Review of Mathematics Teaching in Early Years Settings and Primary Schools

INTERIM REPORT

Contents

Chapter 1: Foreword

This is the interim report of the Review of Mathematics Teaching in Early Years Settings and Primary Schools. It follows a call for evidence which received wide response; an extensive programme of visits to primary schools and early years settings; attendance at conferences and other stakeholder meetings; discussions with practitioners and with leading academic educationalists; consultation with representatives of Government, non-departmental public bodies and agencies; and a series of meetings of the review panel.

This interim report sets out the review panel's current thinking and makes preliminary recommendations to Government and others on a number of important topics. These topics include:

- Initial Teacher Training
- continuing professional development
- early years settings
- intervention
- curriculum and pedagogy
- the role of parents and families.

The executive summary which follows this foreword and Chapter 3, which summarises all the recommendations, taken together, attempt to set out clearly an interpretation of the evidence received and the basis of any resulting arguments. The later chapters cover these matters in greater detail.

It is important to note, however, that at this stage, these are still *interim* conclusions and recommendations, which will be subject to further scrutiny and review. A number of issues throughout the report are deliberately left open in the form of *proposals for consultation* in a continuing and genuine spirit of enquiry. Equally, there are certain clear conclusions drawn at this stage and which the review is unlikely to change in its final report.

Following the publication of this interim report, there will be a six-week period of consultation, during which evidence gathering will continue, together with selective visits. This period will be marked by a number of events and meetings, which it is hoped will attract all interested parties, in particular members of the teaching profession themselves. The review therefore remains open at this stage both to new inputs and especially to responses to the thoughts and ideas explored here. During this period, conclusions will be benchmarked against best practice internationally.

Finally, the review panel is grateful for the help and support received from all the stakeholders concerned, especially for the warm welcome from all the practitioners involved during visits.

Chapter 2: Executive summary

The importance of a young child's ability both to read and communicate fluently and to count, calculate and work confidently with mathematical ideas, cannot be overstated. This review is concerned with identifying educational best practice to enable learners in primary and early years settings to acquire an understanding and appreciation of mathematics, and of its importance to their lives. It follows and is complementary to the Rose Review of the teaching of early reading, although – looking across the full range of mathematics – it has a wider remit.

The achievement of recent generations of young learners in mathematics should be celebrated. Since the introduction of the National Numeracy Strategy (NNS) in 1998, and its associated Primary Frameworks, the percentage of 11 year-olds attaining level 4 and above at Key Stage 2 has risen from 59 per cent to over 77 per cent. In its recently announced *Children's Plan*, the Government has set out further ambitious goals to maintain the progress secured so far.

Central to the achievement of these goals will be the quality of teaching in our schools and settings, and the principal focus of this review is the role of teachers and practitioners, their education and training, and how society values and rewards them.

There are many challenges to face. Mathematics in particular is unique in presenting simultaneously abstract concepts and practical utility, both of which must be addressed if a child's understanding is to be secure and embedded. There is an inherent beauty in mathematics, which finds expression in the natural and physical world, and is readily appreciated by young children. Equally, in the words of a pupil in Reading, the teaching of the subject must: '*make maths fun, and relate to the real world my Mum and Dad can understand*'.

Social issues surrounding the subject affect learners at all levels, including the very young. The United Kingdom remains one of the few advanced nations where it is socially acceptable – fashionable, even – to profess an inability to cope with mathematics. That is hardly conducive to a home environment in which mathematics is seen by children as an essential and rewarding part of their everyday lives.

So there is no room for complacency. The benefits flowing from the NNS are still evident in our classrooms today, but a decade on from its inception, it is appropriate to review what new strategies are needed to make sure levels of attainment can continue to rise.

Teachers and practitioners in primary schools

The well-being and development of the child is of course paramount. Yet this report starts not with the child, but with teachers and practitioners, who remain centre stage in all that follows. No apology is made for this. Whatever the commitment shown by the Government, support demonstrated by the local authority, or care and love shown by the parents, it is on the skills and dedication of the teacher or practitioner that most mathematical learning ultimately depends.

There are almost 200,000 teachers in primary schools in England, and all those with Qualified Teacher Status (QTS) have undertaken one form or another of Initial Teacher Training (ITT). Yet despite the importance of mathematics, the ITT entry-level requirement remains a grade 'C' mathematics GCSE, and on average a trainee teacher will receive only 15 to 30 days' further education in the subject during his or her course.

Worse, there is no register or tracking system to follow the professional career development of the primary teacher. This is in sharp contrast with the engineering, legal and medical professions, in all of which continuing professional development (CPD) is an integral and essential part of all practitioners' lives.

Yet, of all subjects, mathematics is perhaps the most demanding in terms of its need for in-depth subject knowledge, even at primary level. Confidence and flexibility in the classroom are essential prerequisites for the successful teacher of mathematics, and children are perhaps the most acutely sensitive barometer of any uncertainty on their part.

Nevertheless, there are reasons for optimism. Advanced Skills Teachers represent something of an elite force among teachers. There are 1,500 in primary schools, of whom approximately 200 are mathematics specialists. More generally, at the time of the NNS, the concept of a Leading Subject Teacher was introduced and the review has encountered a number of Leading Mathematics Teachers. Unfortunately, the momentum towards this subject specialism appears to have stalled. Building on this invaluable core of expertise, it is recommended that every primary school in England should have at least one Mathematics Specialist, with the skills and knowledge to influence mathematical learning throughout the school. This goal would require additional CPD, over time, for approximately 15,000 teachers in the existing schools workforce.

The commitment and motivation of the individual teacher or practitioner is essential. CPD must be seen to be adding value and should lead to tangible recognition in terms of qualifications, with progression to Masters level a desirable and career-enhancing goal. Equally, this career development must be recognised in remuneration levels.

Teaching assistants also make an invaluable contribution to the learning of mathematics in schools. Both supporting the classroom teacher in the class,

and working in parallel in intervention or guided learning, teaching assistants have a significant role to play.

This review makes a number of specific recommendations on aspects of the above, which are summarised in the following chapter. In addition, the review outlines certain further preliminary proposals for comment and debate in the consultation phase which will follow publication of this interim report.

Further work will need to be done to assess the likely costs of the measures proposed, given the inevitable financial constraints. More importantly, work is currently being undertaken to estimate the financial *benefits* to society and to the individual of the successful implementation of the review's recommendations. However, the review panel remains sceptical of placing too much faith in expressing the value of successful learning outcomes for the young solely in financial terms.

Early years practitioners

In early years settings, the focus of this report is again on the practitioner. For those with QTS, formal qualifications have great value and it is recommended that the same ITT entry requirements (in mathematics at GCSE) are applied as for the primary sector. While young children's earliest experiences of mathematics will be through exploring shape, space, pattern and problem solving in their play, it is important that the practitioners working with them have a genuine understanding of, and are comfortable with, mathematical concepts and language. This is needed to underpin the choices that they make as they help to guide the children's thinking and play.

It is equally important that other practitioners have appropriate qualifications. The Government's focus on increasing the proportion of graduates working in early years is welcomed, as is the guidance in the Early Years Foundation Stage on other non-graduate qualifications. Childminders, for example, have a vitally important role.

During this review, visits to excellent settings have demonstrated what can be achieved, and some of the common factors identified during the visits are highlighted in the body of this report. Evidence demonstrates conclusively that learning benefits gained in early years endure through formal education until at least Year 6. The panel nevertheless remains concerned to ensure that the benefits of the early years are sustained as children grow, particularly through times of transition. In this context, the report comments on curriculum continuity, on class sizes in early years relative to primary, and on the use of the Foundation Stage Profile.

Intervention in primary schools

The measures advocated above will, over time, improve overall attainment levels, but there will always be children who struggle to acquire a sufficient degree of proficiency and confidence with mathematics.

At Key Stage 2, around six per cent of children fail to attain level 3 in mathematics, a percentage which has remained roughly constant for almost a decade. Many countries face a similar challenge, and programmes have been introduced in a number of nations to 'intervene' and provide additional educational support to under-attaining children.

Observed practice in such interventions, and the research base which underpins them, clearly demonstrates the impact they can have. There are many intervention programmes and variants currently being implemented in regions of England, and the panel has considered seven of these in detail, observing a number of intervention sessions.

Effective interventions observed typically comprised a daily session, one-to-one or possibly with a group of three or four children, with a specially trained teacher, for a whole school term. Best practice found in many programmes includes careful selection of the children who will benefit most, detailed assessment of their strengths and weaknesses (including in some cases the use of video techniques), parental consultation and attendance at sessions, dedicated resource rooms and materials, and multi-sensory tools and IT facilities.

With the right support, the progress of individual children can be rapid. In the terminology of the National Curriculum, a gain of three sub-levels after one term is routinely observed – and occasionally considerably more. Equally importantly, children also appear to enjoy the experience.

Questions remain, however, on which the panel is still gathering evidence. The issue of sustainability of learning after this intervention is critical, as are the linkages made between the child's learning in the intervention and in class. There is an emerging consensus in the academic community that the timing of any intervention should be carried out by the end of Key Stage 1, i.e. by seven years of age – in other words, as soon as under-attainment is identified, the problem must be tackled. Equally, views have been cogently expressed by respected figures that later intervention might be essential.

Some of the factors that contribute to under-attainment in mathematics are clear. However, other causes remain the subject of ongoing debate among educationalists and researchers in cognitive learning. One is worthy of note here – the possibility of a condition, often termed 'dyscalculia', which is analogous to dyslexia. The interim report does not take a firm view on this, but the panel remains open-minded and continues to seek inputs.

What is certainly true is that there is no single cause of under-attainment, nor is there a single remedy – there is no 'one size fits all' solution.

The Government has given a significant boost to tackling under-attainment with its announcement of 'Every Child Counts', a national programme to fund intensive interventions. At the invitation of the Secretary of State, recommendations are made in this review on the nature of this programme, addressing all of the issues considered in outline above. As with CPD, an

attempt is also made to assess the likely costs of the programme, on the assumption that the under-attaining cohort remains at around six per cent, or 30,000–35,000 children a year.

The review panel is working closely with the Every Child a Chance charity and awaits the outcome of its pilot trials throughout England of a number of intervention schemes. The outcome of these will be incorporated in the thinking leading up to the final report in June 2008.

Only two further observations on intervention are made at this interim stage. Firstly, the importance of good mainstream classroom teaching – if the general measures proposed by this review are implemented successfully, then in years to come, the size of the intervention cohort will reduce. However, prudence dictates that, given the present uncertainty on the causes of this under-attainment, annual funding for intervention should continue to be provided at close to the levels presently being considered by Government.

And secondly, it is important to note the long timescales associated with a proper evaluation of the outcomes of these intervention schemes. Successful intervention by the age of seven will, it is hoped, increase the numbers gaining a 'C' grade at GCSE at age 16, so a meaningful longitudinal study, as recommended below, will necessarily take place over a period longer than the lifetime of a single Parliament.

Other issues – curriculum, pedagogy and families

The primary mathematics curriculum has now been stable for a number of years, and will of course be covered by Sir Jim Rose's review of the primary curriculum as a whole. The existing curriculum is comprehensive and forms a firm foundation for mathematics in Key Stage 3 and beyond. During the panel's discussions with teachers, the perennial question of whether there is still too much material in the present Key Stage 2 curriculum – and if so, what might profitably be moved to Key Stage 3 – has been probed. The interim conclusion is that there should be little, if any, fundamental change in content at this stage.

Where a concern exists, however, it is that 'using and applying' mathematics is not given the prominence it requires. This is a common weakness in children's learning in early years, which continues throughout the primary years. In Key Stages 3 and 4, a 'functional' element of mathematics is being introduced, and an equal emphasis on the importance of the functionality of mathematics in everyday life should also inform primary mathematics education.

On pedagogy, the panel has seen clear evidence that the frameworks introduced as part of the NNS continue to form a useful backbone of mathematics teaching in all years. Equally, the most effective teachers have the confidence to depart from them when appropriate. There is, however, concern over the complexity of access to the recently revised frameworks, especially the interactive planning tool. This may be due as much to the way

the content is organised and the tool's navigability as to the content itself, and the review panel is working constructively with the National Strategies to help make sure the frameworks can be used with ease by all teachers.

Finally, reference has been made above to economic and social issues and to the engagement of parents and carers as essential to the educational well-being of their children. The questions this raises are perhaps the largest and most intractable of all, and they are the subject of the Government's recently announced *Children's Plan*.

The head teacher and senior management

It is clear that few, if any, of the recommendations made in this review can be implemented without the wholehearted support of head teachers and leaders and managers in early years settings. Specifically, it is clear that placing a Mathematics Specialist in a primary school will have little impact if the head teacher does not share a strategic vision for improving the quality of mathematics teaching and learning. In meetings so far with a considerable number of head teachers, however, their enthusiasm for mathematics and the measures proposed has been encouraging. The panel has further plans to meet with representative groups during the consultation phase of the review which will follow this interim report.

The next phase of the review

In conclusion, this interim review focuses on Initial Teacher Education, CPD, early years and intervention, together with considerations of suitable provision. Recommendations are also made about pedagogy and the curriculum, along with preliminary observations on the vital role of parents and families. Following its publication, a six-week period of consultation will start, including a number of meetings, conferences and further visits. Further information will also be pursued on international comparisons and what we can learn from them. The early outcomes of the Every Child Counts pilot will become known during this period and will be incorporated into the final recommendations, which will be submitted in the summer.

Chapter 3: Principal recommendations

Recommendation 1: ***The potential for an ITT entry requirement of grade 'C' GCSE in*** *both* ***mathematics I and II, when they are firmly established, should be closely examined. For students who have taken or will take GCSEs before then, a grade 'C' in single award mathematics should remain the requirement. This should apply to the QTS in all phases.***
(Chapter 6: The teacher – Initial Teacher Training and continuing professional development, paragraph 20)

Recommendation 2: ***A renewed emphasis on CPD is required by practitioners, head teachers, local authorities and Government, focused on both in-school activities and third party 'market' provision (including HEIs), with the clear delegation to school level of the responsibility for CPD undertaken.***
(Chapter 6: The teacher – Initial Teacher Training and continuing professional development, paragraph 38)

Recommendation 3: ***Local authorities should strengthen the field force of mathematics consultants. The National Strategies, in partnership with the National Centre of Excellence in the Teaching of Mathematics, should develop 'refresher' CPD for all mathematics consultants.***
(Chapter 6: The teacher – Initial Teacher Training and continuing professional development, paragraph 42)

Recommendation 4: ***Within five years, there should be in post at least one Mathematics Specialist in each primary school, with deep mathematical subject and pedagogical knowledge, making appropriate arrangements for small and rural schools.***
(Chapter 6: The teacher – Initial Teacher Training and continuing professional development, paragraph 55)

Recommendation 5: ***The review endorses the Government's goal of increasing the proportion of graduate practitioners in early years settings.***
(Chapter 7: The Early Years Foundation Stage, paragraph 77)

Recommendation 6: ***Intervention in Every Child Counts should be led by a qualified teacher, normally with a single child, but in the research and development phase, there should also be investigation of the potential benefits of working with small groups of up to three children.***
(Chapter 8: Under-attainment and intervention – Every Child Counts, paragraph 131)

Recommendation 7: ***Before any intervention programme is implemented, it is vital that the child is fully committed and that the parents or carers are involved and understand the nature of the programme. These issues and the question around the integration of intervention teaching and classroom teaching for pupils should be***

considered carefully in the research and development phases of Every Child Counts.
(Chapter 8: Under-attainment and intervention – Every Child Counts, paragraph 142)

Recommendation 8: ***The primary National Curriculum in mathematics should continue as currently prescribed, subject to any changes which may result from Sir Jim Rose's forthcoming review of the primary curriculum; the latter should examine the concept of 'use and application' more generally across subjects to assess whether the mathematical or other aspects of the curriculum need to be amended.***
(Chapter 9: Curriculum and pedagogy, paragraph 163)

Chapter 4: The remit of the review and membership of the advisory panel

In his letter of 9 July 2007, the Secretary of State set out the following remit:

'Through examination of the available evidence including international best practice and through engagement with the teaching profession, to consider and make recommendations in the following areas:

1. *What is the **most effective pedagogy of maths teaching** in primary schools and early years settings? That consideration should include instructional methodologies, teaching and learning strategies, and lesson designs that are most effective in helping children to progress in their learning.*

2. *What **range of provision** best supports children across the full ability range, including the most gifted? The highest priority should be given to those who are not progressing fast enough to reach national expectations.*

3. *The review should specifically make recommendations to inform the development of an early intervention programme for children (age five to seven) who are failing to master the basics of numeracy – **Every Child Counts** – as recently announced by the Prime Minister.*

4. *What **conceptual and subject knowledge** of mathematics should be expected of primary school teachers and early years practitioners, and how should Initial Teacher Training and continuing professional development be improved to secure that knowledge?*

5. *What is the most effective design and sequencing of the **mathematics curriculum**? Recommendations in this area should inform a future review of the primary curriculum as a whole.*

6. *How should **parents and families** best be helped to support young children's mathematical development?*

The review should build on the recent renewal of the primary framework for mathematics and the EYFS.'

The members of Sir Peter Williams' review panel are:

- **Professor Janet Ainley** – Director of School of Education at University of Leicester.
- **Professor Celia Hoyles OBE** – Director of the National Centre for Excellence in the Teaching of Mathematics.
- **Laurie Jacques** – Primary teacher representative member of the Advisory Committee for Mathematics Education (ACME).

