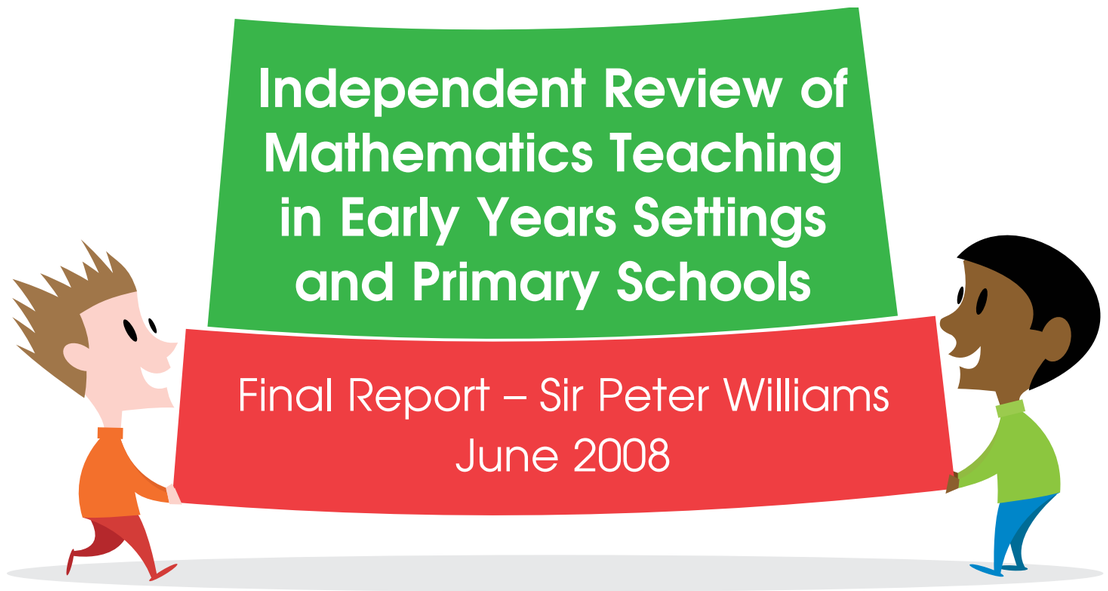
Independent Review of Mathematics Teaching in Early Years Settings and Primary Schools



Final Report – Sir Peter Williams
June 2008

department for
children, schools and families

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Dear Secretary of State

I am pleased to attach the Final Report of the Review of Mathematics Teaching in Early Years Settings and Primary Schools, which you asked me to undertake in July 2007. The Final Report follows from and develops the thinking contained in the Interim Report (published in March of this year).

The Review has reached its conclusions on the basis of evidence which includes robust published research; relevant data and statistics; and a programme of visits to schools and settings throughout England. In addition, we have undertaken an extensive consultation with teachers and practitioners, trainers, providers of resources and policy makers. Of particular value has been a series of meetings and events during the consultation phase following the publication of the Interim Report.

The Review has found much from which to draw encouragement, especially during its programme of visits. I am most grateful for the warm reception we received in schools and settings. These visits helped crystallize our views on the issues confronting the teaching of mathematics to young learners.

The high standards achieved in mathematics in recent years can be maintained and improved further only by addressing the unique needs of this subject, a discipline which is not always embraced with enthusiasm and confidence. That is why the principal conclusions of the Review centre on the teaching force rather than the content of the programme of learning in primary and early years. My key recommendation is the presence of a Mathematics Specialist in every primary school, who will champion this challenging subject and act as the nucleus for achieving best pedagogical practice. The value of a sound start in Early Years is also stressed, as are the vital roles of parents, carers and families.

I hope that the recommendations will help you in addressing the future needs of all young learners of mathematics, whatever their ability. In this regard, the Review endorses your plans for the Every Child Counts programme, which is designed to help those children struggling with numeracy. The Review also stresses the value not only to the individual child, but also to society as a whole, of a successful outcome to this programme.

Finally, I wish to acknowledge the dedication of my support team in your Department and that of my advisory panel, whose involvement has been invaluable. I would also like to thank all those who contributed to the Review and whose responses to the call for evidence were so helpful and informative. Above all, I would like to thank all the headteachers, teachers and practitioners for their openness and willingness to address the issues raised.

Yours sincerely

Sir Peter Williams

Chapter 1: Executive summary

In his letter of 9 July 2007, the Secretary of State set out the following remit for a review of mathematics teaching in early years settings and primary schools:

'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 mathematics 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 (aged 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 (ITT) and continuing professional development (CPD) 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 Early Years Foundation Stage (EYFS).'

This review responds directly to the Secretary of State's remit and has been informed by extensive evidence gathering, together with a programme of visits to schools and settings. Details of these activities and the membership of the advisory panel to the review are set out in Appendix 3.

In addition, since the publication of the interim report on 19 March 2008, there has been a period of consultation which has facilitated fruitful dialogue between the review team and practitioners, educationalists and Ministers regarding the way forward. As a result of this, ideas have been refined and further recommendations added to those made at the interim stage. This consultation process has greatly assisted the review and has helped to establish a clear and strong consensus within the community on many of the major issues.

This final report sets out the review's findings, supported by evidence, regarding educational best practice to enable young learners in primary schools and early years settings to acquire an understanding and appreciation of mathematics and of its importance to their lives. The review follows and is complementary to the Rose Review of the teaching of early reading, although the scope of this review is wider. 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.

Since the National Numeracy Strategy (NNS) was introduced almost a decade ago, there has been considerable progress in the attainment of young learners in mathematics, with the percentage of the cohort attaining Level 4 and above at Key Stage 2 rising from 59 per cent to over 77 per cent.

Nevertheless, issues regarding the teaching and learning of mathematics remain, and the United Kingdom is still one of the few advanced nations where it is socially acceptable – fashionable, even – to profess an inability to cope with the subject. A parent expressing such sentiments can hardly be conducive to a learning environment at home in which mathematics is seen by children as an essential and rewarding part of their everyday lives. The review has therefore considered carefully the role of parents and families and their influence on the young learner, with examples of best practice in this regard highlighted.

Yet it is a central conclusion of this review that the teacher, even more than the parent, determines learning outcomes in mathematics, the more so given that the way in which mathematics is taught has undergone considerable change since most parents' own schooling. The prime focus of the review has therefore been the teacher.

Excellent teaching has been observed in many schools during the course of a series of visits, and the 200,000 teachers and other practitioners in our primary schools and early years settings deserve great credit for their efforts. However, mathematics is a demanding subject at primary level, where the practitioner delivers a broad and challenging mathematics curriculum. Confidence and dexterity 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. The review believes that this confidence stems from deep mathematical subject and pedagogical knowledge and it has therefore examined the available provision in mathematics during Initial Teacher Training (ITT) and education.

Regarding the mathematics requirement for entry to ITT, the review has reluctantly concluded, on pragmatic grounds, that the present GCSE grade C should remain. However, when mathematics I and II at GCSE are firmly established, the Government

should review whether a grade C in both subjects should become the entry requirement. The review has also identified ITT courses that offer considerably greater mathematics content. Nevertheless, it is firmly argued that most ITT does not in itself constitute a sound basis for deep subject and pedagogical knowledge in mathematics, and this report therefore lays great emphasis on continuing professional development (CPD).

Recognising the logistical and financial challenges in addressing the immediate mathematical CPD needs for all 200,000 primary teachers, the review has made the following principal recommendation – that there should be at least one Mathematics Specialist in each primary school, while recognising the need to make sensible allowances for small and rural schools.

The Mathematics Specialist would be drawn from within the existing teaching force. This teacher will in effect 'champion' mathematics in the school and act as mentor and coach, as well as being an outstanding classroom teacher. Full details of the proposed role are described in Chapter 2.

The role of local authorities, universities and other providers of CPD is reviewed, and specific recommendations made regarding programmes for the Mathematics Specialists, in which progression to a Masters-level qualification is a key feature. A model is presented which initially targets weaker schools and which leads to national coverage within 10 years. Of paramount importance to this strategy are the head teachers, the senior management teams and the school governors, all of whose vital roles are acknowledged.

Of critical importance, of course, in any successful programme of teaching and learning, is a curriculum that is fit for purpose. The forthcoming review of the whole of the primary curriculum by Sir Jim Rose will look into this issue more broadly, but this review, having carefully examined the present mathematics programme of study for Key Stages 1 and 2, makes no recommendation for radical change. Indeed, it judges that the curriculum, by and large, is well balanced, and recommends that it should continue in its current form.

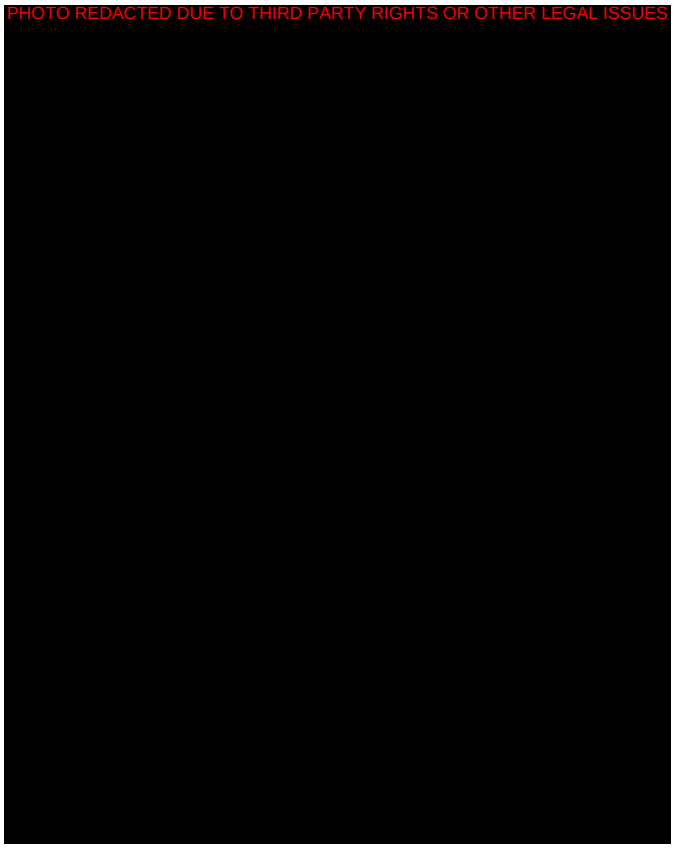
Two issues only are singled out: the need for an increased focus on the 'use and application' of mathematics and on the vitally important question of the classroom discussion of mathematics. It is often suggested that 'mathematics itself is a language' but it must not be overlooked that only by constructive dialogue in the medium of the English language in the classroom can logic and reasoning be fully developed – the factors at the very heart of embedded learning in mathematics.

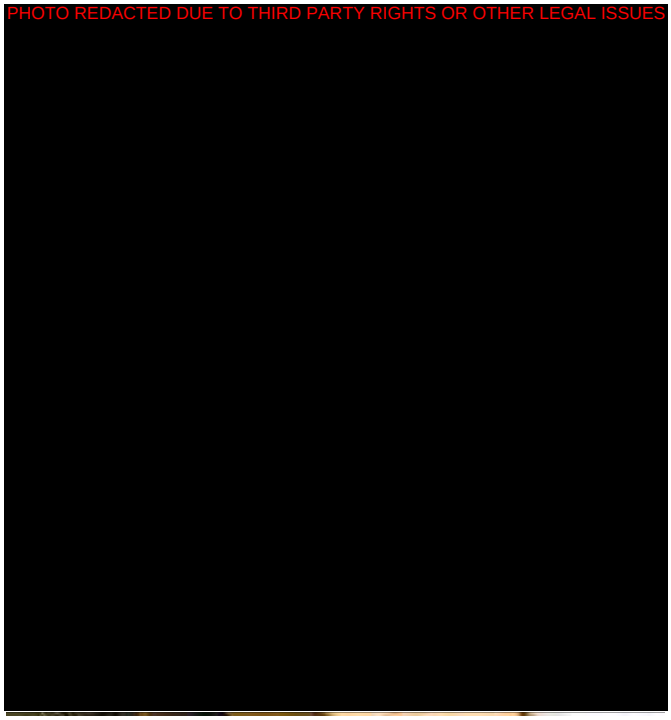
In early years, many similar considerations apply as in primary, although there are certain unique differences. The learning processes of very young children require tailored pedagogies and a highly sensitive approach. Mathematics in the Early Years Foundation Stage (EYFS) is incorporated into Problem Solving, Reasoning and Numeracy, and the review draws Government's attention to issues such as time and capacity in preparation for the 2010 review of the EYFS. The review also lays great store by play-based learning of a mathematical nature, and makes specific recommendations regarding early mark-making as a precursor to abstract mathematical symbolism.

The review emphasises the critical role of appropriately qualified staff in early years. The qualified teacher enjoys a leadership role under EYFS and the review stresses their importance in laying the foundations for later mathematical learning. The increasingly important role of the graduate early years professional (EYP) is also

acknowledged. Finally, the question of the transition from early years to primary is discussed, and suggestions are made which focus on the better use of the Foundation Stage Profile (FSP) in this regard.

Despite the foregoing, it remains the case that around six per cent of all children leave primary school without attaining level 3 in mathematics at Key Stage 2. This is a problem shared internationally and which has prompted action in all advanced nations. The review therefore warmly welcomes the UK Government's announcement last year of 'Every Child Counts', a programme of intervention in mathematics for under-attaining children, following the 'Every Child a Reader' programme. At the invitation of the Secretary of State, and working closely with the Every Child a Chance Trust, the review has sought to identify the essential requirements in a successful intervention in mathematics. Specific recommendations are made on this, following an extensive review of many programmes currently deployed in schools or under development.





Finally, the review recognises the financial implications of its recommendations, particularly with regard to the Mathematics Specialist and intervention. Estimates are therefore made of the costs associated with these proposals, together with reference to a study that assesses the long-term benefits to society of successful mathematical learning in primary and early years. The tentative, early findings are striking – the Every Child A Chance Trust estimates that for every pound spent on early intervention for the lowest attaining pupils, at least £12 will be saved long-term on the costs to the public purse.

Overall, the principal measures proposed in this review are directed at improving learning outcomes for the young through improved classroom practice, to help children of all abilities. Acknowledging the progress made since the National Numeracy Strategy (NNS), and the dedication of the existing workforce in primary schools and early years settings, these recommendations are not made lightly. They are long term in nature and ultimately seek only to enhance the standing of the teaching profession and the mathematical learning of the children in their care.

Chapter 2: 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 Training (ITT) and continuing professional development (CPD), and in doing so, examines:

The teacher and subject knowledge

The importance of subject mastery in teaching mathematics at primary level.

