world view significantly more than those not completing the programme. Low ability students improved their learning significantly more than high ability students. Female students improved in their attitudes towards science more than male students (Yager & Weld, 1999).

Focusing on how children think
The study examines changes in beliefs and instruction of 21 primary school teachers in the 4 year long Cognitively Guided instruction CPD programme in the USA. Teachers' beliefs and instruction exist in a complex relationship and researchers' describe a range 'levels' of beliefs, ranging from not believing that children can solve problems without instruction to a belief that what teachers know about children's thinking should inform their decision making regarding interaction with students and curriculum design. As teachers developed their knowledge of children's thinking and hence their instruction, students made gains in conceptual understanding and problem solving. There was a consistent pattern of gains for all the teachers participating in the study (Fennema, 1996).

Applying a thinking skills programme to chemistry learning
This experimental study looked at the application of a thinking skills programme – Feurstein's Instrumental Enrichment – to the teaching of chemistry to 14 year olds. 21 students were split into two groups, a control group of 10 and experimental group of 11. The experimental group was taught a chemistry module designed to compensate for conceptual deficiencies displayed in interviews. Facilitated discussion was used to emphasise the key concepts in order to enable more students to progress successfully through more complex

aspects of the curriculum. The experimental group scored significantly higher in the post test than the control group (Strang & Shayer, 1993).

Increasing students' understanding of mathematical problems
Three classes of boys aged 10-12 in Belgium were involved in this study, with two classes acting as control groups. Five teaching/learning units of about 2.5 hours each were spread over two and a half weeks. The experimental class was given word problems to ground the maths in a real world context. For example, solving number problems relating to collecting comics. This class made significantly higher gains in post tests than two control classes. Students' conceptual understanding improved through the application of real world scenarios in mathematics. The experimental students had been the lowest achievers in the pre test and the highest in the post test (Verschaffel & De Corte, 1997).

What is the evidence about key subject-based processes which need to be mastered?

A number of studies in the review which helpfully illustrate specific approaches to identifying and learning key subject-based processes are described below. Again, science features strongly in the various interventions. There are also descriptions of successful strategies in mathematics and languages.

Understanding chemistry
An experimental study which looked at the application of a thinking skills programme – Feurstein's Instrumental Enrichment – to the teaching of chemistry to 14 year olds.. Discussion was followed by experimental work and then further class discussion in which every student was encouraged to support each other by the teacher acting as facilitator. In the control group the first lesson included chemical reactions before going on to identify gasses, and in subsequent lessons include elements and compounds. To the science teacher the ideas seem simple and with explanations and diagrams it seems reasonable to him that pupils understand without difficulty. However to the pupils they do not always make sense and some prerequisite concepts need to be made explicit before pupils can understand. The experimental group was taught a chemistry module designed to compensate for cognitive misconceptions. Mean post test score for the experimental group was 58.8% compared with 38.1% for the control group

Understanding physics
This study aimed to examine if understanding of underlying physics concepts can be developed by confronting groups of students with varying views and helping them collaboratively solve physics problems. Pupils' understandings increased and problem solving skills improved (Tao, 2003).

Evaluating Experiments
This study examined the ability of pupils to use control variable strategy (CVS)(keeping all variables constant except one to test if that element has an effect. Or being able to say which elements could have had an effect if more than one uncontrolled variable is present.) Pupils received different levels of input. The first group had explicit training plus probe. It included an explanation of the rationale behind controlling variables as well as examples of how to make unfounded comparisons. Pupils also received probe questions about each comparison or test they made. The second group received implicit training and a probe but no explanations. The third group did unprompted exploration with no training or probe.

The report focused on the Ramps task, where pupils rolled 2 different types of balls down ramps of varying steepness and surface. Only pupils in the first group improved their CVS skills when asked to apply what they had learned 7 months later (Toth *et al*, 2000).