- **Sir Jim Rose** – Chair of the Independent Review of the Primary Curriculum, which was recently announced in the Department's *Children's Plan* (published in December 2007).
- **Brenda Spencer** – Member of the Early Education Advisory Group.

Chapter 5: The evidence-gathering process

1. In dealing with such a complex, interrelated series of topics on an accelerated timetable, it was essential to prioritise both the sequence in which investigative work was undertaken and the depth of investigation and evidence gathering. At its first meeting in September 2007, the review panel decided that it should initially prioritise the following areas (and cover the other parts of the remit in subsequent review panel meetings):

   - Initial Teacher Training and continuing professional development
   - early years settings
   - intervention and Every Child Counts.

2. Since September 2007, there has been a wide-ranging evidence-gathering process, which has sought information from a variety of sources, as follows:

   - from written evidence
   - through a programme of visits to primary schools and early years settings
   - through face-to-face meetings with key stakeholders
   - through seminars, workshops and conferences (both internal to the Department and external)
   - through analysis of existing publications, research and statistics
   - from pupils and parents
   - from Ofsted research findings.

3. There was an intensive 'call for evidence' period in the months of October and November 2007, which generated approximately 150 written submissions on all aspects of the review.

4. The review panel has been on a wide-ranging programme of visits to approximately 20 primary schools and early years settings, across the country and beyond. Places visited include Hackney, Cumbria, Devon, Hampshire, Liverpool, Tower Hamlets, Birmingham, Blackbird Leys, Reading, Norfolk, Leicester, Brighton, Bristol, Oxford, Harrow, and more recently, Hungary and Scotland. During these visits, the panel has spoken to pupils not only in early years settings and primary schools, but also in secondary schools.

5. Members of the review panel have spoken at conferences, including the QCA Mathematics Stakeholder Day and the National Centre for Excellence in the Teaching of Mathematics (NCETM) Conference. There have been presentations and discussions with the Early Childhood Forum, with the Social Partners, and with the Department's Primary Head Teachers Reference Group. During the course of the review,

meetings and discussions have been held with approximately 100 head teachers and 200 teachers and practitioners.

The focus of the interim report

6. The prime focus for the review remains the educational development of the child, but the natural sequence of the panel's work places the teacher at the centre stage throughout.

7. This interim report follows that sequence and it is therefore intended to continue gathering evidence on other important topics in time for the final report. These include vitally important questions about 'gifted and talented' children and international comparisons, as well as paying further attention to pedagogy and curriculum, on which there is preliminary comment in this report.

8. As readers will note, there is no chapter specifically dealing with the second term of reference, concerned with the 'gifted and talented' pupil and the 'pupil who is not progressing fast enough to reach national expectations'. On the latter, it is felt that this is addressed implicitly in Chapter 6 on the teacher, Chapter 8 on intervention and Chapter 9 on curriculum and pedagogy.

The next steps

9. The responses to this interim report will be carefully considered and will be incorporated into the final report, which will be published in June 2008.

Chapter 6: The teacher – Initial Teacher Training and continuing professional development

*'What **conceptual and subject knowledge** of mathematics should be expected of primary school teachers and early years practitioners, and how should Initial Teacher Training and continuing professional development be improved to secure that knowledge?'* Remit 4 from the Secretary of State

Chapter summary

This chapter deals with questions of Initial Teacher Education (ITE) and Initial Teacher Training (ITT), though we refer to ITT throughout the rest of this report. It also looks at continuing professional development (CPD), and in doing so, considers the following:

The teacher and subject knowledge
This section looks at the importance of subject mastery in teaching mathematics at primary level.

Initial Teacher Training: primary schools
This section examines the mathematical content and effectiveness of Initial Teacher Training with specific emphasis on primary schools.

Continuing professional development in primary schools
The importance of CPD in upskilling teachers to the level required. This section focuses on the following issues:

- **School leadership and the head teacher**
  This section examines how successful delivery of CPD is dependent on strong leadership in the school.

- **The role of local authorities in CPD provision**
  This section examines the critical role of local authorities in providing the support of mathematics consultants and CPD for schools.

- **Current CPD practice and the NCETM survey**
  Current practice is examined and the dynamic between subject knowledge and pedagogic skill is explored, highlighting good practice and feedback from practising teachers.

- **The future of CPD for the practitioner – the Mathematics Specialist**
  Building on the evidence received, both anecdotal and written, this section proposes a new model for mentoring and coaching in schools.

The chapter makes the following **four** principal recommendations:

Recommendation 1: ***The potential for an ITT entry requirement of grade 'C' GCSE in*** *both* ***mathematics I and II, when they are firmly established, should be closely examined. For students who have taken or will take GCSEs before then, a grade 'C' in single award mathematics should remain the requirement. This should apply to the QTS in all phases.***

Recommendation 2: ***A renewed emphasis on CPD is required by practitioners, head teachers, local authorities and Government, focused on both in-school activities and third party 'market' provision (including HEIs), with the clear delegation to school level of the responsibility for CPD undertaken.***

Recommendation 3: ***Local authorities should strengthen the field force of mathematics consultants. The National Strategies, in partnership with the National Centre of Excellence in the Teaching of Mathematics, should develop 'refresher' CPD for all mathematics consultants.***

Recommendation 4: ***Within five years, there should be in post at least one Mathematics Specialist in each primary school, with deep mathematical subject and pedagogical knowledge, making appropriate arrangements for small and rural schools.***

In addition, a number of other proposals are included in the text. These are for discussion during consultation and do not constitute firm recommendations of the review at this interim stage.

The teacher and subject knowledge

10. Remit 4 from the Secretary of State requires a focus on the effectiveness of ITT and CPD, as currently delivered, in creating a generation of teachers and other practitioners with the required *mathematical* competence, both to teach mathematics in our primary schools and to promote a sound understanding of problem solving, reasoning and numeracy in early years settings. The review's remit is to propose changes and improvements in teacher education, where necessary, to bring this about.

11. There are many routes into teaching, both through undergraduate studies (BEd, BA/BSc with QTS) and postgraduate courses (PGCE, PGDE), plus other initiatives and employment-based schemes. This interim report primarily considers the PGCE and undergraduate routes.

12. Teachers and practitioners in primary schools or early years settings are not, of course, usually 'mathematics specialists', nor do they necessarily aspire to be so. But the figures for postgraduate primary trainees are nevertheless discouraging. The table below[i] shows that for the past three years, even if those with degrees in science, technology and

engineering as well as mathematics (STEM) are included, only between two and four per cent come from a related background discipline. As the table shows, the trend is strongly negative. Trainees may of course have studied mathematics to AS or A-level, but the TDA does not as yet collect this data so we have no means of assessing the degree to which the table may understate the average mathematical competence of the cohort.

Year	Primary PGCE 'STEM'	Total primary PGCE
2004	428	10,228
2005	389	10,405
2006	227	9,937

13. It would be a mistake simply to equate specialist knowledge of mathematics alone with excellent teaching at this level. Indeed, a 1997 study[ii] for the (then) Teacher Training Agency (TTA) found that having an A-level in mathematics was not associated with effective teaching (as measured by higher gains in pupils' attainment).

14. The primary school teacher confronts a formidable and quite general set of challenges over and above their subject specialism. Intuitively, we all refer to the 'good teacher', and there is huge importance in that concept. The link between subject knowledge and pedagogy was eloquently articulated by the Secretary of State at the then DfES in March 2003:

    'It is a combination of deep subject knowledge and a range of appropriate teaching and learning techniques which make for the most powerful interactions between teachers and pupils. Enhancing subject specialism therefore needs to be seen not as an end in itself, but as a way of bringing about excellence in teaching and learning to improve standards in our schools.'

    But while mathematical ability may not represent a *sufficient* condition in its own right for successful teaching, it is nevertheless a *necessary* condition for world-class teaching in mathematics.

15. The primary mathematics curriculum today is comprehensive, and contains some difficult and abstract concepts. Its content is reviewed in Chapter 9. By Years 5 and 6, even the 'mental and oral' starter in the daily mathematics lesson can be a taxing experience for teachers who are not in command of their subject. In-depth subject knowledge inspires confident teaching, which in turn extends children's mathematical knowledge, skills and understanding. This requires a mastery of the subject to a level sufficient to progress learning for all children up to the end of Key Stage 2, which leaves them well prepared for Key Stage 3.

16. In its evidence gathering and visits across England, the review panel were encouraged in terms of the quality and motivation of teachers. In particular, the introduction of the National Numeracy Strategy (NNS)

brought about nothing less than a transformation in the way mathematics was taught, as is considered later in this review. This in turn is strongly correlated with the increase in the attainment levels of primary school children. The percentage of the cohort leaving primary school at Key Stage 2 with level 4 and above rose between 1998 and 2006, from 59 per cent to 77 per cent. It is entirely reasonable to suggest that the changes introduced into the pedagogy of mathematics and the support networks for teachers as a result of the NNS were the major contributory factors in bringing about this improvement. The question confronting this review is how to maintain and, if possible, increase the rate of progress in that positive trend. This chapter identifies the key issues and makes a number of recommendations to Government and the teaching profession.

Initial Teacher Training: primary schools

17. In addition to the 10,000 trainee teachers on postgraduate courses for primary teaching in England at the present time (2006 figures above), there are 6,490 on undergraduate courses. The great majority of these trainees will teach for much of their career in a primary school.

18. The minimum requirement for admission to a BEd or PGCE course is a grade 'C' in mathematics at GCSE. While this demonstrates a basic understanding of the subject, it does not constitute in itself 'deep subject knowledge'. It must also be remembered that in the vast majority of cases GCSE constitutes the last and most recent occasion on which the trainee teacher has encountered any mathematics whatsoever – and that may have been anything up to a decade or more earlier.

19. The panel considered the idea of raising the required entry level to a grade 'B' at GCSE, or perhaps to some form of level 3 qualification at either AS or A-level. Reluctantly, it has concluded at this interim stage in the review that in the immediate future, this strategy would be inadvisable given the risk of falling enrolment of trainee teachers. However, at Key Stage 4 considerable change has recently taken place and there will soon be two mathematics subject options at GCSE. In addition, a 'functional mathematics' element has been introduced in Key Stages 3 and 4, and this will become mandatory. The review panel therefore considered whether any future changes to ITT entry requirements might be necessary in the light of the above.

20. Single subject mathematics at GCSE is intended to remain just as demanding after these changes and is to share the curriculum content with the second GCSE in mathematics. It is understood that the Government's aspiration is nevertheless for a significant proportion of the cohort, perhaps as high as 75 per cent, to take *both* GCSEs. It could therefore be argued that 'deep subject knowledge' may in future become synonymous with passing mathematics GCSE 1 and 2 with at least a grade 'C'. The interim conclusion of this review is that when both GCSEs

are established and when cohort sizes become clear, the latter requirement (i.e. both GCSEs) should be the norm.

Recommendation 1: ***The potential for an ITT entry requirement of grade 'C' GCSE in*** *both* ***mathematics I and II, when they are firmly established, should be closely examined. For students who have taken or will take GCSEs before then, a grade 'C' in single award mathematics should remain the requirement. This should apply to the QTS in all phases.***

21. If it is therefore accepted that at the present time the **input** competences in mathematics of trainee primary teachers at the start of their course cannot be changed, then the mathematical content in the average undergraduate or PGCE course must be considered. The structure of both undergraduate and postgraduate courses accords, quite properly, high priority to teaching experience on placements in schools – typically 18 weeks in a PGCE and around 32 weeks in total on a three-year undergraduate course. The other competing demands on the trainee's time then imply that on most PGCE courses, the amount of learning devoted specifically to mathematics is between 10 and 15 days at most, while on undergraduate courses the TDA judges that a figure of around twice that is normal during the three years. It is fair to observe that this can be expected to bring about little change in the mathematical competence and subject knowledge of a trainee whose previous background in mathematics extends simply to a grade 'C' at GCSE.

22. The next issue to consider is the resulting **output** competences of typical graduates at the end of their course. The QTS standards state that student teachers must 'have a secure knowledge and understanding of … curriculum areas and related pedagogy to enable them to teach effectively across the age and ability range' they are preparing to teach. All primary ITT providers therefore have in place strategies to audit, develop and assess student teachers' mathematical subject knowledge, but there is no universally accepted method for doing this.

23. However, even the providers who are most highly rated by Ofsted recognise that there is little scope in ITT programmes to do more than make relatively minor improvements in students' confidence and fluency. The TDA numeracy skills test, which all student teachers must pass to gain QTS, is not designed to test knowledge of the primary curriculum, and can be retaken as often as necessary for the student to pass.

24. Is this situation acceptable? In the course of fruitful discussions with the TDA, their ambition has become clear that eventually teachers in all sectors at QTS level, including primary, should have completed a course to *Masters* level. The Department's recently published *Children's Plan* (2007) develops this further. This would not, of course, imply a Masters

level in mathematics specifically, but that it should include greater depth in core subjects in both pedagogy and knowledge.

25. One further possibility would be to recommend extending the PGCE course, perhaps from one to two years, and to include a Masters-level qualification. This would permit the inclusion of deeper subject material, not just in mathematics, but in science, English and other subjects as well. However, not only would the cost of training teachers through the PGCE route double at a stroke, but the aspirations of young trainees – many with debts carried forward from their undergraduate years – to start their careers would also be put on hold for a further year. Such a course of action would, apart from any other consequences, probably completely eliminate the present low level of interest on the part of science, technology, engineering and mathematics (STEM) graduates in the primary education sector.

26. STEM graduates might in fact be more likely to respond to precisely the opposite proposition – that the PGCE year be somehow shortened, for example, through a credit towards QTS gained through schemes such as the Student Associates Scheme which give undergraduates experience in schools. Or the PGCE might be combined with the final year of their four-year honours course.

27. While all these measures might have some merits, particularly for those aiming to teach at secondary level, the present primary ITT regime is unlikely to be able to address, for the great majority of teachers, the question of subject knowledge depth in mathematics.

28. Therefore, in the short term, it is unrealistic to seek to improve competence levels in mathematics teaching in primary schools by placing higher hurdles in front of trainee teachers as they enter their training course. It is equally unrealistic to seek to introduce significant new mathematics material into already crowded undergraduate and PGCE courses. If the arguments above on the need for subject knowledge depth are accepted, the only route to raising mathematical understanding among the teaching profession in the primary sector, in the short and medium term, is through *continuing professional development.*

Continuing professional development in primary schools

Background

29. In making its proposals and recommendations for relevant continuing professional development (CPD), the review has been greatly assisted by the recent policy report published in September 2006 by the Advisory Committee on Mathematics Education (ACME) (a committee of the Royal Society and of the Joint Mathematical Council). The report concerned itself with four major policy areas:

- funding CPD
- teachers' subject knowledge
- the nature of CPD
- evaluation of CPD models.

30. Many of their recommendations and conclusions echo the review panel's views and support the arguments outlined below. A summary of ACME's main recommendations is included in Appendix 1.

31. The panel has reviewed the present situation in England in CPD so that wherever possible it can propose measures which build on best practice currently observed in primary schools. It is unfortunate, however, that while there are a number of informative anecdotal examples to support the arguments advanced in this review, there is no national information base from which to make quantitative estimates and recommendations. There are 200,000 QTS-level teachers in our 20,000 or so primary schools, teaching over four million children, yet little is known collectively of their career development since their ITT.

32. This is in stark contrast to other professions, including medicine, law and engineering. In the case of a graduate engineer, for example, membership of a professional institution brings the opportunity for accredited CPD (extensively work-based), leading to *registration*. Depending on the employer, a graduate can become a *chartered engineer (CEng)*, perhaps within five or six years of graduation. Surveys then show that significant enhancement to career earnings results. Other professional routes using accredited CPD can lead to registration as either an *incorporated engineer* or as an *engineering technician.* Standards have been developed jointly by professional institutions, companies and higher education institutions (HEIs), led by the Engineering Council (UK) who hold the register.

33. At this interim stage, this review seeks further views on whether appropriate models for primary CPD in England can usefully draw on these parallel examples from other professions. Is there a case for a national register, as with the engineering profession, developing the teaching register the General Teaching Council for England (GTCe) already hold, recognising that this would apply to all subjects taught? More specifically on mathematics, should the mathematical subject associations be involved? Alternatively, should CPD records simply be held by head teachers and the teachers themselves?

Proposal for consultation: Should the example be followed of other professions and a national register of professional development for teachers be established? If so, who should be responsible for keeping it, and what would be the relative benefits, disadvantages and costs?

CPD: school leadership and the head teacher

34. Despite the absence of comprehensive data, the review panel's visits to schools have included extensive discussions on CPD topics with head teachers and their staff, often held jointly with members of the local authority concerned (see examples below). This has built up a consistent picture of the current CPD provision in England. While this is inevitably anecdotal in nature, the review panel believes it forms an accurate representation of the national situation. The ACME study came to similar conclusions, and noted that there had been an increased focus on in-school programmes, at the expense of local authority and HEI provision of CPD, the latter often being deemed 'too expensive'.

> *'I was a trainee in the ILEA [Inner London Education Authority] days; I had one day of CPD every week for my first two years as a teacher.'*
>
> *'I remember the ten-day CPD course … I even remember the 20-day course.'*
>
> *'I could not get the sort of CPD I needed in this local authority [the city in question], so I managed to get on a course in the county which I wasn't really entitled to.'*
>
> *'I am paying for this CPD course myself as even though I am already an AST, I want to apply for a deputy headship and I think this will help me.' (On a visit to an HEI CPD course.)*

35. The interim conclusion of this review is that a decade or more ago, CPD was given a higher priority than it is today, was more readily available from diverse sources including third party providers, and was regarded more highly by head teachers and classroom teachers alike. The recent NCETM survey outlined below reinforces this conclusion.