Initial Teacher Training for primary education

The mathematical content and effectiveness of ITT – 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**
  How successful delivery of CPD is dependent on strong leadership in the school.
- **The role of local authorities and higher education institutions (HEIs) in CPD provision**
  The dynamic between subject knowledge and pedagogic skill, highlighting good practice and feedback from practising teachers. The roles of local authorities, the National Strategies, higher education institutions (HEIs) and the National Centre for Excellence in the Teaching of Mathematics (NCETM) in the provision of CPD, are also explored.

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. Preliminary proposals for a financial model are discussed.

The chapter makes the following three principal recommendations:

Recommendation 1: When GCSE mathematics I and II are firmly established, the Government should review whether attainment of a minimum of grade C GCSE in both subjects should become a requirement for entry into ITT. For students who have taken or will take GCSEs before then, a grade C in single award mathematics should remain the requirement.

Recommendation 2: Local authorities should upskill their field force of mathematics consultants. The National Strategies, in partnership with the National Centre for Excellence in the Teaching of Mathematics, should develop 'refresher' CPD for all local authority mathematics consultants.

Recommendation 3: There should be at least one Mathematics Specialist in each primary school, in post within 10 years, with deep mathematical subject and pedagogical knowledge, making appropriate arrangements for small and rural schools. Implementation should commence in 2009 and be targeted initially to maximise impact on standards and to narrow attainment gaps.

The teacher and subject knowledge

1. Remit 4 from the Secretary of State requires a focus on the effectiveness of ITT and CPD, as currently delivered, in ensuring teachers and other practitioners have 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.

2. Teachers and practitioners in primary schools or early years settings are not, of course, usually 'Mathematics Specialists', nor do they necessarily aspire to be. Indeed, it would be a mistake to equate specialist knowledge of mathematics *alone* with excellent teaching at this or any level. A small-scale study in 1997[1] for the (then) Teacher Training Agency, for example, found that having an A-level in mathematics was not strongly correlated with effective teaching of numeracy (as measured by higher gains in pupils' attainment). The main thrust of this review, therefore, is that a *combination* of deep subject knowledge and pedagogical skill is required to promote effective learning.

3. The main issues surrounding the interrelationship between subject competence and teaching skills were discussed fully in Professor Adrian Smith's report *Making Mathematics Count* (2004)[2]. The principal conclusions of this were accepted by the then DfES, and while the report concerned 14-19 mathematics, the analysis is widely relevant. This review endorses its findings and subscribes to the view that broadening and deepening the mathematics knowledge of those who teach the subject is as valid for primary school teachers as it is for those in the secondary sector. As Smith summarised:

> *'… it is essential for teachers of mathematics to have sufficient subject knowledge to challenge and develop the full range of pupils they teach. Broadening and deepening mathematical knowledge and understanding are essential.…*
>
> *For teachers of mathematics, an important part of broadening their knowledge of subject specific pedagogy is appreciating how pupils learn mathematics, the role of questioning and response, and the potential obstacles to learning that students are likely to face….*
>
> *Teachers should also have the opportunity to reflect on different approaches to delivering the mathematics curriculum … how it is structured in terms of progression within each topic, the links between topics, and the way topics are revisited in different contexts.… Individual teachers have different combinations of pedagogical skills, mathematical knowledge and experience of teaching. For this reason, subject specific CPD provision should be sufficiently flexible to respond to the individual*

needs of teachers….' (Extracts from paragraphs 5.34-5.37)

4. There is a body of research into what is termed 'Mathematical Knowledge for Teaching'[3] – the most effective pedagogical approaches to teaching mathematics – which even strong mathematicians, as well as those lacking subject knowledge, need to develop:

> *'A teacher cannot explain to her students the principles underlying the multiplication algorithm if she does not explicitly understand them herself. The representations she chooses will be mathematically misleading or may even fail to correspond at all. Yet a teacher who does understand the role of place value and the distributive property in multiplying large numbers will not necessarily draw upon this understanding in her teaching if her ideas about learners or about learning intervene.'* (Ball 1989)

5. Amongst other things, 'Mathematical Knowledge for Teaching' requires, according to the authors, the ability to:

- *'understand the personalised mathematical knowledge of students*
- *build on this knowledge appropriately by designing appropriate tasks, asking appropriate questions, and promoting discussion of different but equivalent representations*
- *analyse students' work: Is it correct? Can it be generalized?*
- *understand the connections between different aspects of mathematics, the connections between different representations of the same mathematical idea, and which representation is more appropriate for use to solve particular problems.'*

6. Recent research has shown this 'Mathematical Knowledge for Teaching' strongly correlates with student achievement gains (Hill, Rowan and Ball, 2005)[4].

7. A recent Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI) study[5] into effective teacher-pupil dialogue in Key Stages 2-3 mathematics pointed out the importance in improving understanding of the following factors:

- *Going beyond 'Initiate, Response, Feedback'.*
- *Focusing attention on mathematics rather than 'getting the answer right'.*
- *Working collaboratively with pupils.*
- *Transformative listening (this relies on teachers listening to pupils' contributions in a manner that conveys that there is a genuine 'meeting of minds' and that the teacher is willing to change their own thinking in the light of what the pupil has said).*
- *Scaffolding.*
- *Enhancing pupils' self-knowledge about using dialogue as a learning experience.*
- *Encouraging high-quality pupil dialogue.*
- *Inclusive teaching.*

8. It is clear therefore that the primary school teacher today confronts a formidable 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 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.'

9. This is supported by evidence from Goulding and Rowland (2002), that for primary PGCE students, mathematical subject knowledge alone is not necessarily the overriding issue. They suggest that obvious 'gaps' in subject knowledge are often addressed within the PGCE when topics are revisited. An equally important, if not more significant issue, is how to ensure students acquire the requisite pedagogical subject knowledge and skills for mathematics teaching. While this may be a significant part of the content of PGCE courses, students generally have limited classroom experience through which to develop their pedagogical skills.

10. Together, this evidence shows clearly the link between deep mathematics subject knowledge and the good pedagogic understanding required to teach it. It should be noted that the current statutory primary curriculum is mathematically comprehensive, and contains some difficult and abstract concepts. Its content is reviewed in Chapter 5. By Years 5 and 6, even the 'oral and mental' starter in the daily mathematics lesson can be a taxing experience for teachers who are not in command of their subject. Hence, while in-depth mathematical knowledge and pedagogical knowledge do not separately represent *sufficient* conditions in their own right for successful teaching, taken together they constitute a *necessary* condition to progress learning for all children up to the end of Key Stage 2, which prepares them well for Key Stage 3. In this context, in-depth subject and pedagogical knowledge inspires confident teaching, which in turn extends children's mathematical knowledge, skills and understanding.

Initial Teacher Training for primary education

Entry qualifications to primary ITT

This section deals with questions of Initial Teacher Education (ITE) and Initial Teacher Training (ITT), though ITT is used throughout the rest of this section and report.

11. There are many routes into teaching, both through undergraduate studies – BEd, BA/BSc with Qualified Teacher Status (QTS) – and postgraduate courses (PGCE, PGDE), plus other initiatives and employment-based schemes. This report considers only the PGCE and undergraduate courses as evidence from the Training and Development Agency for Schools (TDA) suggests that these are the dominant routes into primary teaching (based on 2005 figures, 80 per cent of primary and nursery teachers entered teaching through one of these two routes).

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

13. The minimum requirement for admission to a BEd or PGCE course is a grade C in mathematics at GCSE, or its equivalent. While this demonstrates a basic understanding of the subject, it does not constitute in itself 'deep subject knowledge' and does not therefore necessarily constitute a sound basis for the development of 'Mathematical Knowledge for Teaching' discussed in the previous section.

14. 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's education has addressed mathematics – and that may have been a decade or more before embarking on teacher training. For the PGCE route

specifically, it is relevant to examine the degree specialism of the trainee teacher which might go well beyond GCSE level in mathematics. However, the figures for postgraduate primary trainees are discouraging as far as mathematical background is concerned. The table below[7] shows that for the past three years, even if those with degrees in Science, Technology, Engineering and Mathematics (STEM) are included, only between two and four per cent come from a related background discipline – and 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

15. The panel considered the idea of raising the required entry level for both undergraduate and PGCE courses to some form of level 3 qualification at either AS or A-level in mathematics, or to at least a grade B at GCSE. The latter option would imply, at least for those studying for GCSE from 2008, participation in the higher tier GCSE, which firstly raises expectation in mathematics and secondly means greater engagement with fundamental areas such as algebra. Such a move would accord strongly with the recent report from McKinsey on *How the world's best-performing school systems come out on top*[8] and would, in time, bring the UK closer to international best practice standards in teacher training. An aspiration of recruiting the top 10 per cent of graduates, as is the case in Finland, is one that this review would endorse.

16. However, it is vital to maintain a pragmatic approach. Reluctantly, the review has concluded that in the immediate future, raising entry requirements would be inadvisable given the possible risk of falling enrolment of trainee teachers.

17. At Key Stage 4 considerable change has recently taken place and the Government is planning for the introduction of two GCSEs in mathematics to reflect these changes. The review panel therefore also considered whether any future changes to ITT entry requirements might be necessary in the light of these changes.

18. GCSE mathematics will remain just as demanding after these changes, although the content of the second GCSE in mathematics is yet to be finalised. It remains to be seen whether a significant proportion of the cohort will take *both* GCSEs, but 'deep subject knowledge' may in future become synonymous with passing both mathematics GCSE I and II with at least a grade C. The conclusion of this review is that when both GCSEs are firmly established and when cohort sizes become clear, the Government should examine whether a minimum of grade C in both GCSEs should become the entry requirement into ITT.

Recommendation 1: When GCSE mathematics I and II are firmly established, the Government should review whether attainment of a minimum of grade C GCSE in both subjects should become a requirement for entry into ITT. For students who have taken or will take GCSEs before then, a grade C in single award mathematics should remain the requirement.

Undergraduate and PGCE course content in mathematics

19. If it is therefore accepted that the current **input** competences in mathematics of trainee primary teachers should not be changed in the

immediate future, then the mathematical content in the typical 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 equivalent to 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.

20. Subject specialism within a primary undergraduate or PGCE course seeks to address this issue. The University of Hull, for example, offers a 'Mathematics Pathway' option within its primary education three-year BA. Its aims align well with the recommendations of this review:

> *'This subject specialism pathway aims to develop your academic abilities in mathematics and also prepare you for the role of curriculum leader for mathematics within primary schools. The tutors involved are enthusiastic about their subject, and their wish is that you already are – or will become – equally enthusiastic about mathematics and the teaching of mathematics.'*

21. There are similar options elsewhere: Liverpool John Moores University, for example, offers a four-year primary BEd with a specific fourth year option in 'Core Mathematics' for primary. More commonly, universities and colleges specify the mathematical course content throughout the entire course – the University of Durham, for example, describes a formal work programme over three years of approximately 60-70 hours per year (plus private reading and preparation) in mathematics, very much in line with the indicative figures from the TDA quoted above, and typical of other courses that the review has looked at.

22. Interestingly, Sheffield Hallam University also offers a TDA-approved 'Primary Mathematics Subject Knowledge Booster Course' in preparation for PGCE entry, aimed at candidates who may be:

> *'… thinking of teaching in a primary school? Perhaps it is some time since you completed your degree or perhaps your degree specialism didn't cover all aspects of the current primary school mathematics curriculum?'*

23. However, less encouragingly as far as mathematics in PGCE is concerned, recently published Graduate Teacher Training Registry (GTTR) data on PGCE vacancies for 2008/09 lists 112 courses aimed at primary ITT, of which 45 combine primary with emphasis on a modern foreign language, but only one with a principal focus on mathematics (offered by the University of Exeter). None had a focus on science. Clearly, the presumption is that mathematics is fully addressed within the core curriculum of both undergraduate and PGCE courses, but it is the conclusion of this review that this is not universally a safe assumption.

24. Given that conclusion, the review has considered whether some form of incentive might be effective for trainees on courses with a greater degree of focus on mathematical subject knowledge and pedagogy, and this is discussed below in the section on incentives.

Output competences and qualifications

25. The next issue to consider is whether the resulting **output** competences of typical graduates at the end of their course are sufficient. The Secretary of State's Standards for the award of QTS 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. The TDA numeracy skills test, which all student teachers must pass to gain QTS, is not designed to test knowledge of the primary mathematics curriculum, and can be retaken as often as necessary for the student to pass.

26. Even the providers who are most highly rated by Ofsted recognise that there is little scope in current ITT programmes to do more than make relatively minor improvements in students' confidence and fluency. Goulding and Rowland's research[9] (referred to above) suggests that the process of audits and directed study used within PGCE courses are relatively effective in improving specific areas of weakness, but they may not be able to address deep subject knowledge. There is also evidence (e.g. from Brown et al, 1999[10]) that ITT is effective in improving students attitudes to, and confidence about, mathematics.

27. The TDA's ambition over the long term is for teachers in all sectors at QTS level, including primary, to have completed a course to Masters level. The Department's recently published *Children's Plan* (2007) sets out in further detail the plans for implementing "The Masters in Teaching and Learning".

28. This would not, of course, imply a Masters level in mathematics specifically, but it should include greater depth in all core subjects in both pedagogy and subject knowledge, including mathematics. This review strongly endorses a coherent policy, long term, to aim for such Masters-level teaching in primary schools.

29. One 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. It is interesting to note that the Cockroft Review[11] in 1982 discussed a similar option. However, not only would the cost of training teachers through the PGCE route double at a stroke, but the aspirations of young trainees 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, run a high risk of reducing the already low level of interest on the part of STEM graduates to become primary teachers. Clearly, such an option is unacceptable.

30. 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.

31. In summary, it is the conclusion of this review that, 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; and that it is equally unrealistic to seek to introduce *significant* new mathematics material into the majority of what are already full undergraduate and PGCE courses. If the arguments above on the need for subject and pedagogical knowledge depth are accepted, then the only remaining route to raising mathematical understanding among the teaching profession in the primary sector is through properly funded and rewarded continuing professional development.

Continuing professional development in primary schools

Background

32. 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)[12] (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.

33. 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.

34. The conclusions in *Making Mathematics Count* were noted above, and in that report, Smith also made extensive referral to the question of CPD for teachers:

> *'… Individual teachers have different combinations of pedagogical skills, mathematical knowledge and experience of teaching. For this reason, subject specific CPD provision should be sufficiently flexible to respond to the individual needs of teachers and enable teachers to identify how these needs can best be met. A range of provision must therefore be available at different stages of teachers' careers and at different points in their mathematical development …'*

35. The then DfES accepted in its response to *Making Mathematics Count*[13] that: *' for all teachers, at every stage of their career, there are three important aspects of CPD. These are the need to:*

- *develop a depth of personal subject knowledge to underpin teaching and learning*
- *enhance their repertoire of subject specific teaching methods and pedagogy*
- *apply general strategies for teaching and learning.'*

36. 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. In its evidence gathering and visits across England, the review panel was encouraged by the quality and motivation of teachers it saw.