Learning science concepts
The authors believe that when students learn science concepts they go through a process of successive elaboration and refinement in which science models are created and modified to account for new phenomena. Students were given a sequence of experimental situations and computer models which they used to generate increasingly accurate conceptual explanations. Programme students achieved better than matched control students, especially the case for lower achievers (White & Frederiksen, 1998).

Cognitive processes in listening comprehension
The study explored two cognitive processes in listening comprehension in large scale EFL tests for secondary students in Hong Kong over a period of seven years. They found that skilled listeners tend to rely on bottom-up or text based processes. They use a knowledge based interactive mode of test processing. Less skilled listeners and readers attend mostly to local details – rather than on global questions requiring the listener to synthesise information (Tsui & Fullilove, 1998).

Learning text comprehension
This study examines methods of increasing the use of strategy in learning text comprehension, which is a subject-based process in literacy. The experimental group were taught systematic comprehension strategies while a control group continued with reading lessons as normal.

The study aimed to develop, implement and evaluate a research-based and practically applicable learning environment for enhancing skilled strategy use in primary pupils when reading from printed sources. It used 4 comprehension strategies: activating prior knowledge, clarifying difficult words, making a schematic representation of the text; formulating the main idea and a metacognitive strategy: regulating one's own reading. Students were trained through a variety of interactive instructional techniques: modelling, whole class discussion, small group work and reciprocal teaching. The experimental group made a significant improvement in the Reading Strategy and Retention test. They scored higher on the Reading Comprehension test and the results of the transfer test showed that the experimental group was able to successfully apply the reading comprehension strategies to new contexts (De Corte *et al*, 2001).

Using prediction and evaluation in tackling mathematical problems
237 Belgian children with mathematical learning difficulties were randomly assigned to 5 groups, including one where they were subject to metacognitive strategy teaching. Children were taught the following strategies to help them tackle mathematical problems: prediction, number reading, procedural calculation, language related, mental-representational. This study looked at the effect of metacognition applied before (prediction) and after doing a task (evaluation) rather than while they were doing it. Children in the metacognitive group were involved in particular emphasis on prediction (prediction about whether their strategy could solve the problem) and evaluation whilst other groups focused more sharply on different features. Children in the metacognitive group had the highest post test

mathematical problem=-solving score; highest post test prediction scores (Desoete *et al*, 2003).

Using narrow listening in language learning
Narrow listening is a process for giving language learners input through a combination of repeated listening, self-selection of samples and familiarity with topics. It allows students to acquire language without giving them questions to worry about and lets them work at their own pace. Students listen to tapes recorded by native French speakers who talked conversationally for 1-2 minutes on each topic. Most students found it helpful for improving listening comprehension, improving fluency and developing vocabulary (Dupuy, 1999).

Teaching historical analysis and interpretation
This study investigated the impact of a technology supported historical investigation for 28 students with learning disabilities in grade 5 in a US school. The comparison group was comprised of 59 mixed ability students. Students were explicitly taught how to analyse and interpret historical evidence by asking questions such as: -How do historians know what happened? Why do historians have different opinions about what happened in the past? What is evidence? The assessments showed that the SEN students did not benefit as much as the comparison group in relation to knowledge and understanding but they did benefit equally in terms of self efficacy (Ferretti *et al*, 2001).

Teaching language comprehension
The study explores how multimedia learning environments affect college students learning French. Results showed that students acquired more vocabulary when they had both written and pictorial annotations available. The test comprehension test showed that students who had access to both types of annotation had better comprehension of the text than the others who had either just one type of annotation or none. Pictorial annotations were more important than written ones for long-term retention (Jones & Plass, 2002).

Learning French
The study explored the role of metacognition in learning French among grade 4-6 students in Canada. The key aspect was involving students in thinking about the process of listening as well as the content. This included developing skills for identifying what they want to learn and how. In this way students can become active participants in their learning rather than passive recipients of teaching. Students became aware of what they needed to do and the importance of monitoring and developing listening strategies (eg listen for words we know.) (Vandergrift, 2002)

What is the evidence about interdependencies between content, teaching and learning? What distinctions are there in different learning domains?