36. Mindful of the importance of CPD, the Government made provision in schools' funding in 2004 for CPD, in effect putting finance for this at head teachers' disposal as part of the school's total budget. This was a positive measure and also embodied an important principle: that of *delegation of choice of CPD providers to school level.* This principle remains appropriate today and indeed should remain central to policy in the future.

37. Nevertheless, evidence submitted to this review and gained from visits to schools suggests that as schools have come under increasing financial pressures, the element of the budget notionally intended for CPD has also come under pressure. It is not ring-fenced (and nor should it be if delegated authority and responsibility is to be maintained) – therefore it is vulnerable. There will, of course, always be competition for scarce CPD resources in any school; mathematics is not alone in seeking to continuously improve standards, and must take its place

alongside science and English. The decision on priorities for CPD must, in the end, rest with head teachers and their staff.

38. Head teachers are critical to the outcome of all that we propose – they are the champions of 'quality first teaching' in all subjects, including mathematics. They alone can facilitate the professional development their teaching staff require, subject to the constraints, financial and otherwise, that they face. While they will not necessarily have a mathematical background, their support for the measures advocated in this review are of central importance. In meetings with primary head teachers' reference groups, the panel encountered an open acknowledgement of the issues in mathematics in this review and great enthusiasm to take forward measures designed to address them.

Recommendation 2: ***A renewed emphasis on CPD is required by practitioners, head teachers, local authorities and Government, focused on both in-school activities and third party 'market' provision (including HEIs), with the clear delegation to school level of the responsibility for CPD undertaken.***

The role of local authorities in CPD provision

39. In parallel with its CPD funding for schools, the Government has made extensive provision through local authorities and the Primary National Strategy for various forms of support structures. Excluding central costs, 'pass-through' funding through the National Strategies for educational support in local authorities is approximately £300 million for the next financial year. This funding of course supports local authority specialists and consultants as well as CPD for all subjects, so it is difficult to estimate the specific expenditure on CPD for mathematics.

40. Today, local authority courses remain an important source of CPD for many classroom teachers and teaching assistants. The panel has seen excellent examples of what can be achieved by this means. The Hampshire programme, *'Developing Mathematical Thinking',* currently reaches 164 primary teachers in eight locations. The Hampshire local authority plan is for at least one teacher in every primary school in the county to have attended this course over the next five years, at a cost per teacher of between £500 and £1000. A vital element in the Hampshire course is the involvement of an HEI – in this case, the Open University. Using its proven pedagogies of distance learning, local tutorials and residential summer schools, this may well prove to be the prototype for CPD delivery nationally in the primary sector.

41. Of concern, however, is that the National Strategies and local authorities appear to have become much more general in their approach, with subject speciality becoming de-emphasised. It has also become apparent during this review that nationally, the numbers of properly

qualified and experienced mathematics consultants have decreased since they were first introduced as part of the reforms alongside the introduction of the National Numeracy Strategy, so a first priority will be to remedy this.

42. There are, in fact, still around 400 mathematics consultants active in local authorities (prior to any increase as above). However, it is clear that the increasingly general focus, away from subject specialism, implies that the depth of subject knowledge in mathematics of many consultants is insufficient for them to operate effectively as coaches and mentors for practitioners in schools. There is a national need for a comprehensive CPD programme in mathematics for *all* these consultants, before implementing any further CPD for the practitioners themselves. This CPD would benefit from wide inputs; clearly the National Strategies should have a central role in the development of programmes, but the involvement of the NCETM would add independent validation to the process. This review recognises that in making such a recommendation, there are clear implications for other subjects in the primary curriculum, but contends that there is a special case in mathematics.

Recommendation 3: ***Local authorities should strengthen the field force of mathematics consultants. The National Strategies, in partnership with the National Centre of Excellence in the Teaching of Mathematics, should develop 'refresher' CPD for all mathematics consultants.***

Current CPD practice and the NCETM survey

43. One vitally important aspect of CPD, which should not be overlooked, concerns in-school professional development. In the panel visits to schools and in discussions with teachers and head teachers, the importance of peer-to-peer learning and coaching, mentoring and classroom observation was repeatedly emphasised. The review strongly endorses these approaches, while noting the resultant pressures on staffing and timetabling when more than one teacher is simultaneously involved in any given activity. In discussions, it was also clear that both subject knowledge *and* pedagogy were central in CPD planning.

44. In the context of in-school activities, the review also considered the question of the use of INSET days. When the NNS was first introduced, an extra day was provided to schools to emphasise the importance of CPD. Perhaps over the course of the next three years, head teachers could be encouraged to place an emphasis on mathematics by allocating, say, two further days' classroom-based and one extra funded school closure day? This suggestion will be explored further during the consultation period following this interim report.

45. Moving to the provision of CPD for the practitioner, this review envisages a continuing central role for local authorities, acting together with the National Strategies as outlined above. However, it is also essential that a 'market' exists in which a range of other providers are able to offer complementary CPD packages aimed at both improving subject knowledge and pedagogy. To promote subject knowledge depth, HEIs in particular should be involved in these programmes, which would provide inbuilt verification of standards and intellectual rigour; in turn, it is essential the HEI CPD courses themselves be subject to some form of 'quality assurance'.

46. The review has begun to consider the extent of any third party CPD provision, though as noted above, the situation at present is difficult to assess across the whole cohort in primary schools. In a recent panel visit, it was noted that in Scotland every classroom teacher is entitled to five days' in-school CPD provision, similar to that in England noted above. However, in addition, since 2001 they are entitled to 35 hours' (i.e. approximately one week) further personal CPD a year. It is in fact now both an entitlement *and* an obligation of employment – the school, in turn, is obliged to ensure CPD provision and release from classroom duties for sufficient time, which must cover all subjects, including mathematics.

47. A parallel entitlement in England represents an attractive long-term goal. But any third party CPD provision should *supplement* in-school activities such as coaching and mentoring, which are an equally vital part of the development process. It must also be recognised that there will be other priorities for schools in CPD, and that mathematics must take its place alongside other subjects, but with adequate prioritisation. There would be significant consequences, both financial and practical in adopting the Scottish model, and this suggestion represents an aspiration for the longer term, perhaps within a ten-year period. It does not form an interim recommendation in this review.

48. Looking more broadly, the recent CPD survey of practitioners by the NCETM paints a picture which is far from encouraging. Many classroom teachers acknowledge the description of current CPD uptake given above, yet they do not prioritise CPD as highly as does this review. Despite the enthusiasm for mathematics among respondents, the survey indicated that the majority of schools were not engaged in local mathematics networks. It also suggested that it was mainly the subject leaders who took part in external training, with the assumption that they would cascade the training to their colleagues through staff meetings and INSET days. This confirms that the quality of mathematics professional development experienced by many teachers depends on the knowledge and expertise of their own mathematics subject leader.

49. Hence this review's emphasis, considered in the next section, on ensuring that at least one person is available within a school to ensure that best practice acquired through CPD is transmitted in effective ways,

especially as the survey suggested that the levels of in-class support, coaching and team teaching were relatively low. The responses nevertheless showed that teachers recognised the need for mathematically-focused CPD in Assessment for Learning (AfL) and in the renewed primary frameworks.

50. In terms of meeting a school's priorities, respondents who were subject leaders or head teachers who taught mathematics highlighted the need both for improved general mathematics subject knowledge and for general mathematics subject pedagogy. This highlights the critical importance of the senior management team in schools for standards generally and CPD specifically, as noted above.

The future of CPD for the practitioner: the Mathematics Specialist

51. With costs in mind, this review is conscious of the need for prudence in making any recommendations which affect the whole 200,000-strong teaching force in primary schools. Long term, CPD should deliver greater in-depth subject knowledge in mathematics to all teachers, but it is both unrealistic and unnecessary for the changes proposed by this review to immediately involve the whole of the primary teaching cohort.

52. Our response to this question is to advocate a two-phase approach. The review panel supports ACME's suggestion that there should be *at least one* teacher in each primary school with a deep subject knowledge in mathematics, which is relevant to the whole age range in the school.

53. This specialist teacher would fulfil many roles:

- an excellent classroom teacher in their own right (and one who could be observed by fellow teachers)
- peer-to-peer coach and mentor
- liaison officer with the local authority and other CPD providers
- that of the mathematics coordinator (whilst guarding against overburdening a Mathematics Specialist with administration).

54. In making sensible allowances for small and rural schools (where some degree of pooling would be appropriate), these candidates would be drawn from the existing teaching workforce. Indeed, in many schools such an individual is already in post. However, once identified, a candidate would undertake CPD to enhance their mathematics subject knowledge *and* pedagogical skills. It is estimated that the number of teachers requiring this CPD would exceed 15,000.

55. Parallels already exist for the *Mathematics Specialist*. The National Strategies are already active in developing the role of the *mathematics subject leader*. Among the cohort of *Advanced Skills Teachers (ASTs),* around 200 in the primary sector have specialist mathematics skills, although their duties are somewhat different from that envisaged for the Mathematics Specialist in this review. The panel also visited a number of

schools with *leading mathematics teachers (LMTs), teacher leaders* and other similar designations for subject specialists. In Scotland, the *learning leader* is the subject champion. Our recommendation therefore acknowledges that in many schools the equivalent post to the *Mathematics Specialist* advocated here already exists. However, the visits revealed very varied standards, even among mathematics coordinators, whose role was largely administrative. The review was also encouraged by the positive response to the proposals from practitioners and from head teachers' reference groups.

Recommendation 4: ***Within five years, there should be in post at least one Mathematics Specialist in each primary school, with deep mathematical subject and pedagogical knowledge, making appropriate arrangements for small and rural schools.***

56. This specialist cadre should be the pathfinders for an entirely new breed of primary school teachers. The CPD they receive should be of high academic quality. Already a typical CPD offering in an HEI attracts 'CAT' credits, which can eventually result in diploma accreditation. For the Mathematics Specialist teacher, there is an opportunity for a long-term, carefully designed CPD programme leading to **Masters-level accreditation**. Here it is important to stress that this is not a masters level in mathematics alone, but in primary teaching with an emphasis on mathematical content. This goal would align perfectly with the Government's aspirations in the *Children's Plan* and with the TDA's stated objectives. Moreover, it would apply to the current generation of teachers, not just to those generations to come.

57. The review panel has recently visited Scotland. CPD is an integral part in the career development of all QTS-level teachers in Scotland, organised in four phases following graduation. After five years' classroom experience, teachers can nominate themselves for the fourth phase: a programme leading to a Masters degree and *Chartered Teacher* status, through accredited CPD over a period of six years. A significant supplement to salary follows successful completion of the six-year course, implemented on an increasing scale annually in £1,000 increments. It is interesting to note that in parallel with this, the teacher bears the annual costs of the CPD. While this approach is by no means solely aimed at mathematics, it provides a useful model for further examination in the context of CPD for the Mathematics Specialist. The final report of this review will include an extensive case study of the Scottish system.

Incentives and rewards

58. The teachers encountered during this review are highly dedicated and committed to their jobs, perceive their weaknesses in mathematics, and

are enthusiastic about the opportunity for CPD to rectify this. What can be done to encourage them in this aim?

59. First and foremost, the Government needs to recognise the requirement for appropriate incentive and reward structures. In the case of the chartered engineer (coincidentally, a cohort of approximately the same size as primary school teachers), there is a considerable career salary premium associated with achievement of the standard required for chartered status. Other professions enjoy similar benefits.

60. It appears self-evident that teachers should likewise be rewarded for self-improvement, as is the case in Scotland. This is not a reward to the weak teacher for merely bringing himself or herself up to average standard – it is the management task of the head teacher and the school to make sure all staff conform to basic benchmarked standards. An incentive system should reward excellence and out-performance. Or put another way, a teacher who entered the profession with the minimum 'C' in GCSE mathematics who subsequently masters the subject to a higher level through CPD, deserves more than simply congratulations.

61. The proposal for the *Mathematics Specialist* outlined above raises other specific questions about CPD. If a practitioner undertakes a long-term CPD programme leading to a Masters-level qualification, in line with current Government and TDA aspirations, what would be the financial consequences? The review will look into these matters in greater detail during consultation.

Proposal for consultation: What form of incentive, if any, should there be for all practitioners to undertake CPD, and what difference would it make to uptake? Are there any aspects of this question specific to mathematics? In the case of any long-term CPD programmes leading to formal Masters-level qualifications, what additional incentives should there be?

Financial implications

62. Clearly all the above recommendations have major funding implications, both for ITT and CPD. The proposals made in this review on ITT are broadly cost neutral. The aggregate CPD costs are, however, more difficult to estimate. They include third party provision, including HEIs, and that delivered by local authorities and the National Strategies. While the latter may appear to be 'free at the point of delivery' as far as the schools are concerned, this disguises the economic reality. Similarly, CPD courses delivered by HEIs may appear to the schools to be 'expensive', but in national accounting terms, these 'costs' merely reflect funding redistribution between different parts of the public sector. Careful financial analysis of our proposals will therefore be required, and the

review seeks further inputs on this during the consultation phase following this interim report.

63. For the present, we give only a preliminary outline indication of likely costs for the CPD proposals above, based on the numbers of local authority mathematics consultants and the proposed Mathematics Specialists. The costs of 'refresher' CPD for the consultants is estimated at £1,500 per person for one year.

64. For the *Mathematics Specialist*, the estimate is based on five days' total external provision per year in addition to INSET days. The costs are estimated by reference to the Scottish Chartered Teacher CPD modules (£650 per module, typically two taken a year) and on CPD courses observed in an HEI institution during the course of the review (£750 per two-day course). The working assumption here is that within the five days of annual provision, half is provided by local authorities/National Strategies at *nil marginal cost,* and half by third party providers at the above rates, resulting in an annual cost per person of approximately £1,750. This cost is very sensitive to the detailed blend of the CPD provision.

65. Clearly, the phasing of any programme would determine the annual rate of total costs on a national basis – a five-year programme would cost just in excess of £5 million a year (see table below). Equally, any move towards *long-term* CPD along the lines of the Scottish model, with *all* Mathematics Specialists undertaking five days' CPD each a year for a period of, say, five years, would increase the annual sums involved each year proportionately.

	Number	Cost pp/pa £k	Total cost £m
Local authority consultants	400	1.5	0.6
Mathematics Specialists	15,000	1.75	26.25

CPD for teaching assistants

66. This chapter has focused almost exclusively on qualified teachers. However, the importance of teaching assistants should also be stressed. The panel has witnessed in many visits the vital contribution they make in the modern classroom. There are a number of training and CPD packages, typically at level 2, which are designed for teaching assistants, and it is as important that they should engage in appropriate CPD. There are examples of outstanding teaching assistants who have gone on to undertake study to become qualified teachers as a result. CPD for teaching assistants should be mindful of this possibility of progression, and make provision accordingly. As with much else in this interim report, the review panel seeks further inputs on this important question.

Chapter 7: The Early Years Foundation Stage

'The review should build on the recent renewal of the Primary framework for mathematics ***and the EYFS****.'* Remit from the Secretary of State

Chapter summary

This chapter deals with the Early Years Foundation Stage (EYFS), the first five years of a child's development. It considers the following matters:

Background research into early years
This section looks at the available research in early years.

Teachers and practitioners in early years settings
This section looks at the early years workforce and qualifications of early years practitioners.

Problem solving, reasoning and numeracy in early years
This section looks at mathematics learning through play activities.

The transition from EYFS to Key Stage 1
This section looks at continuity of learning experience, on transition from the EYFS to Key Stage 1.

The following principal recommendation is made. In addition, the text contains a number of proposals for consultation.

Recommendation 5: ***The review endorses the Government's goal of increasing the proportion of graduate practitioners in early years settings.***

Background

67. Previous chapters of the interim report have dealt exclusively with questions of mathematical education in primary schools. They have addressed in particular the training, education and professional development of both teachers and teaching assistants. Chapter 9 returns to issues of pedagogy and curriculum. In his remit to the review, the Secretary of State made clear, however, that the same issues should also be addressed in the context of early years settings. This chapter reports the review's findings in response to this.

68. The Early Years Foundation Stage (EYFS) extends from birth to the end of the academic year in which a child has his or her fifth birthday. During

this vital period in a child's development, the diversity of provision and the differences in children's experiences are immense. One child may be placed in the care of a childminder as a toddler, attend a sessional group later on and at age four join a reception class. Another may stay at home and join playgroups from time to time. Some children may attend just one form of provision in any given week and others several. By the end of the EYFS, one child may have had nearly six years of provision outside the home and another hardly any at all. Nor does length of attendance correlate with attainment, because different types of provision and different providers also vary widely in quality and effectiveness. This range of experience and quality has profound implications for mathematical development in the EYFS.