37. 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.

38. 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.

39. At the interim stage, the review sought inputs during consultation as to whether the teaching profession should follow the example of the others listed above and establish some form of national register, perhaps, by analogy with the engineering profession, with the involvement of the mathematical subject associations. There appears to be little support for this at the present time, although the issue is considered again briefly below in connection with the Mathematics Specialist (at paragraph 71).

School leadership and the head teacher

40. Despite the absence of comprehensive data, 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. Both ACME studies came to similar conclusions, and noted both that there had been a significant decrease in participation in mathematics CPD over the last decade or so, and 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 10-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.'*

41. The recent CPD survey of practitioners by the National Centre for Excellence in the Teaching of Mathematics (NCETM) also paints a picture that 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 this review does. Despite the enthusiasm for mathematics among respondents, the survey indicated that the majority of schools were no longer engaged in local mathematics networks (see paragraph 50 below). A school's involvement in any specific networks must be a decision for individual schools and teachers, but nevertheless, the review panel believes that some form of sharing of expertise and networking would be beneficial for teachers. The NCETM's survey also suggested that it was mainly 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 confirmed that the mathematics professional development experienced by many teachers depended, *in part* (though not wholly), on the knowledge and expertise of their own mathematics subject leader.

42. These findings lead to the review's emphasis on there being at least one person available within a school to ensure that best practice acquired through CPD is transmitted in effective ways. This is all the more important given the survey's suggestion that the levels of in-class support, coaching and team teaching are relatively low.

43. In the review panel's visits to schools, and in discussions with teachers and head teachers, the importance of in-school professional development – 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 National Numeracy Strategy (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 a school closure day or using twilight sessions – these could be used to upskill *all* members of staff in the school. Such a measure would, of course, need to relate to a school's priorities.

Scottish CPD model

During the course of visits of this review, 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, as part of the McCrone settlement since 2001, they are entitled to 35 hours' (i.e. approximately one week) further personal CPD a year. There would be significant consequences both financial and practical in adopting the Scottish model, but a parallel entitlement in England represents an attractive long-term aspiration.

45. 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.*

46. Nevertheless, evidence submitted to this review and gained from visits to schools suggests that, despite funding for schools standing at a record high level, the element of the budget notionally intended for CPD has come under pressure. It is not ring-fenced (and nor should it be if delegated authority and responsibility is to be maintained) – and 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, other curriculum subjects and wider school development priorities. The decision on priorities for CPD must, in the end, rest with head teachers and their staff.

47. The full support of head teachers, together with their governing bodies, is critical to the outcome of all that we propose – they are the champions of 'quality first teaching' in all subjects, including mathematics. Head teachers already receive CPD on the primary frameworks – as such, it may be worth considering adding a mathematics-related component, which would complement and be consonant with their frameworks CPD. While head teachers 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. Overall, a renewed emphasis on CPD is required by practitioners, head teachers and governing bodies, 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.

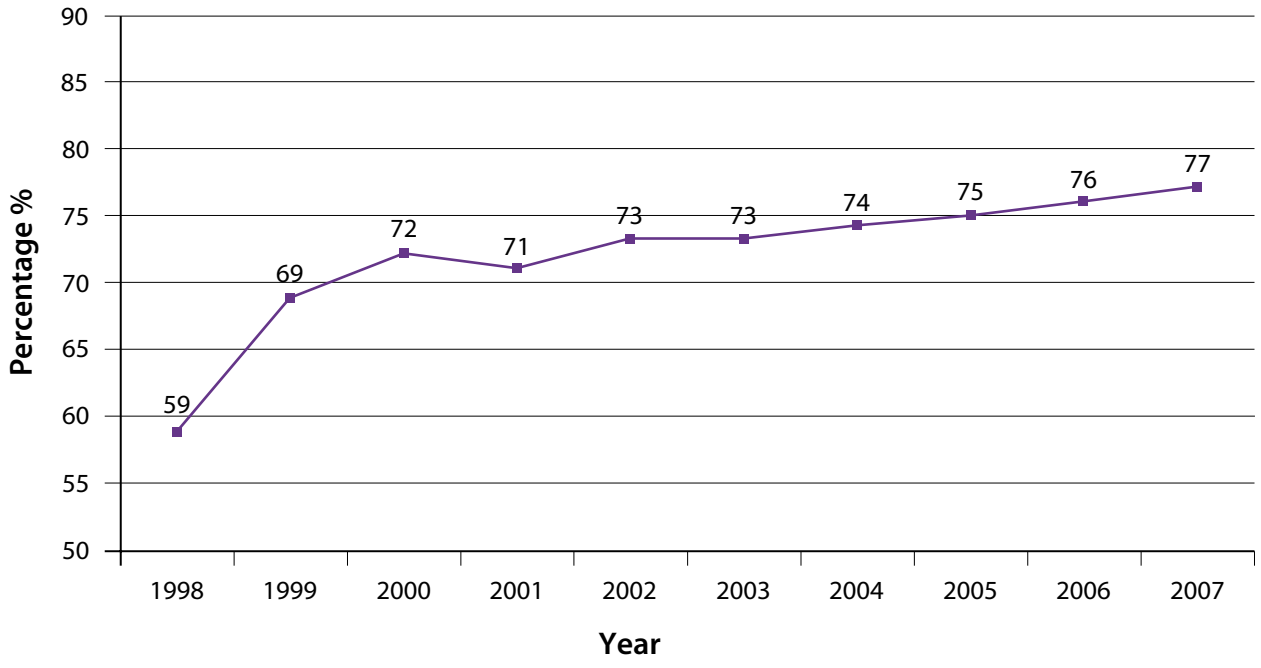
The role of local authorities and HEIs in CPD provision

48. In parallel with its CPD funding for schools, the Government has made extensive provision through local authorities and the National Numeracy Strategy (NNS) – now part of the Primary National Strategy – for various forms of support structures. Excluding central costs, 'pass-through' funding via the National Strategies for educational support in local authorities is approximately £300 million for this financial year – this is not just for primary schools and the Primary Strategy, but for its entire remit. 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 primary mathematics.

49. There was clear evidence that the introduction of the National Numeracy Strategy (NNS) – now part of the Primary National Strategy – has brought about nothing less than a transformation in the way mathematics is taught. 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 the end of Key Stage 2 with level 4 and above rose between 1998 and 2007, from 59 per cent to 77 per cent.

50. This rise can be fairly attributed to changes introduced into the pedagogy of mathematics and the training and support networks for teachers provided. Local authorities also have a role to play in encouraging schools in a close geographical location to work together in a network. In the past, funding from the National Strategies enabled a larger number of networks to successfully work on mathematics as a priority (as referred to in '*Making Mathematics Count in School Networks*[14]). At that time, it enabled teachers to work collaboratively on mathematical problems to develop their subject knowledge as well as focusing on pedagogical issues. More recently, however, the National Strategies have encouraged 'Lesson Study' – a professional learning process that is referred to in McKinsey's report *How the world's best-performing school systems come out on top*[15]; the concept of Lesson Study is outlined below:

Mathematics KS2 results



Lesson Study

Lesson Study is a professional learning process which focuses on the learning and progress made by children as their teachers develop specific pedagogic techniques designed to improve an aspect of teaching and learning identified within their school. Lesson Study, which is used widely in the East Asia (including Japan, China, Hong Kong, Singapore), is a model for ***collaborative*** *classroom professional learning that embodies all the features of effective CPD – namely, high-quality input which is followed by activity where:*

- *two or more teachers work together, developing practice in the classroom, focusing on the needs and learning of real pupils and trying to solve a teaching or learning-based problem which is affecting pupil progress*
- *they are engaged in developing a teaching technique that is designed to improve a specific aspect of learning for identified pupils*
- *they keep a record of what they learn and they pass on the practice knowledge that they gain to others – for example, by coaching, leading a professional development meeting, or providing a demonstration lesson.*

51. The review also noted that, in addition to the research of Joyce et al[16], a key ingredient of CPD is the opportunity and *time for teachers to work* together in *small communities and networks* to *reflect* on their practice with the *support of specialists and experts* when required – again, Lesson Study could play a useful role in this respect. CPD is much more than a set of training days (Goodall et al, 2005, a report commissioned by then DfES[17]). But networks need support to set up and sustain. It is only if this balance is achieved that coaching and mentoring will become a vital and effective part of the development process.

52. 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. However, the review panel feels that it is important 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 in-built intellectual verification of standards and rigour; in turn, it is essential the HEI CPD courses themselves be subject to some form of 'quality assurance'.

53. 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 10 day programme, Developing Mathematical Thinking, currently reaches 156 primary teachers a year 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. 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 could prove to be a prototype for CPD delivery nationally in the primary sector and this idea is considered in more detail below.

54. Of immediate concern 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

Hampshire Programme "Developing Mathematical Thinking"

The Hampshire Mathematics Advisory Team has a tradition of offering a varied and comprehensive range of Continuing Professional Development (CPD) opportunities for teachers in Hampshire's 433 infant, junior and primary schools. However, in line with the national picture, improvements in pupils' mathematics achievements had reached a plateau. Much of the support had focused on about a third of the schools and it was clear that many teachers were not accessing CPD in mathematics.

There was clearly a need to raise the profile of mathematics across the whole county, and to excite, inspire and involve all schools. In 2006, the Hampshire Mathematics Advisory Team established maths managers network groups in each of the eleven districts in Hampshire (405 of the 433 schools currently subscribe to this) and crucially, they set up district headteacher planning groups making a core of almost 60 headteachers with whom they now meet regularly and who are involved in shaping local CPD provision.

The Maths Team also felt that primary teachers' lack of subject and pedagogical knowledge, which often led to under confidence, was probably the most significant block to further improving the mathematical progress of pupils in Hampshire. As part of their CPD provision, they recognised the need for a county-wide strategic and cohesive approach to address this issue and decided to offer primary mathematics 10 day courses in partnership with the Open University. The establishment of the maths managers' network groups and particularly the headteacher planning groups was crucial in successfully launching eight 10 day subject knowledge courses in 2007 and recruiting 156 teachers to these.

The aim is for all infant, junior and primary schools in Hampshire to have at least one accredited teacher within the next five years. Headteachers were very supportive of the idea and prepared to pay the subsidised cost of £900 plus supply. The structure of the course is eight full days centre based with the equivalent of two release days back in school.

Aspects of the course include:

- subject knowledge in all aspects of the mathematics curriculum
- solving problems and thinking mathematically
- mathematics pedagogy
- working with colleagues to develop practice

There are school-based tasks in between the centre-based days, most of which are classroom based, including adapting and trying out some of the tasks from the course. Participants are required to keep a journal of the mathematics they do on the course with reflections on their own learning and that of their pupils. They are also asked to undertake some reading and to identify three pupils on which to focus their observations for the period of the course. Accreditation for the course is provided by the Open University. Assessment is through satisfactory course participation and End of Course Assessment in the form of a project report.

Whilst it is early days, headteachers of participating teachers are already reporting observable changes in classroom practice and improvements to teacher assessment. The challenge will be sustaining these changes beyond the period of the course.

of the National Numeracy Strategy, so a first priority will be to remedy this.

55. 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, which should be provided for all these consultants; this, ideally, should take account of further CPD programmes that the teachers and practitioners might undertake.

56. As such, the review panel believes that the mathematics consultants should be strengthened through the improvement of their pedagogical and mathematical subject knowledge. This CPD would benefit from wide inputs – indeed, the NCETM is well placed to support the National Strategies through the use of NCETM's portal. In particular, the NCETM's self-evaluation tools can be adapted and developed for use by consultants and follow-up guidance in the form of a directory to help local authorities direct their consultants to appropriate courses and recommending training.

57. Consideration should also be given to involving a higher education institution in the delivery of the National Strategies' training to provide specialist input and strengthen the provision. A possible approach could involve following the initial induction training (which is not mathematics focused) with further sessions on mathematics pedagogy and subject knowledge. Guidance should also be provided to consultants, during their training and throughout their tenure, about availability of appropriate courses that will help them in their role as mathematics consultant.

58. As well as ensuring national coverage, the sharing of effective programmes and approaches to CPD would promote the formation of communities to engage with the 'big' ideas in the mathematical knowledge required for primary teaching.

59. The consultants will have a key role to play in terms of ensuring that the Mathematics Specialists (a proposal that is set out below) are having maximum impact in their schools. Their enhanced training will ensure that they have the necessary skills and expertise to do this effectively.

Recommendation 2: Local authorities should upskill their field force of mathematics consultants. The National Strategies, in partnership with the National Centre for Excellence in the Teaching of Mathematics, should develop 'refresher' CPD for all local authority mathematics consultants.

The future of CPD for the practitioner: the Mathematics Specialist

60. The above picture of CPD provision and uptake in primary schools is one of considerable variability, hence the proposed measures involving local authorities, the National Strategies and HEIs. However, this review remains concerned that these alone will not adequately address the need for deep subject and pedagogical knowledge, bearing in mind the limitations concerning mathematics in many ITT courses as discussed above. With costs in mind, this review is nevertheless conscious of the need for prudence in making any recommendations regarding CPD that affect the whole 200,000-strong teaching force in primary schools.

61. A phased approach to this dilemma is advocated. In this, the review panel supports ACME's suggestion that there should be *at least one* teacher in each primary school with a deep

subject and pedagogical knowledge in mathematics, which is relevant to the whole age range in the school.

62. The benefits will be two-fold. Firstly, a tangible acknowledgement by the school's senior management of the importance of mathematics within the whole school setting in the overall drive to raise standards in learning and teaching. Having a specialist teacher of mathematics will mean that there is someone with sound mathematical subject and pedagogical knowledge, sufficient to articulate and share a clear vision for mathematics within the school. Secondly, CPD will be more easily accessible to all the teaching and support staff (including teaching assistants) to ensure that immediate action can be taken to begin to raise the competencies of the school workforce in mathematics 'in-house'. Not only would this be a cost benefit, but it would enable CPD to take place with more flexible timing within the school day, avoiding the need to find additional cover to release those attending courses and removing the usual class teacher from his or her class. 'In-house' CPD can also be more easily followed up, reviewed and evaluated, meaning that benefits from the engagement with the CPD are more likely to be sustained.