The studies described below illustrate interdependencies between content, teaching and learning.

- Developing understanding through confronting varying views: the case of solving qualitative physics problems
- The Effect of Speech Modification, Prior Knowledge, and Listening Proficiency on EFL Lecture Learning.
- Effects of parent involvement in isolation or in combination with peer tutoring on student self-concept and mathematics achievement

- Supporting listening comprehension and vocabulary acquisition in French with multimedia annotations
- Cognitive-metacognitive training within a problem-solving based Logo environment

Approaches to Physics
The study aimed to examine if understanding of underlying physics concepts can be developed by confronting groups of students with varying views. Students reflected not only on the different problems and problem-solving strategies but also on their approach to learning physics in general. They were enabled to see things differently: that there several problem solving strategies for the same problem; that there are different learning approaches to physics. The pre and post test scores showed that students' understanding increased and problem solving skills improved (Tao, 2003).

Accessing language learning through listening comprehension
The study explored the listening comprehension of 388 high and low proficiency Chinese Naval Academy students of English as a foreign language. The study findings support the view that prior knowledge of a topic in their own culture (in this case Confucius and his teaching) helps listeners' comprehension as well as their reading comprehension. Prior knowledge provides learners with schema (categories) for assimilating and organising new information. The results suggest that listeners in learning EFL with different proficiencies (including vocabulary and knowledge of language structure of English) need different types of modified speech to support their learning ie simplified speech can be quite different for different learners. Higher proficiency learners were helped by speech modification that included: repetition, paraphase, interdependencies and synonyms (Chiang & Dunkel, 1992).

Talk as a tool for accessing content
Three groups were involved in this study: home based parental involvement plus reciprocal peer tutoring; parental involvement and control. The parental involvement groups showed higher self concepts and the PI plus Peer Tutoring group achieved higher assessment scores in mathematics. Parental involvement took the form of regular home-school communication that emphasised students' achievements; parent-student conversations about the students' mathematics work at school. The study shows how teachers can use talk as a learning tool – for joint reasoning – which enables the pupils to access the content more effectively and solve problems together (Fantuzzo *et al*, 1995).

Making use of resources for language learning
The study explored how multimedia learning environments affected 171 college students' learning of French. A pre and post test design was used in order to observe the effect of two factors: absence or presence of written annotations; and absence or presence of pictorial annotations – on students' acquisition of vocabulary and their completion of an aural passage. Results showed that students acquired more vocabulary when they had both written and pictorial annotations available. Similarly the text comprehension test showed that students who had access to both types of annotation had better comprehension of the text than the others who had either just one type of annotation or no annotation at all. Pictorial annotations were more important then written ones for long-term retention. According to the Generative Theory of Multimedia Learning, students organised the aural passage along with the relevant verbally and visually annotated words into verbal and visual representations and integrated the newly-constructed pieces of information with one another and with their mental model (Jones & Plass, 2002).

ICT as a tool for learning

This study investigated the effects on students' problem-solving of metacognitive training implemented within a Logo environment. The computer software can be used to represent and display quantities/graphs.) The treatment group constructed better graphs and could talk in more detail about both the mathematics and the reasoning they had used. The study highlighted the effectiveness of a particular learning approach in achieving greater mastery over content (Kramarski & Mevarech, 1997).

What is the evidence of the teaching and learning processes involved in personalising learning?

The superficial view of personalisation tends to equate it with individual choice between predetermined options. In some UK classrooms teachers have interpreted personalisation as setting individual tasks for personal learning. However the all-embracing position is that it involves developing organisational and teaching strategies to ensure every child's education is tailored to their needs so as to support higher levels of student engagement and attainment.