69. There is a very broad consensus on the importance of the early years and the need and demand for uniformly good provision. Extensive research underpins this. The Effective Provision of Pre-School Education project (EPPE) in particular shows just how important the early years are in the context of a child's development, and how the effects can still be seen well into primary education and beyond. The key findings of the first EPPE study (which looked at the pre-school period for children aged three or four years until they started primary school) are highly relevant to the recommendations made below:

- *Pre-school experience, compared to none, enhances children's development.*
- *The duration of attendance is important, with an earlier start being related to better intellectual development and improved independence, concentration and sociability.*
- *Full attendance led to no better gains for children than part-time provision.*
- *Disadvantaged children in particular can benefit significantly from good quality pre-school experiences, especially if they attend centres that cater for a mixture of children from different social backgrounds.*
- *The quality of pre-school centres is directly related to better intellectual/cognitive and social/behavioural development in children.*
- *Good quality can be found across all types of settings. However, quality was higher overall in integrated settings, nursery schools and nursery classes.*
- *Settings which have staff with higher qualifications, especially with a good proportion of trained teachers on the staff, show higher quality and their children make progress.*
- *Where settings view educational and social development as complementary and equal in importance, children make better all round progress.*
- *Effective pedagogy includes interaction traditionally associated with the term 'teaching', the provision of instructive learning environments and 'sustained shared thinking' to extend children's learning.*

(Quoted from EPPE's report of its findings)

Additionally, EPPE found significant differences between pre-school settings and their impact on children. Those in fully integrated settings and nursery schools made the most progress. Where parents actively engaged with children at home, the children's intellectual and social development was promoted.

70. Recent research also emphasises the importance of the interrelationship between the home environment and the early years setting, with the parent (or carer) seen as the most important educational influence in a young child's early development. In their paper, *Effects of the Home Learning Environment and Preschool Centre Experience upon Literacy and Numeracy Development in Early Primary School*,[iii] Melhuish et al explore the effects of home learning and pre-school variables on a child's development, and conclude that '*These analyses indicate powerful effects for the home learning environment and important effects of specific pre-school centres at school entry. Although reduced, such effects remain several years later.'* Chapter 10 explores further the vital influence of parents and families in a child's early learning.

71. The Government, in establishing the Early Years Foundation Stage, has recognised the force of this evidence and given statutory weight to measures designed to address it. The EYFS will be implemented in all early years settings from September 2008 and the full EYFS pack includes the Statutory Framework for the EYFS as well as practical guidance on its implementation. This review supports its aims, which stress the following key themes:

- a unique child
- positive relationships
- enabling environments
- learning and development.

72. The following sections focus on the critical factors which will determine a successful outcome to this, recognising concerns about providing children with experiences appropriate to each stage in their development.

Teachers and practitioners in early years settings

73. The evidence cited from the EPPE research, and more recently the Millennium Cohort Study and the evaluation of the Neighbourhood Nursery Initiative, all point to the need for young children to have direct support from a qualified early years teacher. The EYFS sets as minimum requirements the following qualification levels in early years settings:

- All supervisors and managers must have a full and relevant level 3 qualification (as defined by the Children's Workforce Development Council). The manager should have at least two years' experience of

working in an early years setting, or at least two years' other suitable experience.

- Half of all other staff must have a full and relevant level 2 qualification.
- Childminders must have attended a training course within six months of registration and have a current paediatric first aid certificate.
- For children aged three and over in maintained nursery schools and nursery classes in 'integrated' maintained schools, at least one member of staff must be a school teacher and at least one other member of staff must have a full and relevant level 2 qualification.

74. Based on evidence from visiting a number of excellent early years settings, the review concludes that these criteria are, at best, adequate. To have the greatest impact on children's learning and development, the EPPE conclusions above highlight the need for a *'good proportion of trained teachers on the staff',* not just one*.* The presence of someone with Qualified Teacher Status with early years specialism working with children is vital and in settings with more than perhaps five or six staff, more than one such teacher is necessary. Other appropriately qualified *graduate-level* teachers with Early Years Practitioner Status (EYPS) could also help to address the need identified.

75. However, it remains undesirable that some settings are able to meet statutory requirements when half of the staff may be unqualified. One Children's Centre visited during the review (to be featured in a case study in the final report) had no fewer than 13 teachers with an undergraduate or postgraduate degree-level qualification out of a total staff compliment of 25; in addition, many of the other staff had good level 3 qualifications. A recent Ofsted inspection found the setting 'outstanding'. This is, however, atypical of the centres visited and probably unaffordable for the majority of settings.

76. Encouragingly, the Government's *Children's Workforce Strategy*, echoed in the recent *Children's Plan*, states as a key aim that there shall be a graduate early years professional in every full day care setting in England by 2015, with two graduates per setting in disadvantaged areas. Financial provision is made for both ITT and CPD in this regard.

77. Alongside this, continued priority needs to be given to strengthening the non-graduate workforce, who continue to make up the majority of staff, and many of whom have a strong commitment to and knowledge of children and their development. They, as well as graduate leaders, need to have a clear grasp of how children's understanding of mathematics develops; they need to be comfortable with mathematical language and able to support children's play in a way that helps them develop their understanding of mathematical language. For this reason, priority needs to continue to be given to raising their skills and qualifications as well as a much needed focus on increasing the number of graduates.

Recommendation 5: ***The review endorses the Government's goal of increasing the proportion of graduate practitioners in early years settings.***

Mathematical subject knowledge and the early years practitioner

78. Subject knowledge in mathematics is a key aspect of the review's findings for the primary sector, but it is appropriate to enquire whether the same considerations apply in EYFS. The focus in early years settings is on Problem Solving, Reasoning and Numeracy, rather than the formal teaching of mathematics, although it is important that early years practitioners are comfortable with mathematical language and concepts, especially in everyday circumstances.

79. The review has addressed this issue with respect to *graduate practitioners.* The graduate practitioner who is delivering the EYFS may be a teacher in a primary school, nursery class or linked to another setting, for example a Children's Centre. She or he will need to acquire specialist skills appropriate to the care and teaching of very young children in the EYFS but will also require confidence in certain mathematical elements of pedagogy. By way of illustration, there are excellent examples of early learning in which mathematics is both implicit and explicit in everything from numbers in outdoor areas to fractions in the morning fruit and refreshment session, all embedded naturally in children's everyday experiences and play.

80. Paragraphs 87–92 below address questions of problem solving, reasoning and numeracy in the EYFS. An earlier consideration is whether the *same* ITT entry requirements should apply for both QTS and graduate EYPS in EYFS, as for the QTS in primary. Given the importance of measures which lead to all round improvement in classroom practice, it would be inappropriate to endorse any diminution in standards in early years – quite the opposite.

81. A further consideration is the mobility of the graduate teacher in the profession after graduation – during ITT, the eventual destination of the student, to either primary or the early years, may well be uncertain, so ITT must take account of this. Of course, the early years practitioner will differ in some ways from the Year 6 teacher in primary, employing pedagogies specific to the age group taught, but the question of career mobility nevertheless dictates that the skill sets of all QTS teachers and graduate practitioners should overlap.

82. Recommendation 4 suggests that there should be *at least one* Mathematics Specialist in each primary school with deep subject knowledge in mathematics. Recognising the need for the above overlap in skills, these specialist teachers should include in their professional body of knowledge a comprehensive understanding of the pedagogy for

mathematical learning in the EYFS. On all counts, it therefore seems that the ITT entry qualifications should not distinguish between the primary and early years sectors.

83. As with recommendations for the primary sector, it is important to be sensitive to the possible effects of raising entry requirements to ITT, in this case with the attendant risk that potential students might be deterred from pursuing a career in early years. It is also important to recognise that in the EYFS, implementation of the recommendations will have an impact on private sector, as well as Government, provision. But, pending the consultation with all stakeholders before the final report, the review has concluded that this recommendation is necessary to pursue the long-term aim of raising standards.

84. The previous section relates solely to the graduate-level practitioner in EYFS. The review has not yet formed a definitive view on the equally important question of the practitioner who is not a graduate. Their role in EYFS is vital, and the review will address their situation during the consultation phase. Paragraph 73 notes the minimum qualifications required for supervisors, managers, staff and childminders, but it is open to question whether these are sufficient or whether, long term, higher standards should be sought. For now, in line with the review's remit on *mathematics* in early years settings, it is important to stress the need for *appropriate mathematical content* in the training of all practitioners.

Continuing professional development in early years

85. As with the considerations of the primary sector in the previous chapter, continuing professional development should be both an entitlement and an obligation as far as the early years practitioner is concerned. In this, there is no reason to distinguish between EYFS and primary, so the same general measures recommended above should apply. These include in-school and in-setting, local authority/National Strategies-based and HEI courses, as well as appropriate distance learning packages. The provisions in the *Children's Plan,* which will provide finance for both ITT and CPD for early years practitioners, are to be welcomed. As in primary, all early years practitioners must have access to appropriate CPD, in which mathematics (i.e. problem solving, reasoning and numeracy) is given adequate priority.

86. This applies to staff at all levels, from graduate setting leaders to new entrants with level 2 or 3 qualifications. It is essential that those working in early years have the opportunity to continually develop their knowledge and their understanding of effective pedagogy in supporting young children's mathematical development. That must include a clear grasp of how children's understanding of mathematical concepts such as shape, space, measure, numbers and problem solving develops, and appropriate ways of developing a learning environment that facilitates learning about these things through play. It also involves building

knowledge of how to engage with children and extend the way in which their play helps them become familiar and confident with mathematics as part of their everyday world and experience. It should remain a priority for the Government to support local authorities and providers in developing and delivering effective CPD opportunities to deliver this range of skills, so that the quality of children's experience in all settings continues to be raised.

Problem solving, reasoning and numeracy in early years

87. The early years practitioner promotes many important mathematical concepts whose understanding, if secured by the child, form the basis for much later learning. The EYFS guidance is clear on the importance of good quality mathematical learning and development that will promote positive attitudes and deeply rooted learning. Among these (quoting directly from EYFS) are:

    - *Give children sufficient time, space and encouragement to discover and use new words and mathematical ideas, concepts and language during child-initiated activities in their own play.*
    - *Encourage children to explore real-life problems, to make patterns and to count and match together.*
    - *Support children who use a means of communication other than spoken English to develop and understand specific mathematical language while valuing knowledge of Problem Solving, Reasoning and Numeracy in the language and communication system they use at home.*
    - *Value children's own graphic and practical explorations of Problem Solving, Reasoning and Numeracy.*
    - *Develop mathematical understanding through all children's early experiences including through stories, songs, games and imaginative play.*

88. Preliminary analysis indicates the possibility that not enough attention is given to the use of the Foundation Stage Profile (FSP) at scale point level. Relatively few children attain point 8, '*uses developing mathematical ideas and methods to solve practical problems',* in any of the three mathematical assessment scales. The review will investigate this further during consultation, including the question of weaknesses in the development of an understanding of mathematical language, particularly related to calculating. The final report will consider these matters further.

89. The EYFS guidance stresses the value of children's own graphic explorations, and it is common to see children from an early age making their own marks in role-play to communicate or act out activities they observe in adults, such as writing letters or making lists. It is comparatively rare, however, to find adults supporting children in making mathematical marks as part of developing their abilities to record their

mathematical thinking. While 'emergent writing' is a recognised term, that is not the case for 'emergent mathematical mark-making'. This seems to miss a valuable opportunity to encourage this early experimentation. The review will continue to look into evidence submitted on these matters (Carruthers and Worthington, 2005), and will comment further in the final report.

90. The EYFS also provides guidance on developing '*mathematical understanding through … imaginative play*'. However, it is not clear whether there is sufficient time allocated for 'mathematical' discussion around practical activities such as play with vehicles outside, cooking, shopping and constructing. There is a huge range of opportunities in this area, which are too often underexploited. To be effective, mathematical learning for children in this age group needs to be predominantly social in nature and rooted in these play activities.

91. Nevertheless, the EYFS early learning goals are well judged for the vast majority of children. Issues relating to '*using developing mathematical ideas and methods to solve practical problems'* relate in part to practitioners not recognising this or not providing an environment where this can take place, rather than reflecting on most children's inherent capabilities.

92. The goals related to shape, space and measures focus predominantly on use of mathematical language and do not refer to concepts of time or capacity. Measures provide rich opportunities for children to apply their mathematical knowledge in practical and active ways. They also lend themselves to problem solving. There is scope for the goals relating to shape, space and measures to be redrafted to promote purposeful mathematical activity and to be inclusive of all children's measuring experiences. The final report will return to this, following further discussions with the Department, National Strategies and NAA.

The transition from EYFS to Key Stage 1

93. There are, of course, many other factors in successful provision in this sector, which would need to be considered in a fuller review of the EYFS but fall outside the scope of this review. However, the important question of the *transition* from the end of the Foundation Stage to Key Stage 1, through the early years reception class, directly affects the young learner in mathematics. Successful transition depends on the setting making sure it is ready to provide appropriately for each child. This requires full account to be taken of the child's accomplishments, and needs to reflect the perspectives of a range of contributors, especially parents.

94. There is the question of the summer-born child who can find the transfer to Year 1 problematic, particularly if the change is abrupt, the environment unhelpful to active children and the curriculum not flexible enough to take account of a child's stage of development. Practitioners

and teachers must be ready to provide for the individual development and learning needs of each child. To continue to progress, it is likely that many children in Year 1 will require a curriculum which exploits learning both inside and outside the classroom. This should still continue to encourage play, provide first-hand experiences and opportunities to be active, as in EYFS. There is nothing unique in this for mathematics, however, and the general question of the summer-born child and supporting effective transitions for young children in general is being specifically addressed in the review of the primary curriculum presently being conducted by Sir Jim Rose.

95. Regardless of a child's age on entry, the ratio of adults to children is another factor which immediately affects his or her learning environment when they make this transition. In the EYFS in pre-school settings for children aged three and above, the adult/child ratio is statutorily limited, but when they go into the reception class, that ratio decreases. Despite the advantages offered by QTS-level teaching, it is not obvious that a single teacher acting alone can provide high quality mathematical education for 30 children in this age group. Indeed, many schools already provide additional adult support for just this reason.

96. This less favourable adult/child ratio in reception may not be enough to make sure each child continues to be known as an individual and is supported personally to take the next steps in learning. The progress of children's mathematical learning would be better maintained by ensuring that at least one further suitably qualified adult is present to help the QTS teacher in all reception classes. This practitioner will ideally have a level 3 qualification. In making this recommendation, the review endorses the general view, expressed elsewhere in this report, that head teachers (and of course their governing bodies) should have discretion over allocation of resources between activities. Nonetheless, this recommendation reflects the measures that will best promote *mathematical learning*.

Proposal for consultation: The review acknowledges the change in the statutory QTS-to-pupil ratio from reception class onwards, but stresses the subject-specific need in mathematics for the presence of at least one additional suitably qualified adult, for example a teaching assistant with level 3 qualifications. Views are sought during consultation on how this might best be accomplished.

97. One final important matter on transition to Key Stage 1 involves the use of the Foundation Stage Profile (FSP), referred to above in the context of problem solving, reasoning and numeracy. The FSP provides a wide-ranging account of a child's skills, knowledge, attitudes and understanding – invaluable information for the Year 1 teacher planning a relevant curriculum. It includes insight into a child's confidence in tackling new learning, ability to concentrate, motivation, as well as mathematical attainment in numbers for labels and counting, calculating, shape, space and measures. This wealth of information must be

exploited fully to make sure the next steps in developing personalised learning goals for the individual child are well planned. The FSP also provides a sound basis for developing whole-school responses to patterns of outcomes. However, the evidence suggests that the opportunities afforded by the FSP are frequently *not* being exploited at the present time.

98. It is essential that the FSP is analysed at scale point level, rather than simply looking at total scores. As noted above, point 8 – 'use and apply' – is often identified as a specific weakness for many children. Where schools identify such common factors, measures can and should be put in place to strengthen that aspect of their provision.

99. The FSP should also be used to identify children who will ultimately struggle if they do not receive teaching appropriate to their stage of development. If this assessment information is used well, it is conceivable that fewer children will need intensive support programmes in later years. However, it should be noted that early years provision covers the whole ability range with its diversity of learning difficulties and disabilities, so there will always be a proportion of children who will fall below the norm, no matter how well the data informs planning.

Proposal for consultation: The review sees considerable potential for more effective use to be made by primary practitioners of the Foundation Stage Profile, analysed at the scale point level, not just on total scores. Views are sought on best practice and experience on this, especially from primary and EYFS practitioners.

Chapter 8: Under-attainment and intervention – Every Child Counts

'The review should specifically make recommendations to inform the development of an early intervention programme for children (age five to seven) who are failing to master the basics of numeracy – Every Child Counts – as recently announced by the Prime Minister.' Remit 3 from the Secretary of State

Chapter summary

This chapter deals with the response to this remit from the Secretary of State. It shall be considered in the following sections:

Contributory factors to under-attainment in primary schools

The background justification for intervention

Specific intervention programmes

Every Child Counts – a partnership between Government, businesses and charity

The essential characteristics of intervention:

- assessment
- timing
- duration of interventions
- interrelation with literacy intervention
- group size
- the teacher
- continuing professional development
- resources, and
- the role of parents and carers.

Interim conclusions

The following principal recommendations are made:

Recommendation 6: ***Intervention in Every Child Counts should be led by a qualified teacher, normally with a single child, but in the research and development phase, there should also be investigation of the potential benefits of working with small groups of up to three children.***

Recommendation 7: ***Before any intervention programme is implemented, it is vital that the child is fully committed and that the parents or carers are involved and understand the nature of the programme. These issues and the question around the integration of intervention teaching and classroom teaching for pupils should be considered carefully in the research and development phases of Every Child Counts.***

In addition, the text contains a number of proposals for consideration during consultation.