63. This specialist teacher would fulfil the following personal and job specification:

- In the long run, meet the TDA standards and abilities that could be expected of an Advanced Skills Teacher, thus being recognised amongst the best classroom teachers.
- Share, in partnership with the senior management team, the responsibility and planning for improving, strengthening and developing mathematics teaching and learning within the school.
- Act as peer-to-peer coach and mentor and support the mathematical professional development of serving teachers, NQTs, ITT students on placement and teaching assistants within the school.
- Leading informed in-school collaborative research activity, the expected outcomes of which are to raise the quality of teaching and standards of attainment in mathematics.
- Liaise with and support those involved in the Every Child Counts intervention (and may also be the intervention teacher where this is appropriate).
- Advise on the provision for Gifted and Talented pupils in his or her school.
- Should normally be provided with additional non-contact time to fulfil the additional duties and personal learning required (this would be at the discretion of the head teacher and is considered in further detail in the section on costs).

A Mathematics Specialist would *not necessarily* be the mathematics coordinator in the school, particularly if schools have chosen to replace specific subject leaders with one TLR (Teaching and Learning Responsibility) post with responsibility for teaching and learning.

64. While making sensible allowances for small schools (and rural schools – where some degree of pooling would be appropriate – these candidates would be drawn from the *existing* teaching workforce. It is important to emphasise that the review is not recommending a particular way in which schools should integrate this post into their school workforce. Schools need to manage this flexibly, taking into account their own individual circumstances. Indeed, some rural schools may find that sharing a Mathematics Specialist may not be the most appropriate way

forward – the key, however, is to ensure there is local flexibility.

65. Once identified, unless they meet the pre-agreed standards envisaged for the Mathematics Specialist, a candidate would undertake CPD to enhance their mathematics subject knowledge *and* pedagogical skills. The number of teachers requiring this CPD is considered below.

66. Parallels 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.

67. Our recommendation therefore acknowledges that in many schools the equivalent post to the Mathematics Specialist advocated here already exists; indeed, many have been encountered during this review. While it is difficult to estimate the number of 'pre-qualified' Mathematics Specialists with any precision, the cost estimates below assume that up to 3,000 exist nationally on day one; the remainder should be clearly identified (though not necessarily have completed their CPD) within five years. It must be noted that if the estimate of 3,000 'pre-qualified' Mathematics Specialists is significantly different from the actual number, then this would affect the costs and phasing proportionately.

68. In attempting to assess how many Mathematics Specialists would be needed to bring about the changes envisaged in this review, the following factors have been taken into account:

- The total number of primary schools in England (17,361).
- The number of small (and rural) schools, where sharing between schools may be appropriate.
- The number of schools where, in contrast, more than one Mathematics Specialist per school may be beneficial (e.g. large urban schools or those with specific challenges).
- The minimum number needed nationally for tangible and immediate impact.

The table below illustrates how the total cohort of Mathematics Specialists might eventually be distributed among the various sizes of schools. An analysis of schools by the number of teachers they have yields a very similar outcome.

69. Taking all the above factors into account, and based on the estimates above of the total population needed, it is estimated that 13,000 Mathematics Specialist would be required. The cost models below assume an immediate population of 3,000 designated Mathematics Specialists on day one, and a further 10,000 Mathematics Specialists *completing* their CPD within 10 years. Since the impact of the rising population will be felt before the cohort is fully populated, a phased entry into CPD is proposed for cost and logistics reasons. It could, however, be argued that this phasing will result in inequalities across schools for some years, and that where head teachers wish to opt for earlier adoption, pathways should exist to permit this.

70. If the measures in this review are adopted, it seems unlikely that implementation in schools will be before September 2009. It would be important that this phasing be accomplished both to achieve maximum impact and minimisation of variability

Pupils/school	Up to 100	101-200	201-300	301-400	401-500	501-600	601-700	701-800	801 and over	TOTAL
Number of schools	2,605	5,140	5,230	2,500	1,470	232	149	22	13	**17,361**
Mathematics Specialists/ school(s)	1 to 4	1 to 2	1	1	1	1	2	2	2	
Total number of Mathematics Specialists	650	2,570	5,230	2,500	1,470	232	298	44	26	13,021

across schools as the population of Mathematics Specialists is gradually increased, and there are a number of ways of targeting the CPD programme. There may, for example, be merit in an approach in which the Mathematics Specialist would be targeted at schools that have a higher proportion of under-attaining children – such an approach would help to narrow the long-standing attainment gaps that still persist. In phasing this programme, it would also be important to ensure a reasonable geographical spread – thereby ensuring that the cohort of Mathematics Specialists are not concentrated solely in one area of the country.

71. Within the same time frame as is envisaged for the Mathematics Specialist programme, the potential exists for these numbers to be supplemented by NQTs coming from more mathematically focused ITT, as discussed above. In principle, this would enable a trainee teacher (in either PGCE or undergraduate course) to graduate with the aim, after an appropriate period of classroom teaching and CPD, of becoming a designated Mathematics Specialist, and subsequently aspiring to a Masters-level accreditation. Such a route could be seen as a 'fast track' compared to a CPD-based route for existing teachers to become Mathematics Specialists, and would be suitable only for those trainees already possessing deep subject and pedagogical knowledge and graduating from an approved course.

72. These more mathematically focused NQT's could form the basis, long term, for replacement and replenishment of the Mathematics Specialist workforce, ensuring that the system is sustainable in the face of retirement and departures from the teaching profession. Equally, the continuing need for the focused training and incentive programmes can be re-examined and reviewed by Government from time to time. In the costs estimates, it is therefore assumed that when the CPD programme for the existing teaching workforce is complete, there will remain a small, ongoing programme in mathematically-focused ITT for these reasons.

73. The mechanism for identification of the potential Mathematics Specialist among the existing teaching force should be delegated to school level, an important principle throughout this review. An agreed process should rest on nomination by the head teacher, but this might permit self-nomination (as in Scotland for Chartered Teacher status) as an input for the head teacher's consideration. It would be vital to support this nomination process by a robust monitoring and quality assurance system. This would ensure the introduction of specialist mathematics teachers into primary schools is

successful in reducing the variability in, and strengthening the quality of, teaching and learning in mathematics within and across schools. The quality assurance system would ensure (i) that the teachers possessed a suitable set of skills and experiences, (ii) that the CPD they received was of high quality, and (iii) that the work of the Mathematics Specialist has an impact on pupils and practice in the classroom across the school.

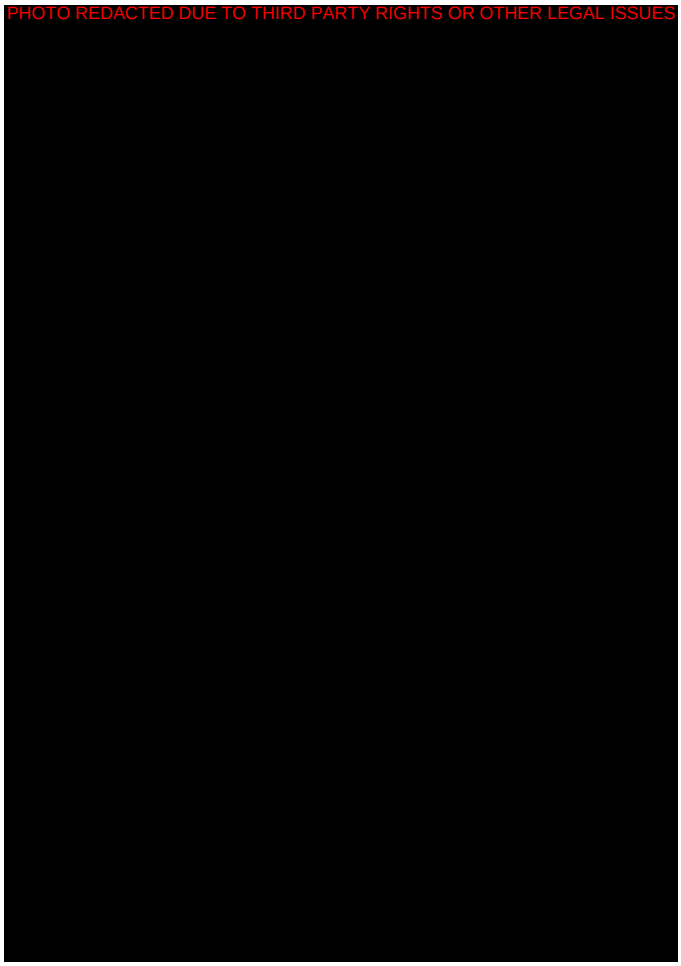
74. The personal characteristics that potential Mathematics Specialists should display might include:

- Good and secure knowledge of mathematics (this would provide a secure platform to develop a wider and deeper understanding of mathematics across the primary curriculum).
- Good teaching skills (this would provide a grounded practice on which to refine and develop a good mathematics pedagogy).
- Good range of assessment strategies for informing their teaching of mathematics (this provides the skills from which to build a better understanding of how diagnostic assessment within mathematics informs teaching and learning).
- Strong inter-personal skills (from which to develop coaching and mentoring skills to work with and support colleagues).
- Good analytic, critical and reflective skills (to ensure that work with colleagues is more than superficial, but does review the learning and teaching in order to improve).

75. Independent verification according to established standards should then follow, with clear, nationally-agreed selection criteria. As identified above, the head teacher is of paramount importance in this process. The review has met with both the Head Teachers' Reference Group of the DCSF and the Primary Head Teachers Group of the National Association of Head Teachers (NAHT). Both are strongly in favour of the measures proposed, as are the many head teachers encountered during the course of visits. In the focus group at the consultation event following publication of the interim report, there was similar unanimous support.

76. Below is a table which summarises some of the benefits that can be expected both by the school and by the Mathematics Specialist too:

Recommendation 3: There should be at least one Mathematics Specialist in each primary school, in post within 10 years, with deep mathematical subject and pedagogical knowledge, making appropriate arrangements for small and rural schools. Implementation should commence in 2009 and be targeted initially to maximise impact on standards and to narrow attainment gaps.



Benefits for the Mathematics Specialist	Benefits for the school/head teacher
Enhanced mathematical subject knowledge and subject-specific pedagogical skills and research evidence and confidence and effectiveness in teaching mathematics. Better equipped to teach children mathematics and to develop enthusiasm across the school for learning the subject. Access to and knowledge of CPD opportunities in mathematics that might be used by the school. Enhanced understanding of progression in mathematics to guide assessment-for-learning strategies and use of tracking systems, and the planning of targeted intervention for children. Opportunities to develop professionally and to gain formal accreditation for training and Masters-level qualification. Opportunities to undertake high-quality mathematics CPD, and incentives to do this in an 'out-of-school hours' context. Opportunities to be part of local authority network and access to support structures. Opportunities to join a national network of other Mathematics Specialist teachers to discuss practices and share ideas.	Access to recent research into effective mathematics teaching and learning practices, models of which can be disseminated through the school. Opportunity to develop a key member of staff who can lead professional development in the teaching and learning of mathematics. Informed planning and delivery of in-school mathematics CPD that is accessible to all the teaching and support staff. Enhanced mathematics professional support available through mentoring to trainees or newly qualified staff, or coaching to teachers or teaching assistants. Mathematics champion in the school who can generate enthusiasm for learning the subject among children, parents and staff. More opportunities to take forward informed in-school collaborative research in mathematics. Informed advice about the mathematical professional needs of staff in the school and the range of CPD opportunities available that can inform school planning and self-evaluation processes.

CPD for the Mathematics Specialist

77. This specialist cadre should be the pathfinders for the profession. The CPD they receive must be of high academic quality. Already a typical CPD offering in an HEI attracts Credit Accumulation and Transfer (CAT) credits, which can eventually result in diploma accreditation. In discussion during the review, many teachers who have been in post for some years reflected affectionately on the '20-day course', an experience which not only changed their practice for the rest of their careers, but provided credits for Masters-level qualifications.

78. For the Mathematics Specialist teacher, there should be an opportunity for a long-term, carefully designed CPD programme leading to **Masters-level accreditation**. This CPD would include elements of compulsory specialist study of primary teaching with an emphasis on mathematical content, the 'mathematical knowledge for teaching' discussed above. It would facilitate critical reflection on putting such learning into practice and would enable sharing the fruits of these reflections with others. It would also promote understanding of the three interrelated strands of mathematical content, mathematical pedagogy and embedded practice, and it would provide time to engage with research. Such a goal would align perfectly with the Government's aspirations in the *Children's Plan* to make teaching a Masters-level profession, and would be consistent with the TDA's stated objectives for future NQTs. Moreover, it would apply to the current generation of teachers, not just to generations to come.

79. This review sees this CPD being provided via a number of complementary pathways – i.e. that

'blended solutions' are appropriate and necessary, provided by HEIs, National Strategies and local authorities. These solutions will involve:

- HEI provision of material on both pedagogical and subject knowledge, with modules attracting credits to build towards a Masters-level qualification.
- Distance learning, as well as course-based working in both HEIs and local authorities.
- In-school activities.
- Specific local authority-based modules aimed at pedagogical development in line with Primary National Strategy (PNS) frameworks.
- Local authority consultant mentoring and coaching (following local authority 'refresher' CPD).
- Provision for involvement with local mathematics networks.

80. The current five days INSET/CPD entitlement is often scheduled for important all-school development activities which may preclude its dedication to personal development tasks. Therefore, it is proposed that the Mathematics Specialist would engage in a further five days CPD per year along the general lines outlined above, for a period of three years, costed below. The sole exception to this timetable should be the 3,000 pre-qualified teachers who should undergo only one year (the final year) of the programme.

81. Stimulating and relevant CPD for the Mathematics Specialist should give teachers the opportunity to explore some mathematics in its own right and to record and share their reflections with other teachers, in some cases 're-learning' certain areas of the mathematics curriculum. There is a rich array of topics relevant to primary from which CPD can be developed, which might, for example include:

- Big ideas and connections – what numbers are and why number operations work as they do.
- Experience of learning new mathematics for themselves and sharing and defending solution process and solutions.
- Experience with dynamic representations of shape and number.
- Exploring geometry.
- Understanding how concepts develop over a large number of years.
- Experience with problem posing and problem solving; selecting and sharing different representations.
- Evaluation of children's solutions.
- Logical reasoning.
- Identifying pupil misconceptions.
- Recent research in mathematics teaching and learning.
- Opportunities to observe children and groups of children.
- Encouraging mental and oral mathematics.
- Opportunities for using and applying mathematics.