A recent Australian review of research and policy on personalisation in the USA, UK and Australia4 identified four broad areas common to the concept of personalising education. These are: student-centred learning, ICT as a key enabler, lifelong learning and communities of collaboration. In this review we found no studies which based interventions on personalisation per se. However nearly all the interventions described in sections 1-10 above involve strategies and processes linked to the broad areas of student centred learning and communities of collaboration. Many also involved the use of ICT and showed how, particularly in the context of structured group work, it enabled learning progress.

In our review protocol we recognised the complexities of extracting illustrative material for so complex a concept as personalisation. Hence we 'chunked' personalisation into six component parts:

- paying close attention to learners' knowledge, skills, understanding and attitudes ;
- using both formative and summative assessment to find out what learners know, can do and might be capable of ;
- teachers and learners using techniques such as open questioning, sharing learning objectives and success criteria;
- giving learners sufficient time to reflect on what they are doing;
- teachers supporting learners in monitoring their own progress;
- learners working with their peers to review what they have learnt and to develop their understanding further.

The studies described in this review offer a richly illustrated picture of curriculum initiatives in personalisation which have been successful to varying degrees in promoting student learning and achievement. They offer insights into all six of the areas of personalisation listed above. In their variety they help illustrate the importance of the underlying pedagogy without the need for prescription and uniformity in its practical applications. All of the interventions were locally contextualised and focused on the needs of particular groups of students or teachers. For example, the studies involving interventions using context-based

[4] Office for Education Policy and Innovation. Personalising Education: From Research Policy to Practice. Paper no. 11. Sept 2007 http://www.eduweb.vic.gov.au/edulibrary/public/publ/research/publ/personalising-education-report.pdf

learning effectively illustrate different ways of personalising the learning processes around a given curriculum area – and in this review, most notably science. They also illustrate ways of paying attention to learners' knowledge, skills and attitudes, as do the Section 4 studies involving interventions which demonstrate ways of building incrementally on students' existing understanding. There are some useful illustrative examples in the field of language learning here too.

Studies describing the processes and impact on pupil motivation and learning of structured dialogue in group work and of collaborative learning also offer a varied menu of interventions for students of all ages and in a range of curriculum areas with cross-curricular potential. A number of studies focused on metacognitive strategies, using a range of techniques to give students opportunities to reflect on their learning. A number of studies also showed how, with professional development in pedagogical subject knowledge, teachers could adapt their teaching towards student thinking and existing misconceptions, with beneficial results. Only one study focused on the whole-school aspects of personalisation. It showed how students, teachers and parents could work together to develop a more inclusive school to the benefit of everybody.

The processes and interventions captured in the studies in this review offer a small snapshot of the different facets of personalised learning. They do, however, help to illustrate how to build on the evidence base about effective curriculum interventions in practical and diverse ways which are nevertheless consistent with the underlying principles.

Appendix 1

USA and English equivalent levels of schooling

Kindergarten and Foundation are the same in the UK and US

UK State Sector Schools:
Infant / First School
AGE:
5 Year 1
6 Year 2
7 Year 3
8 Year 4

Middle School
AGE:
9 Year 5
10 Year 6

Secondary / Upper School
AGE:
11 Year 7
12 Year 8
13 Year 9
14 Year 10
15 Year 11
16 Year 12
17 Year 13

US Grades and Schools:

Elementary School (or Primary School):

Begins with 1st grade at age 6. Goes one grade for each year of age through 6th grade at age 12.
(add a year of age of the child is born after the end of September.)

Some US states break for middle school:

7th & 8th grade, ages 12, 13 and sometimes 14.

Some states break for Junior High:

Grades 7, 8 & 9, ages 12, 13 and 14.

High School:

Grades 9 through 12. One "school year" for each grade with high school "seniors" (grade 12) graduating usually before their 18th birthday or shortly after.

That is the end of "public" education (private schools are generally structured the same way.)

Appendix 2

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