Under-attainment in mathematics in primary schools – contributory factors

100. As summarised above, assessment data in mathematics shows that, despite the great progress made since the introduction of the National Numeracy Strategy, there is still a group of pupils who fail to achieve level 3 in mathematics by the time they leave the primary sector at age 11. The data in the table below[iv] shows that since the introduction of the NNS, the percentage of pupils attaining no more than level 2 has been stable at around six per cent, with little fluctuation. The size of this cohort of young children is around 30,000–35,000 in total and this chapter is concerned with measures aimed at enabling these learners to attain a better mastery of mathematics in the future.

Percentage of pupils failing to achieve level 3 at Key Stage 2

1998	1999	2000	2001	2002	2003	2004	2005	2006
7	6	6	5	5	6	6	6	6

101. From the evidence that has been reviewed, there is no consensus about any single dominant cause of this under-attainment. This is an important conclusion in itself, as it strongly suggests that there is therefore likely to be **no single solution** to the problem. Nevertheless it was observed that several factors must be taken into consideration:

- the overall quality of classroom teaching in mathematics
- the social and economic factors that affect the child's learning environment
- the alleged intrinsic difficulties in mathematics itself as compared to other subjects
- the possibility of fundamental barriers to learning of a clinical or psychological nature.

102. Notwithstanding the excellent teaching that was observed in many of the review panel's visits, the critical importance of measures which will lead to long-term improvement in the quality of teaching in all our primary schools must be stressed yet again. The recommendations made above

in terms of ITT and CPD will not be repeated here again. However, the importance of 'quality first teaching' will be emphasised throughout this report.

103. What is reviewed below are some possibilities for the specialist training of teachers for programmes aimed specifically at under-attaining children. It is nevertheless almost certain that whatever the success of such a renewed emphasis on teaching quality, there will in all probability remain a finite percentage of young children for whom mathematics remains intimidating and unfathomable. However, *it is not acceptable* that this situation should continue unchallenged.

104. Perhaps it is also appropriate to ask whether there are certain unique and intrinsic difficulties in the learning of mathematics? The panel are not, however, persuaded by the familiar assertion that somehow maths is uniquely incomprehensible. Indeed, in many schools throughout the country the review panel saw the enthusiasm with which children take to mathematics when it is taught well – and particularly when it is taught in a context that relates to their own lives and world, and also makes the learning process 'fun'. Nor can it be regarded as acceptable the mantra so often recited by adults that they were 'never any good at maths'.

105. Finally, before beginning to address what might be done about this problem, there is an acknowledgment of a growing body of opinion which cites evidence for a clinical condition, analogous to dyslexia, which may seriously impede the young learner in mathematics. 'Dyscalculia', as this condition has been named,[v] is the subject of cognitive research using sophisticated clinical investigative tools such as magnetic resonance imaging (MRI). If the conclusions of these studies suggest beyond doubt the existence of such a condition as 'dyscalculia', there could clearly be far-reaching implications for teaching mathematics to the affected group. It is important to maintain an open mind on the possible outcomes of this research.

The background justification for intervention

106. There is a growing body of international evidence showing that a carefully considered response to these problems of under-attainment in mathematics can restore young learners to a successful pathway for future study in the subject. The deployment of 'intervention' is not new, but there has been renewed interest in the topic among educational researchers since the early 1990s in the UK, United States, Australia, Ireland and in a number of other countries.

107. The response in the Primary National Strategy in the UK has been the familiar 'three wave' model of intervention:

- wave 1 – as has been stressed above, the provision of 'quality first teaching' in a daily mathematics lesson

- wave 2 – group interventions (often held in the classroom with a small sub-group), and
- wave 3 – personalised and individual remedial teaching.

108. During the course of the review panel's evidence gathering and visits, there was observation of both wave 2 and wave 3 interventions, though review panel members focused largely on the latter – that of wave 3 individualised support. Consideration was also given to the relationship between wave 2 and 3 interventions with wave 1 provision. In this section, there is a brief review of a number of the different programmes currently used or under development in the UK; further details of these are provided in Appendix 2. Consideration is then given to the question of what are the common factors in a successful intervention, and the conclusion makes a number of recommendations for the Government, local authorities, the teaching profession, practitioners and researchers.

109. Most schemes have a number of features in common: the identification and assessment of under-attaining children; intervention, often on a one-to-one basis by a teacher or teaching assistant, between two and five times a week for one term; dedicated resources including software; similar trajectories in the development of activities (larger numbers, representation and multi-sensory approaches); exit evaluation and reintegration into mainstream classroom working; and parental consultation and involvement. It is important to note that some schemes have been developed by local authorities, others by commercial organisations; they also differ in their reliance on a theoretical basis. The recommendations of this report should be seen in educational terms and *do not constitute an endorsement of specific products and services***.**

110. Other forms of intervention (wave 2) were also observed in a number of settings where, in parallel with the classroom teacher, a teaching assistant is active in the whole-class environment, but working with a small group of perhaps three or four children. This can be very effective in enabling weaker learners to keep up with the pace of the class as a whole. The panel will review this possibility further after this interim report stage.

Specific intervention programmes

111. During the course of the review, a number of intervention programmes were considered:

- Numeracy Recovery
- Mathematics Recovery
- Catch Up Numeracy
- Numicon and multi-sensory techniques
- Making Maths Make Sense
- Talking Maths

- RM Maths
- other adaptations of published techniques.

112. The key features of these programmes are outlined in more detail in Appendix 2, and although this is not an exhaustive list of all the numeracy intervention programmes in existence, it does nonetheless cover the vast majority of them.

113. Further, it should be noted that by no means all of them were developed for wave 3 intervention, though they find useful application there. Equally, programmes specifically developed for intervention can be beneficial for wave 1 and whole-class teaching. Drawing on the review panel's observations and also evidence submitted to the review, the essential features of a successful intervention are identified below. The panel does not consider that any single scheme exhibits all these features and this affects the nature of recommendations at this interim stage in the review.

Every Child Counts

114. The panel warmly welcomes the establishment of a new initiative announced by the Prime Minister, 'Every Child Counts'. This is a partnership between the Government and a new charity, Every Child a Chance, a coalition of business partners and charitable trusts. The involvement of the private sector is significant in the launch of this programme – the economic and social importance of adult numeracy require both the private and public sectors to engage in the search for solutions. These solutions must start with the very young.

115. Every Child Counts has twin aims – wave 3 intensive intervention for around five per cent of children, along the lines of those reviewed above, and less intensive interventions for the next five to 10 per cent of lower-attaining learners. The wave 3 intensive intervention will be delivered by a numeracy intensive support teacher; but the less intensive intervention can be provided by a teaching assistant, in this case mentored and coached by the former more highly qualified support teacher. Both aims will be delivered during Key Stage 1.

116. Every Child Counts is currently engaged in a research phase in a number of local authorities and a close working relationship has been established with the team from Every Child a Chance in preparation for this. Early findings will be available after the publication of this interim report, but in time for consideration during the consultation period before the final report is produced. Working together in this way, both reports will seek to inform plans for the next, development phase of the programme (between 2008 and 2010) so that the Government is in a position to implement a national programme from 2010 onwards.

Intervention – a way forward

117. On the basis of the evidence submitted, and following the visits to a number of settings, this section of the report reviews the features of best practice common to the various schemes that were observed. This exercise is not simply one of ranking the various programmes according to their effectiveness so that one individual option can be selected at this stage. Rather, the purpose of the present research phase of the Every Child Counts programme and of this review is to identify the essential ingredients necessary in any scheme. As observed in the preamble, there is no 'one size fits all' solution to such a complex and varied set of problems. It may in fact prove necessary to approve or somehow accredit a small number of schemes tailored to different situations – nonetheless, it is logical that all should conform to certain essential characteristics.

The essential characteristics of intervention

Assessment

118. Before any intervention, it is essential that the child in need of help is correctly identified and that the same assessment regime will be used to evaluate, for the benefit of the child, the teacher and the parent, their learning progress after completing the programme. To use medical parlance, both 'false positive' and 'false negative' screening are equally undesirable. So how can the correct selection be ensured? First and foremost, there should reliance on the judgement of the teacher. It has been a central tenet throughout this review that the teacher must be trusted and empowered, while at the same time making sure teaching quality standards in primary schools are raised. It therefore follows that the practitioner with direct contact with the child must take the lead in shaping any decision to intervene.

119. However, he or she will have valuable data readily available to help with early identification of weakness. Under-attainment in mathematics is sometimes apparent early, in reception class or Year 1. It is detectable in the Foundation Stage Profile (FSP) where, correctly interpreted, there may be many warning signs. More effective use of the FSP has already been highlighted in the preceding chapter of this report. All these inputs must be taken into account.

120. At the end of Year 1, the panel noted the fairly widespread use of the NfER tests to assess progress and identify children in need of intervention. While it is important to maintain a light touch when it comes to assessing the very young, there can be no doubting of the indispensable role of assessment in predicting the need for some additional form of tuition for the struggling child. In this context, although it is outside the scope of this review, it was noted that there is currently

no national standardised assessment tool for Year 1, hence the adoption by some schools of the commercially available NfER test.

121. In the case of Mathematics Recovery (MR), the panel were initially very attracted by the idea that a preliminary exploratory session with a struggling learner could be videotaped and re-examined later by both the intervention specialist and the classroom teacher together. It is important to stress that such sessions involve a very fine-grained assessment of what the child can and cannot do, based on very detailed criteria. This is a distinctive feature of MR, which was highly valued by the teachers observed. Indeed, this technique also proves invaluable in the training programme for MR intervention specialists. However, it appears that in practice it is simply neither practical nor technically possible to adopt this as a screening process for the likely cohort of 30,000 children who will eventually benefit from the Every Child Counts programme.

Proposal for consultation: Careful selection of the child who will benefit from intervention is of critical importance and should be based on robust research evidence and on a fine-grained assessment of the child's current level of competence. How can that best be achieved?

Timing

122. As asserted above, though there is good supporting evidence for this position, weakness in the understanding of mathematics becomes apparent quite early in a child's education. In this, distinction is made between routine difficulties experienced by any child and fundamental difficulties in comprehension. If this is indeed the case, can there be any argument against early intervention?

123. This question is asked in a genuine spirit of inquiry. The panel received inputs from valued and respected sources that an optimum timing for intervention in mathematics is during Key Stage 2, around Year 4, and indeed it is clear from international comparisons that we are prone in this country to accelerate steps in our educational processes to ever earlier ages, contrary to practice elsewhere, notably for example in Finland and Japan.

124. Nevertheless, the review panel is persuaded by the argument that a weakness, once identified, must be addressed before the child's long-term confidence is eroded. Perhaps a contributory factor underlying our national propensity to be baffled by mathematics is that our system has not in the past acknowledged genuine early learning difficulties with the subject. Further, the opportunities for engaging young children in interesting mathematical activities at an early age are not sufficiently exploited.

Proposal for consultation: The review seeks confirmation on whether the intervention programme in Every Child Counts should, wherever possible, be completed by the end of Key Stage 1, i.e. around seven years of age?

Duration of the intervention

125. Typically, in the programmes that were observed, intervention took place, perhaps daily, over the course of a single term. The outcome of a term's intervention will, however, be different for each child, although the magnitude of improvement (measured in National Curriculum Attainment Target sub-levels) follows an encouraging pattern with many groups in the pilot schemes. It is therefore appropriate to ask at what point an intervention can be deemed to have accomplished its objective? The panel would argue that this should not simply be construed in terms of achieving some arbitrary scale point; but it should also be construed in more subjective terms as the point at which the child can constructively rejoin mainstream classroom working (without the need for additional intervention). This is best judged by the intervention specialist and the classroom teacher in consultation with one another.

Intervention in literacy *and* numeracy

126. The stance on the *timing* of intervention would perhaps be modified in a situation where a young learner is confronting literacy difficulties too. In these circumstances, it seems eminently sensible to sort out any difficulties with literacy first and to return to mathematics intervention later. In terms of sequence, this does not necessarily present a problem as the Every Child a Reader (ECAR) programme is often delivered in Year 1, with time for a mathematics intervention, if required, in Year 2, so that the child is well prepared by the end of Key Stage 1.

127. Compartmentalisation of intervention programmes can of course bring problems, and the implementation of any programme should take account of the impact on the young child of repeated withdrawal from the normal classroom environment and their subsequent re-entry to the whole-class structure. This is considered below. It is also likely that opportunities to benefit from the synergy between mathematics and language may be lost in this way – it should be stressed that the importance of *talking* about mathematics in the classroom is an integral part of all waves of provision.

128. Finally, financial considerations may inevitably influence the prioritisation of intervention. In one school visited, it was clearly the case that with limited funding, literacy intervention was always given a higher priority, occasionally to the detriment of *any* provision for mathematics intervention. This is unacceptable, given the importance of mathematics, and where short-term financial pressures may inhibit and constrain expenditure overall on intervention, both literacy *and* mathematics must be given equal priority over the course of Key Stage 1.

Proposal for consultation: Where a child is in need of intervention support in both literacy and mathematics is there a logical sequence in the literacy and mathematics intervention programmes?

Group size

129. Implicit in much of the foregoing is an assumption that wave 3 intervention is delivered one-to-one and that a typical wave 2 intervention can involve a group of up to three or four children, perhaps in the whole-class environment. During research visits, the panel observed very successful wave 3-style interventions, separate from the class, with a practitioner and up to four children – where, for example, the benefits for children of learning from group discussion and shared problem solving are very obvious. However, the picture is not clear-cut.

130. Ann Dowker's authoritative research review[vi] referred to small-scale research by Denvir and Brown (1986b) on group tuition, which suggested that children improved more in their performance when taught in groups than when taught individually, but that there were some significant problems too. '*The children taught in groups seemed more relaxed and positive than those taught individually; but they were more often distracted; it was more difficult to ensure that each child was participating when they could "hide behind" others; and target skills could not be so precisely matched to each child's existing level.'* It must be noted that there is not much research in this area – indeed there is a paucity of research and information on numeracy intervention in comparison to literacy intervention.

131. Against such a background, and given the scarcity of trained intervention practitioners and the likely costs of any programme, it is important that group tuition is investigated further, as there are clear attractions in such an approach.

Recommendation 6: ***Intervention in Every Child Counts should be led by a qualified teacher, normally with a single child, but in the research and development phase, there should also be investigation of the potential benefits of working with small groups of up to three children.***

The teacher

132. The role of teachers and other practitioners is the central topic of this review. The likely costs of a national intervention programme are considered further below, but as noted previously, individualised, one-to-one intervention can be expensive. Alongside the proposal in the previous paragraph of the possibility of obtaining greater reach using group rather than individual sessions, there will also be a tendency to look towards other methods of delivery which are more economic than the use of a highly qualified teacher. These include the use of teaching assistants (excellent examples of support work have been observed during research visits), and certain intervention schemes that have been reviewed can even be delivered by carers and parents, and by adult helpers with no formal training. The use of software and other multi-sensory approaches have also been impressive. However, in the great

majority of cases where intervention is needed, these arguments seem to us to miss one very fundamental point.

133. It is of course commonly the case in education at all levels that the better teacher often teaches the more able students, and there are various reasons for this which we do not propose to rehearse here. Yet there is a very compelling argument that the *reverse* should be the case because learners with difficulties present a considerably greater pedagogical challenge than those without. Nowhere is this more true than for the child in Year 1 or Year 2 with severe learning difficulties in mathematics. It therefore seems self-evident to us that for successful intervention in Every Child Counts, there is a need for highly qualified specialist teachers. Of course, they may well be assisted in certain respects by teaching assistants and others, and we review below the need for greater availability of multi- sensory tools and software support. However, these are the adjuncts to high-quality teaching and not a substitute for it. The next section reviews the CPD needs for numeracy intensive support teachers and makes further recommendations on this question.

Continuing professional development

134. It will already be clear that the needs of an intervention programme and the requirements placed on the practitioner are quite specific, and that current ITT and CPD programmes do not, in most cases, cover material appropriate to the needs of an intervention specialist. While most of the specific programmes that were reviewed have associated training packages – for which the developers of the programmes are to be congratulated – there is as yet a very small pool of experienced intervention specialists at any level. Moreover, the panel are unaware of any in-school intervention experience during ITT which the trainee teacher can access as part of their course. This is clearly a situation which must change as intervention becomes more widely adopted. Once the extent of intervention programmes becomes clear, there will need to be parallel development of appropriate CPD courses and every ITT course will need to take account of intervention policy.

135. In this regard, the panel welcomes the recent call for tenders from higher education institutions from the Every Child Counts programme to facilitate the development of appropriate CPD packages. There is great significance in the academic research which underpins the various approaches to intervention, and it is therefore essential that the HE sector is involved in this development phase. The combination of HE and the private sector involvement will be needed to provide the resources necessary to ensure availability of the programmes required in every school.

Resources and tools

136. One of the outcomes of the research phase in Every Child Counts will be the identification of resources to facilitate fruitful intervention sessions. Particularly in the Numeracy Recovery sessions that were observed, the dedicated setting becomes a familiar environment to the child, and it should become a feature of all programmes in Every Child Counts. Number lines, number squares, a laptop PC, cards and other resources are typically provided, and the room for one-to-one intervention need not, of course, be large. In suggesting this, the panel is of course mindful of the cost implications, which are considered further below.

137. The panel also observed the great value in multi-sensory approaches to intervention. Interactive whiteboards are of course ubiquitous today following extensive Government investment. A large number of other multi-sensory resources were observed in use in primary classrooms, including 'Cuisenaire Rods' and their associated number tracks, Numicon and tools from other providers, many of which can be used in conjunction with the interactive whiteboard. Indeed, in a single mixed-ability class, small groups of children were observed using all the above resources selectively and simultaneously, with the brightest in the class already moving on to abstract representation alone. Many are also applicable in early years settings as well as in primary schools.