82. Perhaps more important at this stage is to recommend practical means by which such CPD can be organised. An obvious barrier to the extra five days of CPD this review recommends for the Mathematics Specialists involves classroom absence, both from the standpoint of the teacher's personal sense of responsibility to their class and year group and the questions of supply cover availability and cost. This review's proposed solution is intimately interlinked with the nature of the nomination process and the incentives. It is the recommendation of this review *that the teacher should undertake the CPD outside normal school*

hours, but should receive additional incentive payments both during CPD and on its successful conclusion.

83. It is possible that the five days' CPD could be undertaken part time throughout the school year, and indeed there are many attractions in this route, not least the 'continuous', steady nature of the CPD. Indeed, during the course of this review, one university was visited which offered twilight CPD sessions in the afternoon and evening for its students. Both HEI and local authority/National Strategies modules could form part of a typical accredited programme, and the NCETM, amongst others, should also be involved in the development of these CPD programmes.

84. However, recognising the great value in shared experience during the intense CPD envisaged, the review is attracted to the concept of the 'summer school', which is used so effectively by many educational bodies, of which the Open University is perhaps the longest established model. A five-day annual summer school during each of the three years of the programme, coupled with regular reading and private study, would bring together students who share common goals and ambitions in their chosen field, and has been shown to be highly effective in other disciplines. This proposal is not advanced lightly and it is recognised that the prospective Mathematics Specialist will need to be highly motivated. The nomination process would entail careful discussion between the prospective teacher and the head teacher. The financial elements of the proposal are set out in the section below on incentives.

85. Such a summer school could be residential in an HEI, or it could be local to preclude residential and travel costs and family absence. School facilities or local HEIs and colleges themselves could be used for a consortium of local schools. Providers could include all the stakeholders identified above – HEI, local authorities, National Strategies, and possibly other third party providers.

86. Specific examples of such summer school programmes already exist. The Universities of Brighton, Liverpool Hope and Wolverhampton are currently involved in a pilot mathematics CPD programme, aimed at teachers who are not Mathematics Specialists. Although it is intended for teachers of 11-19 year olds, the course structure and methodology are interesting and could readily apply to the primary CPD proposed by this review. The Brighton course, for example, has the following structure

- Four days' intensive mathematics at the university.
- Six half term sessions throughout the school year.
- Two full days teaching at Brighton (a Friday and Saturday).
- Two twilight sessions in local schools with strong mathematics departments.
- One twilight session at Brighton to review the half term and to plan for the next phase of the programme.

87. It will be essential to maintain quality standards throughout. The review envisages that DCSF will take overall responsibility for the implementation of the Mathematics Specialist programme, and in doing so will work with the appropriate partners. Following achievement by a teacher of Mathematics Specialist status, it is envisaged that a further period of appropriate study and classroom experience can lead to a Masters-level accreditation, on an equivalent basis to the TDA's plans for The Masters in Teaching and Learning. This review does not address the details of this final development period in detail, but in the cost models below it is assumed that all

Mathematics Specialists will progress within two years to Master-level status. It will therefore be important to define the output standards, and to ensure that Masters-level accreditation through CPD will be subject to exactly the same criteria as the planned Masters in Teaching and Learning. This will lead to a common basis of professional employment for teachers who have achieved Masters-level standard via different pathways.

88. The above proposal also has close parallels with the Scottish system in which CPD leads to Chartered Teacher status and Masters-level recognition. While this approach in Scotland 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 in England.

89. Finally, the review has also considered the interrelated question of CPD for the 'intervention specialist' discussed in Chapter 4. Depending on the outcome of the pilot evaluation of small group as opposed solely to one-to-one intervention, a cohort of between 500 and 1,500 specialist teachers will be required for Every Child Counts. It has already been noted above that the Mathematics Specialist will have responsibility to support both QTS and teaching assistant level intervention staff, but due to the specialist nature of intervention, no further economies of scale have been assumed regarding the CPD for the Mathematics Specialist. The costs for the intervention specialist are therefore treated separately in Chapter 4. The only situation where this demarcation might sensibly be varied is in the case of small, rural schools. Given that the Mathematics Specialists in this sector will be active in more than one school in any case, it is probably worthwhile examining whether their normal classroom duties could sensibly be combined with a limited amount of intervention. Clearly the CPD requirements for such a teacher would need careful examination.

Costs, incentives and rewards: Financial implications

90. This section sets out preliminary ideas on the financial implications of the recommendations in this chapter for ITT and CPD. In addition, it sets out proposals for appropriate incentive structures for those teachers who successfully complete the multi-year CPD programme and become Mathematics Specialists.

ITT costs

91. The proposals made in this review on ITT, however, are broadly cost neutral for the providers. In the future, primary ITT providers wishing to offer greater focus on mathematics, for example, should be able to do so at modest marginal costs. The question of incentive costs for teachers entering ITT is considered below.

CPD costs

92. The aggregate CPD costs are more difficult to estimate and are highly model-dependent. In the case of the local authority consultants, the involvement of the NCETM would add some external expertise into the content and design of the CPD offered. The sort of 'blended solution' CPD advocated above for the Mathematics Specialist includes third party provision, primarily HEI in origin, and that delivered by local authorities and the National Strategies. While the latter two 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.

93. For the Mathematics Specialist, the estimate is based on the above model of five days' total personal provision per year. For the purpose of illustrating costs, it is assumed that this CPD is undertaken in the form of a five working day summer school. The costs are estimated by reference to the Scottish Chartered Teacher CPD modules (£650 per module, typically two or three taken a year) and on CPD courses observed in an HEI institution during the course of the review (£750 per two-day course), although it is noted that the pilot scheme referred to above at Brighton (for 11-19 year teachers) is free to the school, with the costs presumably being borne centrally. Regardless of the source of funding, for the current proposals, a cost of £2,500 is assumed, based on the summer school model.

Incentives, rewards and associated staff costs

ITT incentives

94. Examples are cited above of ITT courses, both undergraduate and PGCE, that focus on mathematics to a greater extent than is normally the case. Would incentives ensure a greater demand for, and uptake of places on, such courses? Government has accepted the need for a similar policy in the case of secondary teachers in its Golden Hello scheme, in which specific incentive arrangements are made for mathematics and science teachers, as well as other 'priority subjects'. The scheme applies only to the PGCE route – teachers gaining QTS through undergraduate or employment-based routes are ineligible (although it should be noted that the majority of entrants into teaching come through the PGCE route). For those eligible, an incentive payment of £5,000 is made.

95. A clear difficulty emerges, however, when exploring the possibility of the scheme's extension to the primary sector. All primary teachers take the daily mathematics lesson, so in that sense there are no 'priority subject teachers' as all are, in principle, equivalent. Nevertheless, the model may be applicable to a fast track route to 'Mathematics Specialist' status through mathematically-focused undergraduate or PGCE courses (such as that at Exeter University). If so, the possibility of an incentive payment on a par with that already offered to secondary teachers has great attractions. Such a payment could be made in two equal instalments, one of £2,500 at the start of an eligible course, the other on the successful completion of at least two years in the classroom when 'Mathematics Specialist' status is finally conferred.

96. For the purposes of the cost model below, it is assumed that for both undergraduate and PGCE ITT, such an incentive will be payable. In addition, following achievement of Mathematics Specialist status, as with existing teachers following CPD, the opportunity should also exist to continue their studies to a Master level over two further years, at which time a further incentive becomes payable for successful eligible graduates.

CPD incentives for the Mathematics Specialist

97. Teachers encountered during this review were highly dedicated and committed to their jobs, perceive their relative weaknesses in mathematics, and were enthusiastic about the opportunity for CPD to strengthen their skills. However, not enough teachers were taking up these opportunities, and therefore it is the firmly held view of this review that, in these circumstances, the Government needs to recognise the requirement for appropriate incentive structures. This is not to advocate reward for 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. Rather, an incentive system should reward

excellence and out-performance. In this respect, the review distinguishes between that CPD undertaken by all teachers as part of a regular pattern of updating and professional competence, for example through INSET days, and that undertaken outside the ordinary and normal course of their occupation. The CPD programme proposed in this review falls into the latter category and should therefore attract incentive payments.

98. In arriving at the financial model considered below, the following assumptions have been made to address the above question:

- All CPD costs are fully funded.
- Each Mathematics Specialist attending the five-day CPD summer school will receive a payment of £1,000 for each of the three years.
- On successful completion of the three-year programme to accredited standards, the Mathematics Specialist will receive a one-off incentive payment of £2,500.
- After two further years of classroom teaching leading successfully to the award of a Masters-level qualification, a further one-off incentive payment of £2,500 will be made.
- For the pre-qualified cohort of Mathematics Specialists, similar terms will apply, **except** that only one year of CPD will be required prior to the granting of full Mathematics Specialist status.
- The details for implementation – particularly in regard to the phasing and payments for the pre-qualified cohort of Mathematics Specialists – will require careful consideration.

99. Finally, no additional costs have been included in the model for the qualified Mathematics Specialist associated with any additional non-contact time away from the classroom (over and above the current 10 per cent for all teachers). As proposed above, it is envisaged that the detailed manner in which schools introduce the Mathematics Specialist will be tailored to specific circumstances and be delegated to the head teacher and senior management team. For example, in the 7,775 schools with up to 200 pupils, where a Mathematics Specialist could operate in two to four schools, special arrangements will have to be made by the head teachers and management teams concerned. This may automatically involve additional non-contact time of necessity as a result of the complexity of planning and timetabling. For the balance of almost 10,000 schools and Mathematics Specialists, additional non-contact time would be at the discretion of the head teacher, in line with the review's belief in the importance of delegating such decisions to individual schools.

Cost model

100. Clearly, the phasing of any programme would determine the annual rate of total costs on a national basis. The model below is intended to be illustrative only, and further detailed work would be necessary prior to the implementation of the recommendations of this review. The assumptions in the model are as follows:

- Up to 3,000 teachers on day one already qualify for Mathematics Specialist status, and following one years' CPD, are eligible to receive the appropriate incentive payments in year two and four of the scheme.
- The remainder of the (approximately) 10,000 cohort enter in a phased manner as reviewed above, commencing with a pilot group of 500 in year two.
- Teachers spend three years in total in CPD (other than the pre-qualified group).

- All costs are in 2008 money, non-indexed.
- Incentive payments for ITT (undergraduate and PGCE) are paid on enrolment in an approved course of high mathematical content. After two years in the classroom following graduation, the Mathematics Specialist incentive payment is made. Following further study, and a minimum of two years in the classroom, successful candidates will be eligible for the final Masters-level incentive payment.

101. The outcomes of this simple model are set out in the chart below.

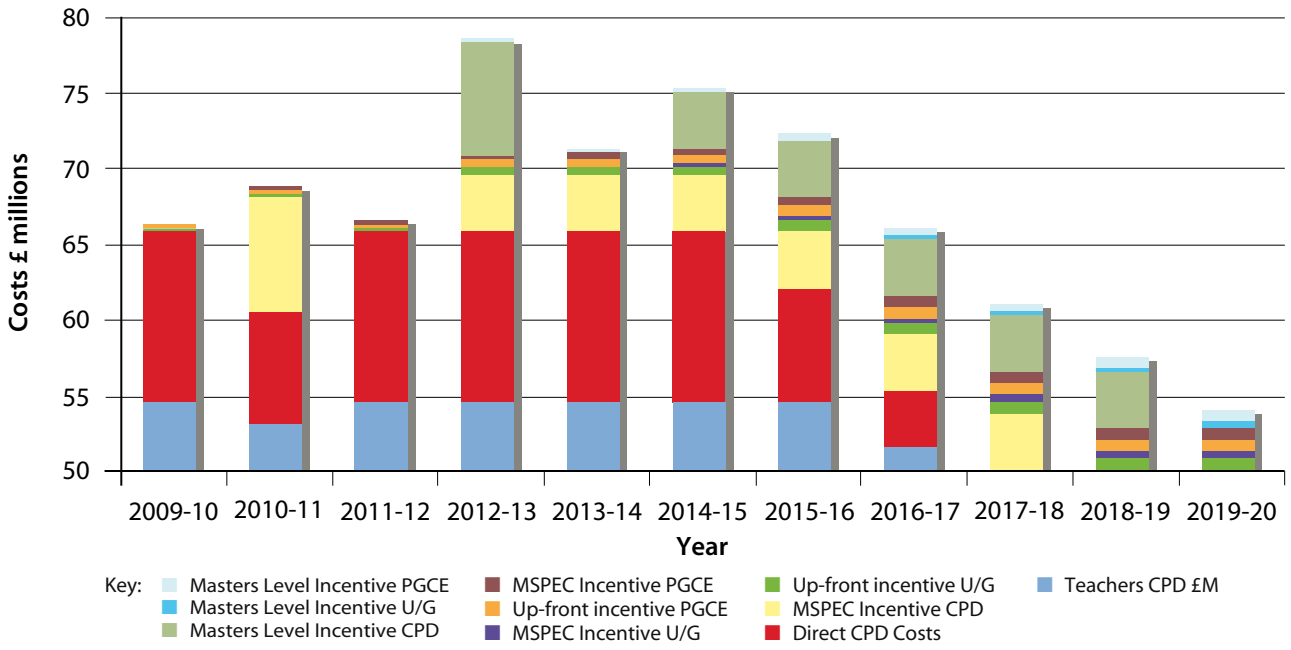
The cost model is dominated by the CPD costs for the existing teaching workforce (teachers 'fee', direct CPD costs and the Mathematics Specialist incentive payment). The model also shows the effect of all the Mathematics Specialists proceeding to Masters-level status by further study, thereby receiving the final incentive payment. While this may not necessarily represent the most realistic outcome, it is one to be encouraged. It also demonstrates the relative costs of the ongoing 'sustainable' entry through ITT.

Cost benefits

102. In making its recommendations to Government, this review is mindful of the need to demonstrate, whenever possible, the resultant benefits. In the later chapter on intervention, work currently in hand for Every Child Counts on the costs to society of an innumerate population, highlights, unsurprisingly, that the financial impact of mathematics is considerable. With one quarter of national GDP resulting from the mathematics-based financial services sector, the importance of mathematics in general hardly needs stating. More challenging is to relate present proposals in detail to this national economic situation.

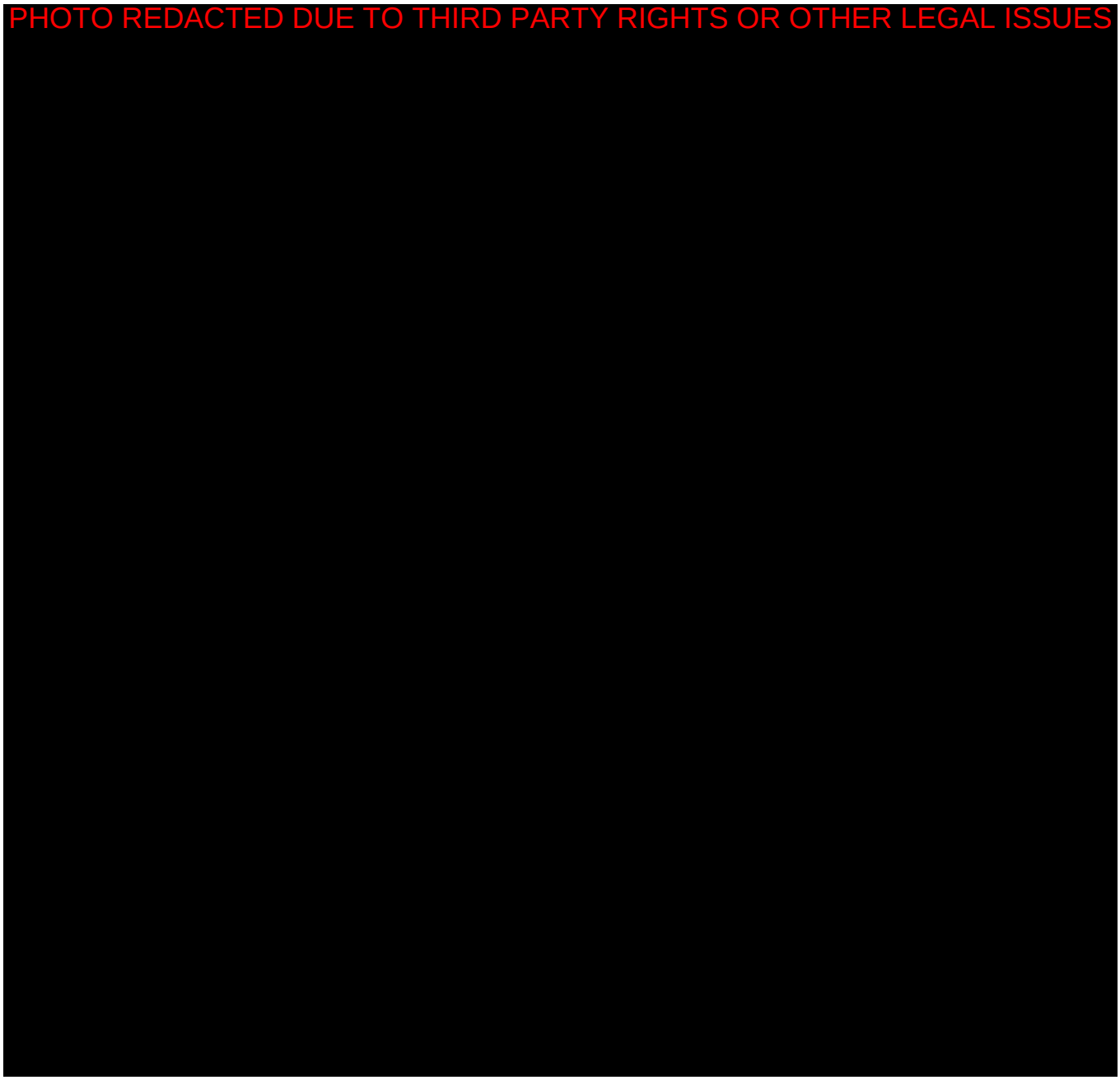
103. Preliminary results from the ECC study indicate a significant cost to society of adult innumeracy. While intervention is the preferred targeted approach to laying a firm foundation for the minimisation of adult innumeracy, it is appropriate to stress here the essence of the argument which is repeated in Chapter 4 – namely the critical importance of high-quality classroom teaching to minimise the need for later, intensive remedial intervention. It is the position of this review that quality first ('wave 1') teaching for **all**

Mathematics Specialists



children, over the long term, is the major determining factor in adult numeracy, not intervention. As such, the total cost of this programme over 11 years of £187 million averages less than £20 million per annum, and should be seen as an investment in the nation's future, not as a cost. It represents an increase in the employment costs of the total primary teaching force of less than 0.15 per cent per year.

104. A related factor in arguments concerning costs is the question of whether mathematics should be singled out for additional investment, rather than other subjects. The remit of this review did not include any such comparative analysis, which would be necessary before, for example, mathematics and English could usefully be compared. However, in no way does this diminish the case for mathematics and the powerful arguments advanced in this chapter. In fact, regarding the equally important matter of the teaching of English, it is interesting to conjecture what the reaction might have been if the data in paragraph 25 had revealed that only 227 graduates out of 9,937 on PGCE courses in primary had degrees in English, history, geography or modern languages.



Chapter 3: The Early Years

'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

This section considers some of the available research in early years and the Early Years Foundation Stage.

Effective mathematical pedagogy in the early years

This section looks at mathematical learning through play activities.

Teachers and practitioners in early years settings

This section discusses the early years workforce, qualifications and CPD of early years practitioners.

Transition

This section looks at continuity of learning experience and how this can be achieved in mathematics.

The following principal recommendations are made.

Recommendation 4: That the DCSF commissions a set of materials on mathematical mark making and children's mathematical development which can be used to support early years practitioners' CPD.

Recommendation 5: That the forthcoming review of the EYFS in 2010 considers the inclusion of time and capacity within the early learning goals.

Recommendation 6: That the DCSF continues to increase the proportion of graduate practitioners in early years settings, recognising the respective contributions of the Qualified Teacher (QTS) and the Graduate Early Years Practitioner (graduate EYP). The review supports the goals which are currently in place.

Background

105. The previous chapter of the report has 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 5 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.

106. 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. This range of experience and quality has profound implications for mathematical development in the EYFS.

107. 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, in particular the Effective Provision of Pre-School Education project (EPPE). 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, shows just how important the early years are in the context of a child's development, and the lasting effects on achievement in primary education and) are strongly endorsed by this review, in particular:

- *The quality of pre-school centres is directly related to better intellectual/cognitive and social/ behavioural development in children.*
- *Settings that have staff with higher qualifications, especially with a good proportion of trained teachers on the staff, show higher quality and their children make 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.*[18]
- *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.*

108. 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 *Effects of the Home Learning Environment and Pre-school Centre Experience upon Literacy and Numeracy Development in Early Primary School*[19], 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 6 of this review explores further the vital influence of parents and families in a child's early learning.

109. 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 this review supports its aims, which stress the following key themes:

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

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

Effective mathematical pedagogy in the early years

111. Central to effective mathematical pedagogy in the early years is fostering children's natural interest in numeracy, problem solving, reasoning, shapes and measures. Children should be given opportunities in a broad range of contexts, both indoors and outdoors, to explore, enjoy, learn, practise and talk about their developing mathematical understanding. Such experiences develop a child's confidence in tackling problem solving, asking probing questions, and pondering and reasoning answers across their learning. Vitally important is ensuring that children's mathematical experiences are fun, meaningful and build confidence. The EYFS guidance is clear on the importance of good quality mathematical learning and development that will promote positive attitudes and deeply rooted learning.

112. Effective early years mathematical pedagogy is crucial as it supports children in:

- learning new skills
- developing their understanding of concepts and process, and
- using, consolidating and refining skills and understanding.

113. Effective early years mathematical pedagogy is typified by skilled practitioners interacting with children in a rich, stimulating and interesting environment. Practitioners' use of mathematical language in open-ended discussions – for example, 'bigger', 'smaller', 'fewer', 'more' – to build on these daily experiences in an enabling environment is essential.

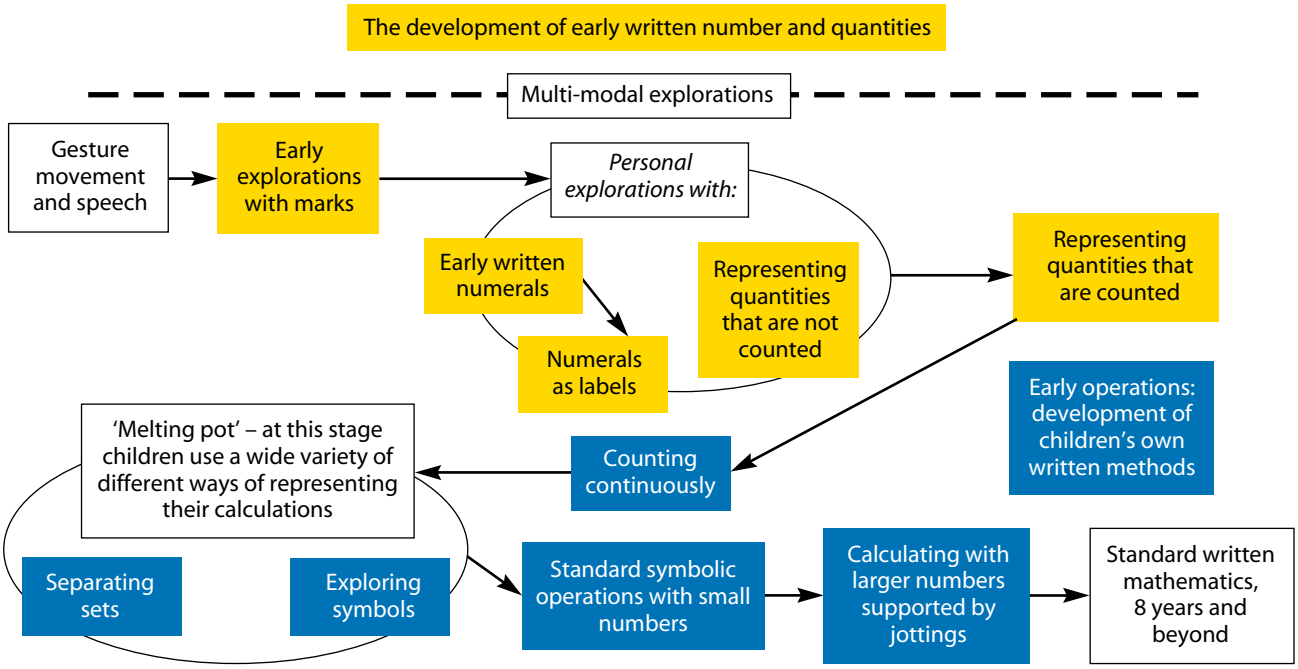
114. Other features of effective early years mathematical pedagogy are:

- building on play
- making the most of everyday routines and spontaneous learning to develop mathematical skills and concepts
- requiring practitioners to support, challenge and extend children's thinking and learning through sustained shared thinking and use of accurate mathematical language, and
- giving children opportunities to record their understanding and thoughts in early mathematical mark-making.

Mathematical mark-making

115. 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 extend and organise their mathematical thinking. While 'emergent writing' is a recognised term, that is not the case for 'emergent mathematical mark-making'[20]. This misses a valuable opportunity to encourage early experimentation. The role of mark-making in children's cognitive development is set out in the taxonomy below. Early years practitioners should encourage mathematical mark-making and open-ended discussion (or sustained shared thinking) in children's mathematical development.

Taxonomy: tracing the development of children's mathematical graphics from birth to 8 years



Recommendation 4: That the DCSF commissions a set of materials on mathematical mark making and children's mathematical development which can be used to support early years practitioners' CPD.

Case study on mathematical mark-making

Redcliffe Children's Centre and Maintained Nursery School (Bristol) provides outreach work to 640 families, and educates and cares for children between three months to five years. Its head teacher Elizabeth Carruthers explains:

'We have observed that children make mathematical marks as well as marks for writing and one of our focuses is children's early mathematical graphics. We believe this is the very beginning of the process of children understanding the abstract symbolism of mathematics.[21]

'The nursery environment encourages everyday opportunities for children to freely explore all kinds of mark making and some of their marks show their mathematical thinking or 'thinking in action'. Teachers and practitioners are supported in understanding these marks and interact sensitively with the children.

'To support children's mathematical thinking we plan open opportunities for free play and provide a variety of writing and drawing implements inside and outside. Staff model written mathematics in purposeful contexts and assessment is from a positive perspective linked to Carruthers and Worthington's taxonomy (see diagram above). We share children's processes of thinking with parents and discuss opportunities for mark-making at home.'

The following is a quotation from a reception class teacher at Kew Riverside Primary School (Richmond upon Thames)

'I have been encouraging children to mark make in mathematics since June 2007. When I started my children were nearing the end of their time in reception and quickly became used to recording their mathematical thinking as they went along. Some children were coming up with quite sophisticated ways of recording using pictures, numbers, words and endless post-it notes! I also recorded them working in photographs.

'When my new reception children started in September this year, I provided them with the opportunity to use paper to assist them with the mathematics they were doing. Some children initially found it very difficult to record their thinking. We did lots of talking about it first. I have never shown them how they should record and have always given lots of praise for what they have produced.

'Children mark make by drawing pictures, letters, numbers, lines – in a whole variety of ways. When they show their work we always annotate and write down exactly what they say. As their writing skills have developed some are choosing to write in sentences, recording their thoughts or findings. Some prefer to use pictures and symbols.

'The emphasis has very much been on encouraging them to record what they are doing, and to clarify their own ideas. This may be done during a group session or in their free play. Most children automatically get a piece of paper now and 'have a go' at tracking their thinking. I always have A5 paper around the class available for them to access, as well as post-it notes and various frames that they might like to use – for example, a purse if we have been doing money. All of the children are now much better at explaining their thinking and ideas. I think the mark-making has really helped this as we have had much more of a focus on explanation and the thought processes children go through to arrive at their answer.'

EYFS guidance and early learning goals

116. The EYFS provides guidance on developing '*mathematical understanding through … imaginative play*'. However, opportunities in this area seem to be missed. Early years settings should ensure that sufficient time is given to mathematical discussion around practical activities such as play with vehicles outside, cooking, shopping and constructing. To be effective, mathematical learning for children in this age group needs to be predominantly social in nature and rooted in these play activities.

117. 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.

118. The early learning goals related to shape, space and measures focus predominantly on use of mathematical language; they do not refer to concepts of time or capacity. This seems an unfortunate omission, bearing in mind that such 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 these goals to be redrafted to promote purposeful mathematical

activity and to be inclusive of all children's measuring experiences, including time and capacity.

Recommendation 5: That the forthcoming review of the EYFS in 2010 considers the inclusion of time and capacity within the early learning goals.

Implementation of effective early years mathematical pedagogy

119. To secure effective pedagogy, local authorities, leaders, managers and head teachers should provide the following key elements of support in order for all settings to develop the conditions for learning:

- A preliminary audit that supports the identification of strengths and areas for development within a setting.
- A review of the mathematical learning environment which enables staff to monitor and evaluate resourcing and organisation for problem solving, reasoning and numeracy.
- Examples of effective and good practice through modelling, demonstrating and coaching in order to enable settings to enhance the quality of their learning and development in problem solving, reasoning and numeracy.
- Models of open questions and discussions and a mathematical language list to support staff in their dialogues with children.
- A culture with a significant focus on mathematical mark-making in line with early writing through, for example, role-play, making of number books, and the use of popular mathematical mark signage in the environment.
- A learning environment that encourages children to choose to use their own mathematical graphics to support their mathematical thinking and processes.