138. Essentially, these resources are not necessarily intervention pedagogies in their own right, but rather tools which could usefully feature in all interventions, particularly at Key Stage 1. Many of them are commercial products, and the panel is therefore aware of the financial aspects of any recommendation, but it would be regrettable if such a clear enhancement to the learning process for those struggling with mathematics were not readily available in all schools.

Proposal for consultation: Whatever intervention programme or programmes are advocated as part of Every Child Counts, what resources and equipment are required, and how can schools be adequately funded to provide them?

Parents and carers

139. Finally, before considering the important question of the cost of intervention, there are two more vitally important features in the successful schemes that were observed. First, following the assessment and before placement of a young learner on the programme, priority should be given to communicating these plans to the child's parents or carers. The involvement of the parent or carer is crucial to achieving maximum benefits for the child. In the Numeracy Recovery approach, the parent or carer is first of all invited to the school to discuss the intervention with both the classroom and specialist teacher. He or she then attends the first session, purely as an observer, and there is an exit interview at the end of the period (typically one term). Throughout the

programme parents and carers are given activities to do with their child at home, to support their mathematical learning.

140. Bearing in mind that this programme will be concerned with young learners, it is equally important that the children receive a positive explanation as to why they are to take part in the programme. In the interventions that were observed, the enthusiasm of the child has been clear, as has their evident pleasure at making genuine progress with their learning. The importance of this factor should not be underestimated for a successful programme.

141. Finally, the effect of repeated absence from the regular class is a factor which cannot be ignored – in fact, interruptions to regular schooling, for whatever reason, can actually contribute to under-attainment. Where intensive intervention involves a session each school day, the review panel observed that the intervention slot can be varied in the timetable so that the child does not keep missing the same lesson or subject each day and each week. This is a desirable feature of the programme, if the timetable and availability of specialist teaching permit.

142. A clear issue arises, of course, when the intervention session clashes with a scheduled mathematics lesson, which must occur from time to time. Most interventions that were observed have taken place in normal school hours, rather than after the school day has finished – such timetable conflicts are inevitable. Equally, the reintegration of the child into their regular class must be handled sensitively if the new-found confidence that was observed in intervention sessions is not to prove fragile when the child returns to a class of perhaps 30 others.

Recommendation 7: ***Before any intervention programme is implemented, it is vital that the child is fully committed and that the parents or carers are involved and understand the nature of the programme. These issues and the question around the integration of intervention teaching and classroom teaching for pupils should be considered carefully in the research and development phases of Every Child Counts.***

The cost of intervention

143. In conclusion, it is relevant to enquire about the costs of intervention, bearing in mind the size of the cohort identified in the Every Child Counts programme. It will already be clear that some of the intervention programmes outlined here are intrinsically expensive, inevitably as one teacher and only one child are involved. What follows is not intended to provide precise financial solutions to this dilemma; rather it is to stimulate useful debate on an important matter. By the same token, this report acknowledges work currently being done by Every Child a Chance to assess the nationwide *benefits* of adult numeracy. In this context, it is surely appropriate to regard intervention in the case of a

young learner as an *investment* in their future ability to contribute positively to the economy in adult life. A corresponding study of the effects of literacy intervention suggests that the economic benefits to society vastly outweigh the costs of the programme.

144. Further, it is important to note the long timescales associated with a proper evaluation of the outcome of Every Child Counts. Successful intervention at age six or seven will, ideally:

(i) reduce the numbers of pupils requiring intervention in Key Stage 2 and Key Stage 3, and
(ii) increase the numbers gaining a 'C' grade or above at GCSE at age 16.

There should be a meaningful longitudinal study over the next 10 to 15 years, which measures the outcomes of the pupils who benefited from the Every Child Counts programme.

145. Viewed on a nationwide basis, the cost elements in intensive mathematical intervention are simple:

- the cohort size (currently estimated at around 30,000)
- employment costs of the intervention specialist
- number of interventions per week / per year
- the number of children per practitioner
- the costs of training, space and resources
- the length of intervention (one term per child is the current assumption).

As an interim set of working assumptions, if the cohort size is (relatively) invariant at 30,000; the total employment costs of a QTS-level intervention specialist are £40,000 a year and that of a teaching assistant £25,000 a year; an overhead burden factor to cover resources, space and training is 20 per cent of salary; a ratio between 1:1 and 1:3 (maximum) between practitioner and children is required; and for flexible timetabling, a single intervention practitioner can be responsible for only seven children (or groups of children) each term, with one session each school day (i.e. around 20 individual children or groups in a year); then a relatively straightforward range of outcomes is possible for the total *national* costs of the Every Child Counts programme:

Annual costs £m

Ratio	QTS	Teaching assistants
1:1	72	45
1:2	36	22.5
1:3	24	15

146. Absent from these financial considerations is the *quality factor.* This report has stressed the need wherever possible for the best teachers to

take the responsibility for intervention, and that the benefits of a one-to-one ratio are clear. Some variation of ratios and some proportion of intervention time directed by a teaching assistant-level practitioner (e.g. three days a week QTS; two days teaching assistant) could imply cost savings, but this 'mix and match' approach may prove impossible to timetable efficiently, and so negate any potential savings.

147. There is also the question of whether, at this relatively early stage in the development of intervention pedagogies, a trained intervention teacher could in fact take responsibility for larger numbers of children each day in 1:1 sessions than the seven assumed above, without reducing the quality of the teaching? Clearly, costs are linearly proportional to this parameter. However, when considering small and rural schools, where some 'pooling' of resources would clearly be necessary, travel between schools in rural areas, for example, would necessitate careful timetabling of the intervention teacher to avoid costs becoming unfavourable.

148. Finally, adoption in parallel of less intensive programmes directed at the next weakest cohort of children – if based on programmes involving whole-class discussion and group intervention – will of course add further costs. While these are estimated as considerably less per head than intensive wave 3 intervention, the sheer cohort size (possibly 300,000 to 600,000) implies additional expenditure of between £5 million and £15 million a year. The precise pedagogies for this cohort remain to be determined, but a number of the programmes that have been reviewed in Appendix 1 would offer appropriate features.

Interim conclusions

At this stage, pending the outcome of the research phase of Every Child Counts, this report refrains from making final, definitive recommendations on the structure and identity of the programmes to be adopted. However, by the time of our final report, it seems likely that the panel will recommend an approach in which a very limited number of schemes, or a hybrid of existing schemes, should attract Government funding.

At the present time, the following options seem to be the most attractive:

(i) For the lowest achievers in the bottom five per cent, who require wave 3 one-to-one intervention, both Numeracy Recovery and Mathematics Recovery have features which should be developed further and which should probably form the core of any programme if it is to be eligible for Government funding under Every Child Counts.

(ii) How these programmes are deployed must, however, take note of local circumstances and experience. It would be a mistake to attempt to 'roll out' a single national programme when local authorities are currently delivering excellent interventions using both of these schemes. Some ongoing flexibility would seem sensible.

(iii) All wave 3 one-to-one interventions in Every Child Counts should be delivered by a specially trained qualified teacher.

(iv) The possibility of group tuition (one practitioner with up to three children) should also be examined.

(v) For the next cohort of between five and 10 per cent of under-attainers, as yet no single programme addresses all the learners' needs. Catch Up Numeracy, less intensive than Numeracy Recovery or Mathematics Recovery, could play a useful role in this group.

(vi) For all early learners, learning to communicate in different ways is invaluable – by talking, listening and mark-making. The intervention programme should include these activities (for example, as in Talking Maths).

(vii) Finally, the panel are persuaded of the value of using multi-sensory techniques, both in intervention and in 'quality first teaching'.

Chapter 9: Curriculum and pedagogy

*'What is the **most effective pedagogy of maths teaching** in primary schools and early years settings? …'*
*'What is the most effective design and sequencing of the **mathematics curriculum**? …'*
Remits 1 and 5 from the Secretary of State

Chapter summary

This chapter deals with both curriculum and pedagogy in mathematics in primary schools (Key Stages 1 and 2) and also considers further the transition from EYFS. Both topics are treated together in this chapter, rather than separately, as they are intimately interconnected. The following topics are addressed:

The primary mathematics curriculum
This section looks at the design and content of the mathematics curriculum.

The EYFS – areas of learning and development
This section examines the transition and continuity in learning from the EYFS to Key Stage 1.

Attitudes to mathematics and 'use and application'
This section seeks to address pupils' 'use and application' of mathematics.

Pedagogy in primary mathematics and **Features of effective pedagogy**
This section focuses on Assessment for Learning, use of mathematical language, connections within the curriculum and use of mental mathematics.

Future challenges
This section looks at the issue of setting, differentiation strategies and the renewed frameworks.

In doing so, the following is recommended:

Recommendation 8: ***The primary National Curriculum in mathematics should continue as currently prescribed, subject to any changes which may result from Sir Jim Rose's forthcoming review of the primary curriculum; the latter should examine the concept of 'use and application' more generally across subjects to assess whether the mathematical or other aspects of the curriculum need to be amended.***

The primary mathematics curriculum

149. It may appear idiosyncratic to come so late in this interim account of the review to the twin questions of curriculum and pedagogy. But, as outlined in the introduction, it is done deliberately and it is appropriate, again, to reiterate the views on the critical importance of the teacher, over and above all other factors. The need for world-class teaching, together with secure early years experiences for children and timely intervention for under-attainment in Key Stage 1, remains the principal message. But in stating this, the critical importance cannot be underestimated of putting the right curriculum and pedagogy into the hands of the practitioner.

150. What, then, is the optimum curriculum in mathematics and what constitutes best practice in pedagogy? Starting with the National Curriculum Programme of Study for Mathematics at Key Stage 1 and Key Stage 2, at this interim stage in the review, it is intended that no *radical* recommendations for fundamental changes to this will be made. Where there are certain concerns, is in the transition from the EYFS (shortly to become statutory) to the primary curriculum, and in the question of the use and application of mathematics, both of which are considered below.

151. But what is implied by the word 'curriculum'? Three interpretations are possible: first, as is usually understood by the term, is that which is *prescribed* and documented in the programme of study, as above. This may seem obvious and self-evident, but is far from a complete picture of what constitutes the reality in practice. Secondly, and equally important, is the curriculum which is *actually enacted* in the classroom. It has been the Government's clearly stated intention (in *Excellence and Enjoyment*) to encourage a certain amount of discretion on the part of the teaching profession. Thirdly, and perhaps most important of all, is the curriculum which is *received by the child.* All of these definitions are addressed in what follows.

152. It is of course simplest to begin with the curriculum in the sense of that which is intended. It can be seen as a set of decisions about what mathematics is deemed to be essential and worthwhile for *all* children. The goal is to provide and secure a 'world-class' mathematics curriculum that befits children in the early years and the primary phase, and enables them to make as much progress in the subject as possible thereafter. It is therefore essential that if this curriculum is accepted as specifying an entitlement for all children, it is clearly paramount that the pedagogy to be adopted then enables *all* children to access the full range of the curriculum.

153. Having agreed what mathematics children need to learn, the curriculum should then be designed so that it can be effectively managed, well taught and successfully learned in the time available in a wide range of early years settings and primary schools. Experience shows that, as with

other subjects, it has been considerably more difficult to design a curriculum to fulfil these conditions than to define its content. This can lead to the risk of overload of content, which can then be increasingly difficult to fit into the framework designed to accommodate it – an issue considered further on.

154. The approach to determining what, if any, curricular (and pedagogical) changes may be necessary in primary mathematics is to start by identifying what is of proven worth in the content and design of the existing curriculum and build on it, rather than assuming that an entire overhaul is needed. Because it appears to suit the purposes of teaching and learning the subject well, there is no good reason for construing the structure of the National Curriculum for mathematics differently. In other words, the review advises holding to the programme of study and three-part structure of knowledge, skills and understanding for developing children's mathematical thinking. It is acknowledged that this continues to be a useful structure, for example for the purposes of lesson planning and achieving continuity and progression in learning. Arguably, one remaining weakness in the programme of study, however, lies in the insufficient stress placed on building good attitudes to mathematics – a point developed further below.

155. Specifically, there is little benefit for children or teachers in shifting particular elements of content from one key stage to another. For example, moving the study of 'ratio' from Key Stage 2 into Key Stage 3 would be little more than a cosmetic change and may weaken the steady build-up of children's understanding of an important mathematical concept from an appropriately early stage.

156. The question of sequencing in mathematics in the primary years is also addressed. Building on the EYFS, there is a clear and logical evolution in the primary curriculum from number and counting, eventually to more complex and abstract concepts in mathematics. This conventional approach has much to offer and no recommendations for fundamental changes to the *sequence* in which the mathematics curriculum is delivered are being made at this stage. However, a number of schemes visited stress at the very beginning the *abstract* aspect of mathematics, to which the concepts of number and then calculation are later added. The review will continue to examine this question during the consultation period following this interim report, and as with other open questions before the final conclusions in June, further inputs on this topic are welcomed.

157. Following this interim stage in the review, it is also intended to benchmark conclusions more closely against best practice internationally and incorporate any new thinking which may result in the final report. On the curriculum specifically, for example, the similarity is noted in learning goals for 5 to 11 year-old children in many countries, though it is interesting to observe that the entire New Zealand mathematics curriculum from 5 to 16 years of age is incorporated into a

single document four pages in length. Perhaps the UK would benefit from a similar conciseness in the statement of our learning goals for our young?

158. Finally, the comprehensive review of the primary curriculum as a whole currently being conducted by Sir Jim Rose is acknowledged. His membership of the review panel for this review will ensure continuity of thinking on the mathematics curriculum and the review will make available to him all working papers and data. One small matter of potential significance that should be signalled to him at this stage concerns children's understanding of the cultural and historical importance of both science and mathematics. Comparatively minor curriculum amendments to include this could have considerable impact, for example on children's subsequent attitudes to mathematics.

Attitudes to mathematics and 'use and application'

159. Before moving on from consideration of the curriculum, it is essential to return to a theme which is stressed elsewhere in this report – our national attitudes to mathematics in England and their impact on young learners. There is considerable evidence to suggest that much more needs to be done to deepen children's interest in mathematics and develop better attitudes to learning the subject. Obviously, the attitudes of teachers – that is to say their enthusiasm and 'passion' for the subject – strongly influence the formation of good attitudes to mathematics on the part of children. It is discussed in Chapter 6, that this 'passion' stems from, among other things, confidence in the classroom flowing from sound subject knowledge.

160. Findings from Ofsted and the QCA also indicate that while most primary schools cover the teaching of mathematical knowledge and skills quite well, the understanding that comes from *using and applying* knowledge and skills tends to receive much less attention in the curriculum than it should. Hence a long-standing obstacle remains to be overcome, notably that too many children may be able to do 'sums' but are unable to decide what sums to do to solve 'real-life' mathematical problems and carry out investigations where mathematics needs to be applied.

161. Nor is this weakness solely linked to 'real world' problems. The development of true mathematical understanding requires dexterity in the use and application of skills to solve *mathematical* problems for their own sake, for example in the exploration by children of patterns and shapes, and eventually simple algebra. This philosophy extends to the related and equally important question of the use and application of *mathematics* in the solution of problems in *science*. An excellent example of best practice in this was observed during a visit in a Year 5 class, which skilfully brought together strands of learning from both these cognate disciplines.

162. The question of ‘use and application’ in real world situations has, of course, attracted considerable attention in recent years. The introduction of ‘functional mathematics’ in Key Stages 3 and 4 is now well in hand, so enquiry is made as to whether the curriculum in Key Stages 1 and 2 would also benefit from a *functional* element? The continuity and progression in the approach to the learning of mathematics between primary and secondary could usefully be enhanced by this change in emphasis.

163. Finally, is it not the central function in any primary mathematics curriculum to make sure the contents capture the imagination of the young learner, help shape positive attitudes, and then go on to equip him or her with knowledge of great use and purpose in their own lives? Only if the curriculum enables the teacher to achieve this can we be sure that that which is *received* by the child closely resembles that which is *intended*.

Recommendation 8: ***The primary National Curriculum in mathematics should continue as currently prescribed, subject to any changes which may result from Sir Jim Rose’s forthcoming review of the primary curriculum; the latter should examine the concept of ‘use and application’ more generally across subjects to assess whether the mathematical or other aspects of the curriculum need to be amended.***

Areas of learning and development in the EYFS

164. One area where there are certain concerns is in the transition from EYFS to the primary National Curriculum. There are, quite properly, significant differences in the definition and design of the mathematics content between the new Foundation Stage Framework and the National Curriculum Programmes of Study for Mathematics, particularly in Key Stage 1. These differences largely stem from genuine attempts to match teaching and educational provision to the development of children’s thinking and learning capabilities as they grow older.

165. In the chapter on EYFS above, the term ‘curriculum’ is therefore replaced in the early learning goals with ‘areas of learning and development’. In the Statutory Framework for the EYFS, mathematics becomes ‘Problem Solving, Reasoning and Numeracy’. Arguably, this runs the risk of confusing curriculum definition with its design. Seven of the 12 early learning goals for problem solving, reasoning and numeracy (i.e. mathematics) are about ‘number’; the rest are largely general statements such as ‘talk about, recognise and recreate simple patterns’.