Teachers and practitioners in early years settings

Mathematical subject knowledge and the early years practitioner

120. 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 ITT entry requirements should apply for both QTS and graduate early years practitioners in EYFS, as for the QTS in primary. 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. Given the importance of measures that lead to all-round improvement in classroom practice, it would be inappropriate to endorse any diminution in standards in early years – quite the opposite.

121. 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. Distinctive features that support high-quality mathematical learning include:

- Practitioners' enthusiasm for, understanding of, and confidence in, mathematics.
- Direct teaching of mathematical skills and knowledge in meaningful contexts.

- Opportunities for open-ended discussions of solutions, exploration of reasoning and mathematical logic.
- Exploitation of mathematics in everyday activities and in play where children use and apply their knowledge, skills and understanding.
- A breadth of mathematical experiences.
- Understanding of the links in mathematics.
- Understanding of mathematical concepts.

122. 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.

123. Recommendation 3 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.

124. Again, 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 it is concluded that this recommendation is necessary to pursue the long-term aim of raising standards.

125. 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.

126. Based on the panel's visits to a number of excellent early years settings, the review concludes that the EYFS criteria for minimum qualification levels[22] 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 review agrees that the presence of someone with Qualified Teacher Status with early years specialism working with children wherever possible is vital, and in settings with more than perhaps five or six staff, more than one such teacher is necessary.

127. It therefore remains undesirable that some settings are able to meet statutory requirements which allow for a proportion of the staff to be unqualified. In contrast, one Sure Start Children's Centre visited during the review had no fewer than 13 practitioners with an undergraduate or postgraduate degree-level qualification out of a total staff complement of 25, six of whom were qualified teachers. In addition, many of the other non-graduate 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.

128. The Millennium Cohort Study[23] stresses the linkage between the quality of provision in a setting and the level of qualification of the staff, and the Early Childhood Environment Rating Scale (ECERS) data below, analysed by subject and topic, shows a clear correlation.

> *'The childcare qualifications of staff working in the rooms observed were an important predictor of provision quality. The* ***mean qualification level of all staff*** *had the strongest relationship with quality (compared with other qualification measures) and was significantly related to all aspects of provision measured, with the exception of personal care routines.'*

129. Other appropriately qualified graduate-level practitioners with Early Years Professional Status (EYPS) also have a valuable role to play, and Government's move to increase their numbers is welcomed. This review recognises the need for a well-trained workforce comprising a range of different skills, experience and qualifications. Where Early Years Professionals are leading delivery of the early years provision, it is felt that their training should be underpinned with focused, supervised and assessed practice at graduate level to help them to have an impact on mathematical outcomes for all children. This could be achieved by appropriate continuing professional development.

130. 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.

131. Alongside this, continued priority needs to be given to strengthening the non-graduate early years workforce, who continue to make up the majority of staff. All practitioners 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 as outlined in the previous section on effective mathematical pedagogy. For this reason, priority should continue to be given to raising their skills and qualifications

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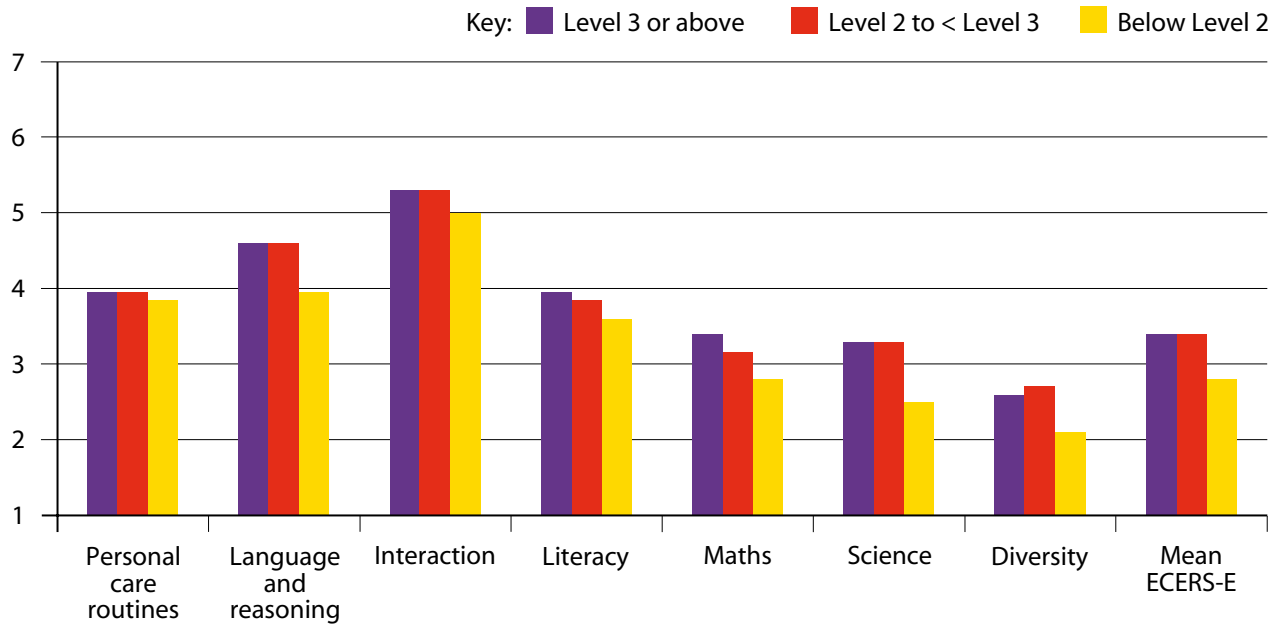


as well as the much needed focus on increasing the number of graduates. The expectation set out in the DCSF publication *Building Brighter Futures* to raise the minimum level of qualification in the early years workforce to level 3, is warmly welcomed.

Recommendation 6: *That DCSF continues to increase the proportion of graduate practitioners in early years settings recognising the respective contributions of the Qualified Teacher (QTS) and the Graduate Early Years Practitioner (graduate EYP). The review supports the goals which are currently in place.*

Continuing professional development in early years

132. As with the considerations of the primary sector in the previous chapter, continuing professional development should be accorded a high priority for early years practitioners. In this, there is no reason to distinguish between EYFS and primary, so the same general CPD 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.

133. 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. These issues should be included in the CPD materials recommended above.

134. 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 mathematical experience in all settings continues to be raised.

Transition

135. The important question of the **transition** from (a) an early years setting to school, and (b) the EYFS to Key Stage 1 (often through a reception class in school) directly affects the young learner in mathematics. Successful transition depends on the setting ensuring 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. During both of the transition phases identified above, communication between families and settings/school should be maintained so that parents understand and can be involved with their children's mathematical learning.

136. 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. Familiar approaches to children's mathematical education should be maintained in Year 1, and Year 1 teachers should be encouraged to increase opportunities for active, independent learning and learning through play, as in the EYFS, to ensure a continuation of positive attitudes to mathematics. Mathematical experiences should be threaded across the different areas of learning, in role-play, construction, and in indoor and outdoor learning. Children's understanding should be developed using practical resources and should make links with other learning so that mathematics is meaningful and relevant.

137. Regardless of a child's age on entry, the ratio of adults to children is another factor that may immediately affect their 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 move into a reception class, the minimum statutory ratio decreases.

138. 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 and to make sure each child continues to be treated as an individual. The progress of children's mathematical learning could be better maintained if a further suitably qualified adult were present to help the QTS teacher in the reception class. Indeed, many schools *already* provide an additional adult to help support each child personally to take the next steps in their mathematical learning. Such as a decision, however, should rest with the head teacher (and of course their governing body) who, in turn, have the ultimate discretion over how to allocate their resources to meet the schools' priorities.

139. One final important matter on transition to Key Stage 1 involves the use of the Foundation Stage Profile (FSP). 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.

140. It is essential that the FSP is analysed at scale point level, rather than simply looking at total scores. Relatively few children attain point 8, '*uses developing mathematical ideas and methods to solve practical problems*', in any of the three mathematical assessment scales. Where schools identify such common factors, measures can and should be put in place to strengthen that aspect of their provision.

141. FSP data and the knowledge of parents and all staff should be used to ensure children who need additional help in Year 1 are identified and supported. 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.

Chapter 4: 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 will be considered in the following sections:

Contributory factors to under-attainment in primary schools

The background to intervention

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

The essential characteristics of intervention:

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

The logistics and costs of intervention

Final conclusions

The following principal recommendations are made:

> *Recommendation 7: Before any intervention programme is implemented, it is important that the child is committed to it and that the parents or carers are involved and understand the nature of the programme. These issues, and the question of the integration of intervention teaching and classroom teaching, should be considered in the development phase of Every Child Counts.*

Recommendation 8: Intervention

The programme for intensive wave 3 intervention in 'Every Child Counts' should be based on the following characteristics:

(i) It should be led by a qualified teacher and should generally involve one child

(ii) However, the development phase of Every Child Counts should give adequate attention to assessing the benefits of small group working, particularly in pairs

(iii) In assessing the child for intervention, the teacher with direct contact with the child must take the lead in shaping the decision to intervene; the use of video techniques in this and in training should be investigated further

(iv) Appropriate diagnostic tools should be developed to assist in assessment and in measuring progress on exit from intervention

(v) Intervention in mathematics should be complete by the end of Key Stage 1; where a child needs intervention in both literacy and numeracy, both must be given equal priority over the course of Key Stage 1

(vi) A wide range of multi-sensory resources should be available to enable the child and the intervention specialist to select those appropriate to the specific circumstances

(vii) CPD programmes should be developed for both the intervention specialist and the LA intervention teacher leader

(viii) Consideration should be given to combining the roles of intervention specialist and Mathematics Specialist, depending on the size and circumstances of the school

(ix) Less intensive wave 3 and wave 2 interventions could be led by appropriately trained Teaching Assistants; consideration should be given to the training required and the use of interventions, with a robust evidence base of impact on learning and progress

(x) A longitudinal study should be commissioned to assess the long term benefits of intervention both at Key Stage 2 and, eventually, at GCSE level

Under-attainment in mathematics in primary schools – contributory factors

142. Assessment data in mathematics shows that, despite the great progress made since the introduction of the National Numeracy Strategy (NNS), 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[24] 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.

143. 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**

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

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

144. Despite the excellent teaching that was observed in many of the review panel's visits, the critical importance of measures that will lead to further long-term improvement in the quality of all teaching in our primary schools must be stressed yet again. The significance of 'quality first teaching' is emphasised throughout this report and it should always remain an ambition that improvements to this will reduce the numbers of children struggling with mathematics.

145. It is nevertheless almost certain that whatever the success of a renewed emphasis on teaching quality, there will in all probability remain a finite percentage of young children who find mathematics intimidating and unfathomable. However, **it is not acceptable** that this situation should continue unchallenged – this chapter therefore deals with programmes aimed specifically at these under-attaining children.

146. Perhaps it is appropriate first of all to ask: are there specific and intrinsic difficulties in learning mathematics for all children? The panel is not, however, persuaded by the familiar assertion that somehow mathematics 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 could the review find any evidence from international comparisons that mathematics presents unique problems distinct from other subjects; indeed the relative prowess of children in other countries in mathematics strongly suggests otherwise.

147. Social factors clearly play a role, and 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. Even more seriously, there can be little doubt that economic factors and social deprivation contribute to learning difficulties in all subjects, including mathematics. Given that 15–20 per cent of adults do not have basic functional numeracy skills, many parents will be unable to support their child's learning – measures to address this are considered in Chapter 6.

148. Finally, before beginning to address what might be done about this problem, there is an acknowledgement of a growing body of opinion which cites evidence for a clinical condition, analogous to dyslexia, which may seriously impede young learners in mathematics. 'Dyscalculia', as this condition has been named,[25] is the subject of cognitive research using sophisticated clinical investigative tools such as magnetic resonance imaging (MRI).

149. The Department for Children, Schools and Families provides interim guidance on dyscalculia for parents and teachers,[26] while research continues into the origin of the condition, its identification and the screening techniques. To date, the evidence is not as comprehensive as that for dyslexia and reading difficulties, but it seems likely that the analogous condition exists in the symbolism for mathematics. Here, it is important to distinguish between numbers and arithmetic, and other branches of mathematics, such as geometry. It is possible to be an intrinsically good mathematician but with an inability to perform simple calculations. Clearly there could be far-reaching implications for teaching mathematics to the affected group, and it is important to maintain an open mind on the possible outcomes of this research. Certainly the measures proposed in this chapter to address under-attainment must take into account future developments in this field.

The background to intervention

150. 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 use 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 a number of other countries (Dowker, 2005).

151. 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 often individual remedial teaching.

152. 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 – wave 3 individual support. Consideration was also given to the relationship between wave 2 and 3 interventions with wave 1 provision.

153. 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 any specific products or services*.

154. 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.

155. The intervention programmes considered specifically include:

- Numeracy Recovery
- Mathematics Recovery
- Catch Up Numeracy
- Numicon and multi-sensory techniques (though it should be noted that Numicon is more often used as a wave 1 whole-classroom resource, rather than for wave 3 intervention)
- Making Maths Make Sense
- Talking Maths
- RM Maths
- Maths Extra
- other adaptations of published techniques.

156. 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.

157. It should also be noted that by no means all of these programmes 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 its recommendations.

Every Child Counts

158. The review 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.

159. Every Child Counts has twin aims – wave 3 intensive intervention for around five per cent of children and less intensive interventions for the next five to 10 per cent of lower-attaining learners. It should be noted that Every Child Counts is not aimed at the five per cent of lowest-attaining children in *each and every school*, but rather it is targeted across the five per cent of under-attaining pupils *nationally*. Further, it is proposed that 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.

160. The ECC Development Group – which comprise Every Child a Chance Trust, the Primary National Strategy, Edgehill University and the DCSF – is currently engaged in a research phase in a number of local authorities. This research phase will be followed by a two year development phase, commencing in September 2008 and involving increasing numbers of schools and local authorities, leading up to a full launch of a national programme in 2010/11.