166. This suggests that concerns about the risks of imbalance and discontinuity between the statutory EYFS Framework and the National Curriculum Programmes of Study may be justified. In short, a better rationale is needed to capture the salient aspects of continuity and

progression that need to be in place for children to succeed in a subject like mathematics. There are comments above on other potential difficulties of a more general nature in the transition from EYFS to Key Stage 1, highlighting the need for a coherent approach overall to the progression from EYFS via reception class to Year 1. It is essential that the momentum in learning in mathematics is maintained through this transition.

Proposal for consultation: Issues of transition between EYFS and primary remain a concern to this review. It is therefore suggested that there should be greater coherence between 'problem solving, reasoning and numeracy' in EYFS and 'mathematics' in Key Stage 1 to ensure continuity in learning. The review seeks views on how this might best be accomplished.

Pedagogy in primary mathematics

167. Next, the vitally important topic of pedagogy in primary mathematics – the classroom practice which ensures that the curriculum as *enacted* does indeed reflect closely that which is *intended*, and that, most important of all, it is *received* successfully by the child.

168. The term 'pedagogy' is generally used by researchers and teacher educators to encompass both classroom practice *and* the teacher's knowledge and beliefs about the subject and the learning and teaching that underpin it. However there is a danger that pedagogy is interpreted as meaning simply 'teaching methods', which can be carried out by anyone. It is therefore important that discussion of pedagogy is clearly linked to discussion of ITT and CPD, as well as to the curriculum. This is a continuing theme which is stressed throughout this report.

169. There is in fact considerable evidence that a teacher's own enthusiasm for, and knowledge of, mathematics, as well as their beliefs about teaching and learning, will affect their classroom practice, regardless of the external constraints on curriculum and lesson design. But, even following the implementation of the recommendations of this review, there will remain many non-specialists in schools with limited knowledge of mathematics. A critical task facing the Mathematics Specialist proposed in Chapter 6 will be to improve the practice and performance of these teachers. A robust pedagogy is essential to accomplish this.

170. Any meaningful discussion of pedagogy also needs to be based in a model of learning. The notes provided by the National Strategies about pedagogy fail to do this explicitly, but implicitly appear to adopt a broadly constructivist view (i.e. constructing knowledge is an active process in the mind of the learner – knowledge is not passively received from the environment), an approach the review supports.

Features of effective pedagogy

171. With the above in mind, what *does* constitute 'the most effective pedagogy', as per the remit from the Secretary of State? The review believes that it is not possible to define a single 'most effective' approach, and instead, focuses on the essential aspects which, taken together, constitute best practice.

172. First and foremost, pedagogy needs to be learner-centred, in the sense that it is responsive to the needs of the particular children being taught, through effective use of diagnostic assessment and through a broader adoption of Assessment for Learning as considered below. It must be truly interactive, in that children are given time to think, to talk (and be listened to) and to try out their own ideas and strategies. The 'tempo' observed in many lessons during this review has often been well judged to address precisely this issue. Equally, numerous examples of undue haste on the part of practitioners – in some cases even delivering the answer to their own question before the child has had time to formulate his or her thoughts – have also been observed.

173. Assessment for Learning (AfL) seeks to establish an evidence base to assess children's learning progress. Aimed at improving individual attainment levels, it encourages a close understanding between teacher and pupil on what they both need to do to improve the pupil's learning. There is clear value in this dialogue between teacher and child, which echoes the benefits felt by teachers using the fine-grained assessment techniques in intervention referred to in Chapter 7. More recently, 'Assessing Pupils' Progress' (APP) has provided teachers with further support for AfL, initially in Key Stage 3 but eventually aimed at all key stages; materials specifically in mathematics have been available since 2007. These will undoubtedly have an impact on how teachers think about all aspects of their teaching, from whole-class to guided and individual learning. Extensive CPD programmes are planned in the use of APP and AfL, available through Primary Framework CPD and supported by the Government with additional funding over the next three years.

174. The medium through which mathematics is taught in this country is of course the English language. The importance is stressed on a number of occasions in this review of simply *talking* about mathematics and of recognising that mathematics itself is in some respects a new language in its own right. Although the Liverpool-based programme, Talking Maths, is reviewed in the intervention chapter, it is felt that encouraging pupils to talk mathematically is a key component in any successful pedagogy on a whole-class basis, as a regular part of the daily mathematics lesson.

175. This is not to be seen simply as a rehearsal in class of the vocabulary of mathematics, novel and important though that may be for the young learner. High-quality discussion of mathematical issues gradually

exposes children to the powers of logic, reasoning and deduction which underpin mathematical thinking. There have been excellent examples of such discussions observed during visits, but it must be recognised that this requires skills that the practitioner needs to acquire carefully and develop. Once more, there is a link, familiar throughout this review, with ITT and CPD, which is considered further below. The potential has been identified for material that helps to develop pedagogies for mathematical argumentation, topic selection and leading classroom discussion. Video techniques, and above all in-school mentoring by fellow teachers, can play a vital role in this.

176. The allocation of time and the 'pace' of lessons therefore need to be flexible enough to allow for different kinds of interaction and activity (whole class, pairs, groups, individuals) and for different timescales for each of these. For example, there should be scope for children to engage in extended problem-solving activity without this being artificially interrupted by the need to close the lesson with a plenary. In short, best practice in pedagogy is observed when the teacher exercises judgement on the implementation of the primary framework for mathematics. Discussions with the National Strategies have confirmed their view that flexibility in approaching the individual circumstances in the classroom is essential.

177. The link between the curriculum and pedagogy is critical, and in particular the curriculum content must be presented in ways that emphasise the connections between mathematical ideas; mathematics is hierarchical, but not necessarily (in fact rarely) linear. However, one effect of the presentation used in the original frameworks was to compartmentalise the curriculum, and then to combine topics in a rather arbitrary way to construct two-week segments. This may have suited class planning, but it in no way reflects the optimum manner in which mathematical concepts should be introduced.

178. It must be more widely recognised that mathematics is a complex and in some respects different subject from others, and that it cannot be arbitrarily compartmentalised, nor can specific modules be timed precisely. There have been excellent examples of teacher consultation with children at the end of a week to plan the next stage of learning – in some cases to repeat a topic, in other cases to move forward perhaps a little faster. Once again, the panel stress the obvious need for flexibility and delegated authority to place such decisions in the hands of the classroom teacher.

179. During the course of the review, a number of mathematics lessons have been witnessed that encourage the use of mental mathematics in an interactive way. This is an important part of the mathematics pedagogy skill set that teachers should possess – indeed, DCSF research tells us that pupils who progress slowly through primary school are the ones whose mental calculation skills are weak. A renewed and sharper focus on the use of mental mathematics would be beneficial, and would

particularly help under-attaining groups of children. The National Strategies are developing 'talk for calculation' and guided practices to address this.

Proposal for consultation: The review seeks inputs on how best to encourage children to improve their mental calculation strategies and develop high-quality classroom discussion of the subject.

180. As noted above, this has considerable implications for ITT and CPD. To teach mathematics in a properly connected manner, teachers require deep curriculum knowledge. This should certainly extend beyond the KS2 curriculum, but as already discussed, may not need to go beyond GCSE. What is more important even than the extent of knowledge or competence is that the mathematics is understood *in depth*. For example, it is important that the teacher can see connections between fractions as parts of a whole, fractions as numbers on the number line, fractions as ratios, divisions, proportions in geometry, etc. This is a critical attribute that again owes much to how well teachers are educated – they need to be able to relate instinctively to, and indeed create, opportunities for children to apply mathematics much more effectively in the full sweep of their learning.

181. Realistically, as stressed above, ITT does not provide enough time for most student teachers to develop this deep knowledge across the whole curriculum, alongside other equally vital issues such as classroom management and understanding children's learning. Understanding of the intimate linkage between curriculum and pedagogy, which is stressed at the start of this chapter, is essential, and CPD is therefore of as much importance in acquiring pedagogical skills as in developing deep subject knowledge.

182. Ideally, ITT and CPD should provide opportunities for teachers to link deep mathematical knowledge with understanding of mathematical learning gained from research, diagnostic skills in observing children's learning, and the critical evaluation of pedagogic resources and approaches. This may not be realistic for all teachers, but would provide the basis on which the Mathematics Specialist (a role articulated in an earlier chapter) could support mathematics in the whole school, or in certain cases, across several schools.

Proposal for consultation: How can ITT and CPD give adequate priority to the development of pedagogies linked directly to the mathematics curriculum and appropriate to the unique needs of teaching mathematics, as well as to more general schemes of pedagogy which seek to address all subjects?

Future challenges

183. The development of the National Curriculum, the pedagogies and frameworks to deliver it consistently, the education of practitioners, the need for evaluation and inspection of their effectiveness and that of their schools, and ultimately the assessment of children's progress, are all intimately interlinked. In an ideal world this linkage informs, helps and optimises each stage in educational progress – indeed, much has been seen during this review to give confidence that this is predominantly the case in primary mathematics. However, in practice, tensions can arise.

184. One such effect can be observed when children in primary years are 'set' for mathematics. This is a difficult and in some respects contentious question. One risk inherent in setting for mathematics, particularly when this is begun at an early age, is that children in lower sets may be offered only a restricted version of the curriculum. This may well be what they are expected to cope with, but it fails to recognise the entitlement stressed above for all children to access the same curriculum. It is an example in which the pressure of expectation will shape the *enacted* and the *received* curriculum, regardless of the *intended* curriculum.

185. Clearly, some form of differentiation is necessary given the range of ability in the average primary class. Setting is one of several options for differentiating work to match children's differing but developing abilities. 'Guided mathematics' in smaller groups within the class offers an alternative, perhaps complementary, approach, a topic on which further inputs are welcome during consultation before the final report. There is, of course, good and bad practice in setting, just as there is in group and guided work, whole-class teaching and one-to-one intervention.

186. An explicit stance is not adopted at this interim stage on the question of setting – other than to leave decisions on such matters in the hands of head teachers and practitioners and their principled judgements of the school and its circumstances. The problem is that such forms of grouping can easily be misinterpreted as categories of children, rather than tailored provision designed to match children's different rates of learning and developing abilities. Good ITT and CPD should help teachers to recognise the difference and make sure children's progress is furthered and not fettered by whatever form of grouping they choose.

187. Even when setting is not used, a pedagogy which is based on an externally determined length of time being allocated to a topic, regardless of the children's progress, is likely to lead to many children 'missing' aspects of the intended curriculum. In fact, AfL seeks to avoid this pitfall and places great weight on the teacher's assessment of a child's progress. In summary, there is no substitute for good teachers who exercise informed judgement and take advantage of flexibility in meeting nationally prescribed curriculum goals.

188. Finally, a question encountered frequently during visits to schools and in discussions with practitioners is the role of the Primary Frameworks in the delivery of the mathematics curriculum. It is noted above that the original Primary Frameworks brought very considerable support to the classroom teacher. Indeed, visits show many classrooms in which these frameworks continue to form the bedrock of primary pedagogy. Widespread concern has been expressed about the recent revision of the Primary Frameworks in literacy and mathematics, both about the increased content and the complexity of the interactive planning tool.

189. It is not believed that the revised Frameworks as they stand are yet in a suitable, user-friendly form, and the review's views have been made clear in very constructive discussions with the National Strategies. The importance has been stressed of ensuring the navigability of these complex CD and web-enabled tools and the need to be mindful of the fact that they are used by practitioners who are already very busy. IT-based approaches often run the risk of introducing a kaleidoscope of new information, which can excite and motivate skilled practitioners but can at the same time deter those who are less comfortable with such methods. Once again, the review is compelled to stress the importance of ITT and CPD in all aspects of practitioner training and development, including pedagogy and, in this case, the effective use of the Frameworks.

190. The National Strategies have acknowledged these issues, which are reflected in their own survey data. A process for improving these aspects of the Primary Framework, based on a new platform, is already underway and will be in place by the summer of 2009.

Chapter 10: Parents and families

*'How should **parents and families** best be helped to support young children's mathematical development?'*
Remit 6 from the Secretary of State

Chapter summary

This chapter explores the role of parents in their child's education and looks at what settings and schools can do to engage parents and involve them specifically in their child's mathematical education. The following sections are considered:

Introduction
The role of parents in their child's education, plus a survey of research and current Government thinking.

The wider policy context
A brief look at recent government publications and what they say about parents, and the Government's attitude and role in parenting.

Parents and mathematics
An overview of the key emerging issues on parents and mathematics.

The evidence base
A review of the evidence supporting the role of parents in their child's education.

Theory into practice
A brief look at how settings and schools are using the evidence to shape their services to parents.

Engaging in learning across the curriculum
A brief overview of current projects from early years to secondary.

No principal recommendations are made at this interim stage of the review in this chapter. However, the text contains a number of proposals for consultation.

Introduction

191. Parents are a child's first and most enduring educator, and their influence cannot be overestimated. Parents should be at the centre of any plan to improve children's outcomes, not only in the early years but right through schooling. It is acknowledged that the overwhelming majority of parents want to do the very best for their children and also

recognised that the majority say they expect to need advice or help at some time or another.

192. Although such statements may appear intuitive, there is an emerging and burgeoning body of evidence to support them. A 2003 study showed that regardless of class or income, the influence of the parent was the single most significant factor in a child's life.[vii] The 2006 document, *Every Parent Matters,*[viii] states that: *'The Government wants to empower parents to influence and shape public services such as early years settings and schools as part of its public service reforms.'* Many parents want to be involved in their children's education. In a 2002 study, 72 per cent of parents said that they wanted more involvement.[ix] Furthermore, most parents believe that responsibility for their children's education is shared between parents and schools.[x] Indeed, it is clear that between the ages of seven and 16, parental involvement in a child's schooling is a more powerful force than family background, size of family or level of parental education.[xi]

193. Parents are demonstrating a growing appetite for discussion, information and advice, as seen from the increasingly vibrant market in television programmes, magazines and websites. This energy should be captured in the context of children's education, working with early years settings and schools.

The wider policy context

194. The document *Every Parent Matters* (March 2007) set out for the first time in one place what the Government is doing to promote the development of services for parents as well as their involvement in shaping services for themselves and their children. In many ways, this was a landmark in terms of Government policy, an open acknowledgement from the centre of the increasing recognition of the importance and value set on parents and parental involvement in services. The establishment of the National Academy of Parenting Practitioners (in September 2007) is a key development here – the Government committing to a national body to support and train those who work with parents. The recently published *Children's Plan*[xii] (December 2007) carries these themes forward, with an underlying principle throughout of the key role of parents in children's lives and the supporting role of Government.

Parents and mathematics

195. During the review a number of themes around parenting have emerged. On visits to schools, the panel heard time and again from children that they would like their parents to be taught the methods they are learning in mathematics, which have changed considerably since their parents

were at school. This makes it difficult for parents to support their children. And indeed, the panel believes that the lack of clarification and setting out of the methods of teaching is a missed opportunity for engaging parents and improving their children's attainment.

Proposal for consultation: It is important that practitioners are encouraged to work with parents to bring them up to date with the methods used to teach mathematics currently, so that parents can support their children effectively. The review seeks views on how this might best be accomplished.

196. Another issue encountered was parental attitude, in particular to mathematics. There is evidence that in the early years, parental aspirations and encouragement have a significant impact on children's cognitive development and literacy and numeracy skills.[xiii]

197. It has already been observed in this interim report that there is a widely accepted 'can't do' attitude to mathematics in England. Those working with parents and children need to be aware of this pervasive negativity and start thinking about how to reverse it. If parents believe they cannot understand mathematics, they have little incentive to act or to persevere in the face of difficulties with their children's learning, and they are unlikely to pass on a positive attitude.

198. From a young age, children need to believe that their work in school will make a difference to their current and future prospects. There is evidence to support this.[xiv] However, pure attitudinal and cultural change is not enough here, as we are aware that there are seven million adults in England who have difficulties in numeracy. There is clearly a link between this and children's under-attainment in mathematics, with a risk, therefore, of perpetuating a cycle of low achievement. The Government's renewed focus on numeracy in existing Family Learning Programmes is welcomed in this regard.

199. Early years settings, and in particular schools, need to be aware of these issues. Indeed, many are already beginning to recognise the added value that involving parents brings to children's attainment and, in a broader context, how it enriches the setting or school and the wider community. The Government's Children's Centres and extended schools programme place parents at the heart of its philosophy. There is an opportunity here for schools to work together with parents to dispel myths about the mystery of mathematics and give both children and parents a good grounding and positive attitude to this subject. The final report will showcase the best examples of work already going on.

Proposal for consultation: The review would welcome inputs from practitioners on innovative ways to actively involve parents in their child's mathematics education, for example through workshops, games and joint parent/child sessions in the setting or school.

Current good practice

200. The most successful educational settings are embracing these principles already. These settings are usually within a local authority which is committed to championing parenting work. For example, the excellent work of the Ocean Maths Project in Tower Hamlets, London is noted (a detailed case study will be provided in the final report).

201. The requirement from the Government set out in *Every Parent Matters*, that every local authority should develop a parenting strategy by April 2008, is helping to raise awareness of parenting issues across England, as is the Government's ambition to have internet access in every home.

Engaging in learning across the curriculum

202. Currently funded projects that take place in early years settings, primary schools and secondary schools (including Bookstart, Early Learning Partnerships Project, Transition Information Sessions and Parent Support Advisers) will be examined in further detail in the final report and inputs will be sought in the consultation phase on these projects to see what can be transferred to a mathematics-specific focus.

203. Primary schools, and to a larger extent, secondary schools can learn a great deal from early years providers and their experience and success in engaging parents. There is clear evidence[xv] that as children move through the early years, parental engagement has a positive impact on children's cognitive and social development, as well as on numeracy and literacy skills. In a sense, however, parents of young children have no choice but to be involved. It is important to remember that as children gain independence, parents still have influence, and that there is no need for parents to be left at the school gate.

Conclusion

204. It is self-evident that parents are central to their child's life, development and attainment. They cannot be ignored or sidelined but should be a critical element in any practitioner's plans for the education of children. Both research and Government policy support this assertion. There are already many examples of successful projects that embrace these principles to good, and sometimes stunning, effect. The aim of the review should be to normalise and mainstream these approaches, not allowing any educational establishment to even consider leaving parents out of the equation.

Chapter 11: Consultation and timetable for the final report

205. Following the publication of this interim report, there will be a six-week consultation period (which finishes at the end of April 2008) to give the profession and other key stakeholders time to reflect on and respond to the recommendations and consultation questions. Following that, the final report will be published in June 2008 with a definitive set of recommendations.

206. The review panel are seeking inputs on all areas of the review and are keen to receive feedback on the recommendations contained in this report. It is important for the review panel to hear opinions on the validity and feasibility of the recommendations, the opportunities they provide, and the issues and barriers that they raise.

207. Details on how you can provide this feedback can be found on the DCSF e-consultation website and on the Mathematics Review website (www.dcsf.gov.uk/consultations/ and www.standards.dcsf.gov.uk/primary/mathematicsreview).

208. In addition to the consultation questions posed on the Consultation website, the Review Team will also be looking to do the following in the run-up to the Final Report:

    a. learn from **international comparisons** which may help to verify our recommendations, or equally which may shed a different light on our findings

    b. address the important questions concerning '**gifted and talented**' pupils, and whether they receive a suitably and sufficiently challenging mathematical experience

    c. develop a finer definition and delivery model for the **Mathematics Specialist** in every primary school;

    d. refine and clarify the recommendations on the design of the **Every Child Counts** programme

    e. develop further thoughts on **early years pedagogy**, and specifically on the omission of concepts of time and capacity in the EYFS

    f. pay further attention to pedagogy and curriculum – in particular, to the issue of **guided working** in mathematics.

209. The review panel will also incorporate the findings from some key areas of research that will become available before the final report is published. They include:

a. a KPMG Foundation-funded study on ‘The long term costs of numeracy difficulties’

b. an Ofsted research paper on mathematics in primary schools and early years settings

c. a joint CFBT/University of Plymouth research project entitled ‘International Comparative Study on Mathematics Teacher Training’

d. a project funded by the DCSF, the TDA and the GTC, on ‘Becoming a Teacher’, which tracks the experience of newly qualified teachers over the first four years of their teaching.

210. For further details on any issues concerning this interim report, please email: WilliamsMaths.Review@dcsf.gsi.gov.uk.

Appendix 1: ACME report

Ensuring effective Continuing Professional Development for teachers of mathematics in primary schools, September 2006

In their report, the Advisory Committee for Mathematics Education (ACME) recommended that:

'The DfES [DCSF] with the TDA research the appropriateness of the current ITT entry requirements in the light of the new GCSE testing arrangements …'

'The DfES [DCSF] with the TDA set out a requirement for widespread provision of sustained CPD which improves subject knowledge and teachers' confidence in, and attitude to, the subject.'

'The NCETM [National Centre of Excellence in the Teaching of Mathematics] monitors CPD provision to help ensure that a broad range of CPD opportunities is made available by providers, including sustained courses of a total of at least 14 days over a period of a year …'

'The NCETM encourages a greater involvement of HEIs in CPD for teachers of mathematics and a closer interaction between HEIs and schools.'

The above recommendations from ACME involve extensively the National Centre of Excellence in the Teaching of Mathematics (NCETM). This was established by Government in response to an earlier recommendation made by ACME in its first ever report, which was then developed and taken forward in the Smith Review of 14–19 mathematics ('Making Mathematics Count').

The NCETM is taking the lead in promoting CPD for all key stages, working with Government and partners, both nationally and regionally, to facilitate its work with teachers and school and college leaders to improve the quality and availability of mathematics-related CPD. Its involvement is essential in the practical implementation of many of the recommendations in this review. It is encouraging that the NCETM is actively pursuing a CPD quality assurance charter mark, and is currently in consultation with all stakeholders and providers.

On CPD provision, ACME noted that:

'There has recently been a move by schools away from LA-based CPD towards school-based CPD. This means that there are no problems of cover and disruption to teaching of classes … This is perceived as being cost-effective.'

This finding highlights an important consideration in planning CPD – absence from the classroom – as well as financial issues. ACME also noted that:

‘*The provision for mathematics varies between LAs depending on the level of advisory staff as well as their experience and expertise; many LAs are struggling because of the need to be successful as businesses. One large LA which has a good record of running successful courses expects to have no permanent advisory staff for primary mathematics and will buy in staff when necessary.’*

This observation hints at changes that this review has also perceived in the support structures in local authorities as well as in the priorities in the schools themselves. Of concern is that the National Strategies and local authorities have become much more general in their approach, with reducing emphasis on subject speciality. As ACME put it:

‘The emphasis in primary schools on improving teaching and learning in mathematics appears to have decreased recently as priorities in schools have changed; just as there has been a move away from subject-specific advisers, at school level there has been a move towards more general school-wide themes.’

ACME makes a further important point, which we note here:

‘An unintended consequence of a strong focus on standards achieved in tests is a loss of vision of what primary mathematics is all about. Teachers feel under pressure to “get a level”, so want professional development that helps in the short term.’

Further details of this report can be found at www.acme-uk.org

Appendix 2: Intervention programmes, resources and materials

Chapter 8 considered the issues concerning the need for intervention in Key Stage 1 for under-attaining children in mathematics. Here the intervention programmes considered at this interim stage in the review are outlined briefly; most have been observed in practice. All these programmes will be considered further in the light of the research outcomes from the Every Child Counts pilots.

Many of the programmes referred to here involve commercial products, and once again it is emphasised that the comments are simply intended to illustrate how these approaches can help in intervention. No specific endorsement of any products or materials in this review is implied or intended.

Numeracy Recovery

This approach has been pioneered in the UK in Hackney. It began in one school in 2002 as part of a local regeneration initiative, but has now been extended to nine schools in the local authority area.

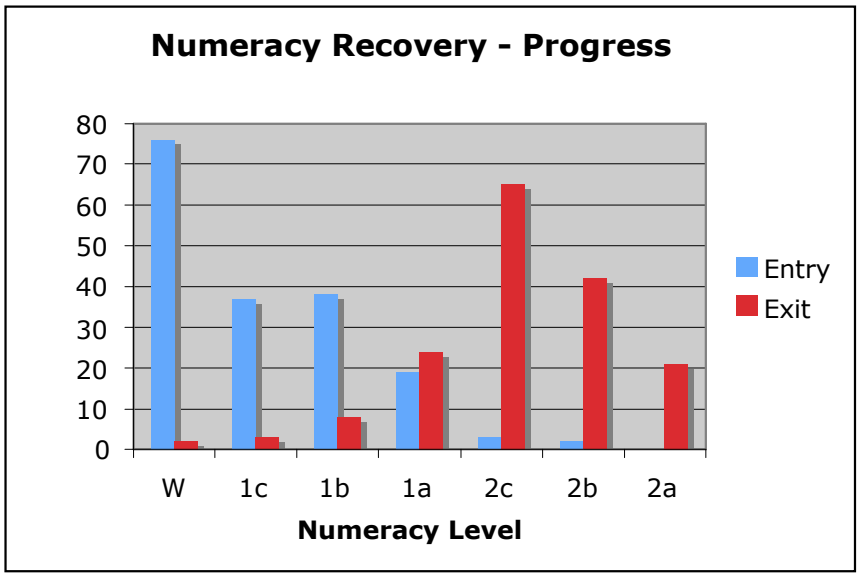
The scheme was modelled on the pedagogy developed for Reading Recovery (the core intervention used in Every Child a Reader) and relies on a dedicated intervention teacher with appropriate training and one-to-one sessions daily for approximately half an hour for one term. Typically, a dedicated resources room is available for the intervention sessions, and it is of interest to note that in different settings we have seen identical facilities. This will be an important consideration in developing a robust scheme capable of delivery in all locations nationally.

Children with mathematics learning difficulties are carefully identified using NfER tests at the end of Year I and the intervention programme is then delivered in Year 2. The involvement of parents is seen as essential and is sensitively handled by the school.

Against a national expectation for Key Stage 1 of three sub-levels of progress over two years, the figures below show recent improvement trends:

Hackney Numeracy Recovery

Academic year	**National Curriculum sub-levels of progress over one year**
2004/5	2.3
2005/6	2.94
2006/7	3.15



Mathematics Recovery

This intervention approach has its origins in a research and development programme in Southern Cross University in New South Wales from 1992–95, which followed earlier work at the University of Georgia in the USA in the 1970s and 1980s. This later Australian-based research involved 18 schools, 20 teachers and 2,000 children in the equivalent to Year 1 in the UK. The programme today is employed in Australia, 24 states in the USA, New Zealand, Canada (Manitoba), Ireland and the UK (predominantly the North West, including Cumbria, Liverpool, Manchester and Flintshire, Scotland).

The features of the scheme are very similar to Numeracy Recovery, with daily one-to-one intervention sessions. Careful assessment is also a feature in the identification of children who need and will benefit from intervention, using video techniques in the training of specialist teachers.

As with Numeracy Recovery, data show considerable improvement in attainment levels following interventions, which typically last 12–15 weeks. The data below are from Cumbria for Key Stage 1 with a cohort of 179 children since 2004:

SAT level	Number of pupils	Percentage of pupils
3	1	1%
2a	10	6%
2b	46	26%
2c	56	31%
1	51	28%
W	15	8%

Catch Up Numeracy

A structured one-to-one intervention, Catch Up Numeracy is a programme currently under development following the research of Dr Ann Dowker, supported by funding from the Esmee Fairbairn Trust and Catch Up (a not-for-profit charity). It is targeted not just at Key Stage 1, but is applicable from Years 2 to 7. Individual learners receive two 15-minute sessions a week, delivered by teachers and teaching assistants, and by carers who have received training through a package which is being accredited by the Open College Network (OCN).

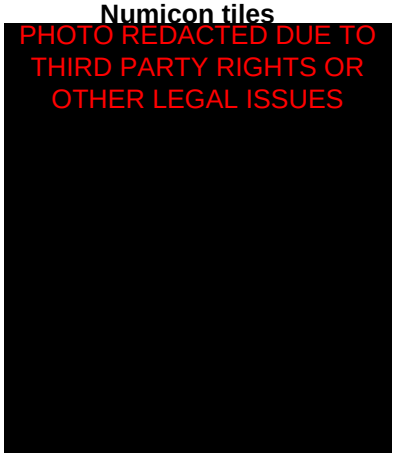
For the first batch of children in a pilot scheme involving 240 pupils in 40 schools across six local authorities between January and July 2007, the mean improvement in 'test age' on the Hodder mathematics test over a four-month period was 8.41 months for the main group, 5.32 months for those who had a matched amount of time on general maths revision, and 4.25 months for those who had no intervention.

The local authorities involved, in addition to the initial research which took place in Oxford schools, include Brent, Hampshire, North Tyneside, Powys, Sandwell and the Vale of Glamorgan. It is hoped that following the publication of this interim report, further evaluation data will become available, which will be incorporated into our thinking before making recommendations in the final report.

Numicon

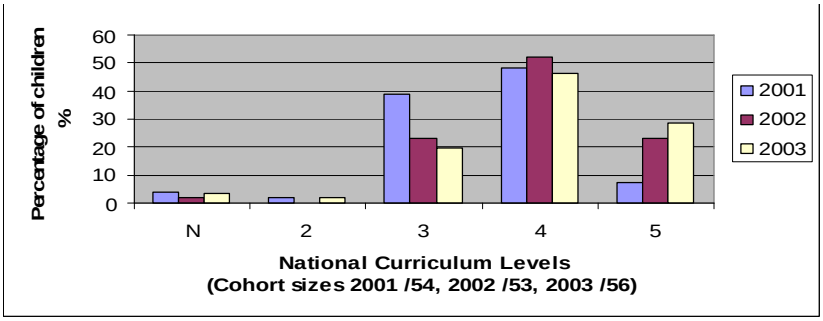
A number of schemes aimed at young children with learning difficulties in mathematics take account of the fact that as 'mathematics' and 'number' are essentially abstract ideas, the way they are represented is of considerable importance. Numicon represents numbers in the form of plastic tiles (see below), so its two-dimensional form lends itself well to parallel presentation to learners in the form of software suitable for interactive whiteboards and PCs. It is also very adaptable in moving towards early arithmetic calculation. Moreover, it has a unique feature in that odd and even numbers are clearly and fundamentally different, something noticed immediately by young children and very helpful in coming to terms with the concept of parity.

Numicon tiles



Completed and ongoing projects to evaluate the use of Numicon in wave 3 interventions are located in Brighton and Hove, Devon, Leeds, Cambridge, Leicester and Doncaster. Local authorities in Carmarthen, Conwy, Leeds, Sutton, Tameside and Thurrock are also looking into its applications in early years settings. As with other wave 3 interventions, there is early data evaluating the effectiveness of these programmes. In this case, the use of Numicon as a resource extends *beyond* Key Stage 1, and the data below suggest its effectiveness quite generally throughout both primary and early years settings. Training materials are well developed and are available in both electronic and hard copy formats.

Progress with Numicon at Key Stage 2 SAT
Hoddern Mathematics SATs levels
2001, 2002, 2003



Making Maths Make Sense

This multi-sensory approach to early learning in mathematics uses three-dimensional objects (cups) as opposed to Numicon tiles. The associated pedagogy seeks to enable the child to deal with the abstract aspects of number and calculation by an association between the 'real world' object ('tell the real world story') and the abstract written concepts of addition, subtraction, multiplication and division ('tell the maths story'). The review will continue to investigate this approach and will comment further in the final report.

Talking Maths

It has been noted in this report that in some respects mathematics represents a language in its own right. It has its own vocabulary, one that is largely unfamiliar to the young learner and one, moreover, that the child may not hear frequently spoken at home. Research, however, indicates that speaking and listening skills are crucial to the development of a child's strategies for learning mathematics, a process in which language is a vital element. Talking Maths was developed by the Liverpool local authority to address precisely these issues, and unlike many of the other intervention schemes reviewed, it can be used just as well in the whole-class environment as in the intervention session (in the latter case, typically with a group of three children). It is aimed at children in Years 1 to 3, but could easily be adapted for older (or even younger) children. Assessment procedures have been developed to measure the child's progress during the 10-week programme and training materials are

readily available. The programme can be delivered by teachers, teaching assistants and carers alike.

RM Maths

A commercially available software approach to the learning of mathematics, RM Maths provides pupils with individual support in mathematics learning, typically for 15 minutes a day. Its use has been observed during the review as an adjunct to intervention and in more general classroom use.

Other Intervention Programmes

In a number of schools visited, intervention was conducted in a more informal, ad hoc manner, without using any of the above schemes. Financial considerations also prevented some local authorities implementing third party developed programmes. It has been noted above that while some schemes have been developed by local authorities and have been made freely available to other, particularly neighbouring, local authorities local authorities (e.g. from Hackney to Tower Hamlets), many other products have been commercially developed. This has led some local authorities to develop their own form of intervention scheme, many with conspicuous success, such as in Hampshire, Lancashire and the East Riding of Yorkshire. A common feature in these cases is deep familiarity with the research literature, committed local authority support, and schools with confident teaching staff.

[i] *UK's Science and Mathematics Teaching Force*, Royal Society, 2007
[ii] Askew et al, *Effective Teachers of Numeracy* (Final Report), London: King's College, 1997
[iii] J Soc Issues, Vol 64, No 1, p95, 2008
[iv] Gross, *Educational and Child Psychology* Volume 24, Number 2, 2007
[v] Butterworth, B and Yeo, D in *Dyscalculia Guidance,* 2004
[vi] *What works for children with numeracy difficulties*, DfES, 2004
[vii] Desforges with Abouchaar, *The Impact of Parental Involvement, Parental Support and Family Education on Pupil Achievement and Adjustment: a review of literature,* London: DfES, 2003
[viii] DfES publication, *Every Parent Matters*, 2007
[ix] Williams, B, Williams, J and Ullman, A, *Parental Involvement in Education,* DfES Research report 332, 2002
[x] Williams, B, Williams, J and Ullman, A, *Parental Involvement in Education,* DfES Research report 332, 2002
[xi] Feinstein, L and Symons, J, *Attainment in Secondary School,* Oxford Economic Papers, 51, 1999
[xii] DCSF publication, *The Children's Plan: Building brighter futures,* 2007
[xiii] Sammons, P, Sylva, K et al, *Measuring the Impact of Pre-school on Children's Cognitive Progress over the Pre-School Period,* EPPE, Technical paper 8a, 2002
[xiv] Bandura's social-cognitive theory of self-efficacy, but similar arguments have been made by Eccles [2] Buchanan (1996); Buchanan et al (2004) cited in Ritchie et al (2005) *Aspirations and Expectations: A policy discussion paper,* [3] Ritchie et al (2005)
[xv] Sammons, P, Sylva, K et al, *Measuring the Impact of Pre-school on Children's Cognitive Progress over the Pre-School Period*, EPPE Technical paper 8a, 2002, and Sammons, P, et al, *Measuring the Impact of Pre-School on Children's Social/behavioural Development over the Pre-School Period*, EPPE, Technical paper 8b, 2003