161. The research phase began in January 2008 in five local authorities – 10 schools in each – to trial existing primary mathematics intervention programmes. Kent and Southwark local authorities implemented 'Numeracy Recovery' in their schools, Birmingham and Middlesbrough implemented 'Mathematics Recovery', and Norfolk implemented a multi-sensory approach including the use of the 'Numicon' programme. Each local authority was provided with training and support from another authority already using the relevant intervention programme. The purpose of this research phase was to identify issues involved in extending existing intervention programmes to new local authority areas; to draw out the essential features the national programme should incorporate to ensure success; to find out the impact of existing programmes on attainment in new local authorities; and to investigate the logistical issues that local authorities and schools must consider when implementing an intervention programme.

162. This research phase will run until July 2008, so the preliminary findings available to this review derive only from early experiences over the first eight weeks of the programme. The emerging picture, taken from the preliminary research report of the ECC Development Group, highlights the following:

- *'Intervention was more successful when carried out by a qualified teacher with secure mathematics who assessed the child's learning needs accurately and used resources and activities flexibly.*
- *one-to-one intervention support was felt by the teachers and LAs to be the most effective approach; however, group work was also perceived to have some benefits, but only when it had specific goals and was used alongside one-to-one teaching.*
- *Schools found ways of ensuring children did not miss the same lesson by timetabling withdrawal in different ways.*
- *Liaison between the intervention support teacher and the class teacher is vital in ensuring that the child's learning is coordinated and intervention is effective and can be sustained beyond the period of support.*
- *Use of common teaching and learning resources during the daily mathematics lessons and intervention sessions enhanced coherence of mathematics learning for children; training and support in the use of the equipment and approaches concerned needs to involve a whole-school approach to build these into quality first teaching for all children.*
- *Emerging evidence indicated that children gain confidence and play a more active part in their daily mathematics and other lessons, following the intervention work.*
- *Many schools sought to secure the engagement of parents with the programme in different ways; while there was some evidence of success schools found this challenging and would welcome guidance and ideas on how to sustain involvement.*
- *With appropriate guidance, schools did not find it difficult to select appropriate children for intervention; teacher assessment and discussions with the class teachers in combination with test data all play a crucial role in this selection process, but accuracy of teacher assessment is paramount.'*

It should be noted that these qualitative findings are in advance of the more quantitative analysis which will follow prior to the commencement of the development phase in September 2008.

163. 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:

- reduce the numbers of pupils requiring intervention in Key Stage 2 and Key Stage 3, and
- increase the numbers gaining grade C or above at GCSE at age 16.

It is a firm recommendation of this review that 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.

Intervention – a way forward

164. On the basis of the evidence submitted, and following the panel's 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. Where available, findings from the Every Child Counts research phase are also included. 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 objective 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.

The essential characteristics of intervention

Assessment

165. Before any intervention, it is essential that the children in need of help are 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, the judgement of the teacher should be relied on. It has been a central tenet throughout this review that teachers 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 who has direct contact with the child must take the lead in shaping any decision to intervene.

166. It was noted in the interim report of this review that under-attainment in mathematics is sometimes apparent early, in reception class or Year 1. It is detectable in the Foundation Stage Profile (FSP) where, if 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. It was also noted that there is currently no national standardised assessment tool for Year 1. However, this review continues to stress that it is important to maintain a light touch when it comes to assessing the very young, and *none of its recommendations are intended to encourage any major extension to the present assessment regime*.

167. In selecting children for intervention, the ECC Development Group's research report notes that: *'In the area of diagnostic assessment, local authorities and schools report that the two-week 'RESK' in-depth assessment/building-on-strengths procedure in Numeracy Recovery was very useful and comprehensive, as was the assessment that forms the basis of Maths Recovery.'* They further comment that: *'to ensure continuity between a child's learning in and out of class, any diagnostic assessment used in intervention must align with the language the class teacher will use to assess children's progress and in their planning."*

168. In the case of Mathematics Recovery (MR), the panel were 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. The research schools using this process also reported very positive feedback on the usefulness of this feature. It is important to stress that these 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 and which also proves invaluable in the training programme for MR intervention specialists. This review recommends that the use of video techniques should be explored further, and the review also comments below on the use of video in CPD for intervention specialists.

Timing

169. As asserted above, weakness in the understanding of mathematics becomes apparent quite early in a child's education, and there is good supporting evidence for this position. In this matter, a 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?

170. This question is posed 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. Indeed, it is clear from international comparisons that in this country we are prone to accelerate steps in our educational processes to ever earlier ages, contrary to practice elsewhere – notably, for example, in Finland and Japan. Nevertheless, in the Every Child Counts research phase, only one local authority has raised the possibility of varying the timing for intervention.

171. Overall, 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 – this view is shared by the ECC Development Group. It is a firm recommendation of this review that intervention in mathematics should be completed by the end of Key Stage 1.

172. This stance on the timing of intervention would be strengthened 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.

173. Further, the increasingly widescale introduction of intensive reading support intervention into schools means that Year 1 children who have been identified as non-readers receive this support. This incorporates a significant focus on developing generic 'learning to learn' skills which, for children requiring significant intervention support for both literacy and mathematics, provides a useful precursor to mathematics intervention.

174. Therefore, introducing the Every Child Counts intensive support programme into Year 1 would place additional pressure on Year 1 teachers and, potentially, on children. Providing this intensive support in Year 2 is timely, practical and likely to have maximum impact on the children's learning and progress.

175. Compartmentalising 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 (as is considered below). It is also likely that opportunities to benefit from the synergy between mathematics and language may be lost in this way – this review has stressed elsewhere that the importance of *talking* about mathematics in the classroom is an integral part of all waves of provision.

176. Finally, financial considerations may inevitably influence the prioritisation of intervention. In one school visited, it was clear 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 overall expenditure on intervention, both literacy and mathematics must be given equal priority over the course of Key Stage 1.

Duration

177. 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 amount 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 can an intervention be deemed to have accomplished its objective? The panel would argue that this should not simply be construed in terms of achieving some arbitrary assessment 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.

Qualitative feedback from the ECC Development Group's research paper suggests that *'12 weeks of one-to-one intervention was probably "about right", but there should be some flexibility around this; one LA reported that teachers could identify a small number of children who would benefit from a longer period.'* The model assumed by this review in the financial estimates that follow is therefore based on a single term's intervention per child, with some flexibility for teacher judgement. The question of the number of children per intervention session is considered later in this chapter.

Withdrawal from, and integration with, classroom teaching

178. In the interim report of this review, concern was expressed about the effects of repeated withdrawal from class of the child selected for intervention. Given that the schemes considered often involve an intervention session daily (or at least for three days a week), it was noted that the effect of repeated absence from the regular class is a factor that 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.

179. In this regard, the review has been reassured by the early reports from the ECC Development Group's research phase:

> *'We are conscious of both the benefits and risks involved in any form of withdrawal teaching and have explored in our research ways in which potential disadvantages can be minimised. Our research schools have found ways of making sure that children do not miss out on essential classroom learning. In one LA, for example, teachers were careful that supported pupils did not always miss the same lessons when they were withdrawn. Another authority taught their children in the afternoon, thus ensuring they avoided missing the morning whole-class mathematics lesson.'*

180. The need for coherence between intervention strategies and whole-class activities was stressed to this review by teachers during panel visits to observe Mathematics Recovery interventions. They also pointed out that the pedagogies employed in successful interventions can help and inform the way mathematics is taught throughout the school. This, in turn, reinforces the message that the teachers involved in intervention and in whole-class teaching must therefore share a common understanding. As the ECC Development Group's research report observes:

> *'Some of our research authorities have shown it is possible to ensure very close links between what happens in the intervention sessions and what happens in class. In one LA, for example, intervention teachers were encouraged to liaise closely with class teachers and incorporate objectives covered in the daily maths lesson into one-to-one sessions where applicable. The same applied for school curricular targets.'*

181. The review acknowledges the management and leadership challenges that schools face when organising an intervention programme. However, it is important for head teachers to take account of the following practical suggestions which came out in the ECC Development Group's findings:

- *'Time should be set aside to develop strong and effective liaison with the Y2 teacher(s) throughout the year through pupil progress meetings and, in order to secure effective transition, with the Y1 and 3 teachers in the summer term.*
- *Intervention teachers should invite the maths subject leader and the Y2 teacher(s) to observe a teaching session and offer to support individual or whole staff continuing professional development (e.g. on using mathematical models and images, assessment or dialogue) when appropriate.*
- *Assessment information must be shared with the class teacher and used formatively to inform planning for effective inclusion of the target pupils in the daily mathematics lesson.*
- *This process should be ongoing and significant progress should be reported to the class teacher.'*

Group size

182. 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 review visits, however, 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. It is therefore the opinion of this review that the picture is not yet clear-cut with regards group size.

183. Ann Dowker's authoritative research review[27] 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.

184. Against such a background, the preliminary findings of the Every Child Counts research phase are of interest, and highlight both the advantages and disadvantages identified by Dowker:

> *'Group work was demonstrated to have some benefits but only when it had specific goals and was used alongside one-to-one teaching. Some teachers found that whilst working in groups children were developing personal and social skills, such as being confident to speak up when amongst their peers, skills which were needed for them to return successfully into classroom teaching.'*

185. However, echoing Dowker, the findings then noted that:

> *'Children who were targeted for the intervention support often struggled to contribute when in a class setting. Consequently they found it difficult to adjust to the small group setting and continued to use avoidance tactics when they are taught in a small group. Teachers felt that overcoming these barriers to learning deflected from the intensive support and teaching these children needed. Some teachers overcame this by working with children initially in pairs and then moving them on to larger groups.'*

Overall, the Every Child Counts research report concludes that the schools involved felt that *'one-to-one was considered the most effective approach'*. However, this review would question the basis on which this conclusion is reached at this early stage and was reassured by the ECC Development Group that it intends to undertake further investigations during its next phase of work. In particular, the review would urge that further careful consideration be given to intervention in carefully chosen pairs, but at the same time, this should not preclude working in groups of three children. This would perhaps represent an attractive compromise between the one-to-one schemes and those in larger groups with the attendant risks of a child 'hiding'.

The teacher

186. 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 it is immediately clear that 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 using a highly qualified teacher. These include using 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 the review to miss one very fundamental point.

187. 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 QTS level. Of course, they may well be assisted in certain respects by teaching assistants and others, and the need for greater availability of multi-sensory tools and software support is reviewed below. However, these are the adjuncts to high-quality teaching and not a substitute for it.

188. In the Every Child Counts research phase, all local authorities appointed qualified teachers to undertake intervention in schools; however, it would appear sensible that during the development phase, there should be an investigation into the role of teaching assistants, which would provide suggestions on how they can assist qualified teachers with intervention work.

189. Teaching assistant-led interventions (as opposed to teaching assistants in support roles) that have been observed by this review appeared less effective than those led by a qualified teacher, although it is recognised that this is at best anecdotal evidence. But later in this report, the review identifies what it considers to be the best use of expensive human resources: that the qualified teacher should lead intensive wave 3 intervention, while the teaching assistant should (where available) lead wave 2 and possibly less intensive wave 3 interventions. Specific recommendations are made on this below.

Continuing professional development

190. 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 programmes that were reviewed have associated training packages – for which the developers of the programmes are to be congratulated – there is as yet only a very small pool of experienced intervention specialists at any level. Moreover, the panel are unaware of any in-school intervention experience during ITT that trainee teachers 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.

191. 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 – as such, the input from Edgehill University will be crucial to the development of the Every Child Counts programme. But the involvement of all providers will be needed to ensure the availability of the CPD programmes required in every school.

192. In discussions during visits, it was clear to the review, for example in Hackney, Hampshire and Liverpool, that local authority leadership is of critical importance. This conclusion is reinforced by the Every Child Counts findings: *'Our research showed that where there was successful management of the intervention programme by the LA, there was an established group responsible for the strategic leadership and management of the programme across its schools.'*

193. The requirements for successful CPD programmes to be established before the launch of an intervention programme therefore echo the two-phase approach recommended elsewhere in this review, to both 'refresh' the local authority consultant community (in this case the intervention teacher leader) and upskill the teaching workforce itself (in this case, the teachers selected to train as intervention specialists). The Every Child Counts research found a clear benefit from training local authority teacher leaders as well as a central focus on training for the intervention teachers themselves. This review supports that conclusion.

Resources and tools

194. 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.

195. The ECC Development Group's research report highlights this need:

> *'Our research provided robust feedback of the importance of an appropriate learning environment for intervention – a dedicated, well resourced teaching space. Local authorities and schools found it useful to be provided with suggested resources and noted that it was helpful to include a wide range of types of resource so that children can work with those that appeal to them. These should include resources for kinaesthetic activities.'*

196. In its visits, the panel closely observed the role of technology and resources. Interactive whiteboards are of course ubiquitous today following extensive Government investment, but 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 of these resources are also applicable in early years settings as well as in primary schools.

197. Essentially, many of these items do not necessarily constitute intervention pedagogies in their own right, but rather tools that could usefully feature in all interventions, particularly at Key Stage 1. Many of them are commercial products – the panel is therefore aware of the financial aspects of any recommendation, and does not endorse any specific product. Nevertheless, it would be regrettable if such clear enhancements to the learning process for those struggling with

mathematics were not readily available in all schools.

198. Nor is there necessarily a unique suite of resources to which all children will respond. Not for the first time, this review stresses that there is no single solution to the needs of under-attaining children. Again, the Every Child Counts report helpfully notes that:

> *'We are clear that resources should not drive the learning, and researchers noted as a weakness some instances of teaching that was driven by a set list of activities using a particular resource, rather than by an understanding of what the child needed to learn and how the resource might or might not be used to support that learning. Training for teachers is crucial here. Our view is that resources such as Numicon can play a very important part in the learning of some children who find linear models of the number system difficult to internalise, but that there cannot be a one-size-fits-all in the use of resources. Different children will benefit from different resources, at different stages in their learning.'*

This review stresses the importance of providing intervention teachers who have insight, through their training, into what resources might help with key areas of difficulty.

Parents and carers

199. 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 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 teachers. 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.

200. So far in the Every Child Counts research phase, not all local authorities involved have focused on parents and carers. But for those who have done so, there is clear anecdotal evidence of success:

> *'Some schools used locally developed leaflets to inform parents about the purpose and expected outcomes of the programme. Schools frequently sought to secure the engagement of parents with the programme by inviting them to meetings with the school's intervention teacher and in a few schools parents attended intervention sessions to observe the teacher working with their child. Some schools used home-school contact books to support home-school links. Teachers often sent home mathematics games activities and resources to support the parent and child working together to develop the child's learning. One parent reported noticing their child reading door numbers and bus numbers.'*

201. Bearing in mind that this programme will be concerned with very young learners, it is equally important that the children themselves receive a positive explanation as to why they are to take part in the programme. In the interventions that were observed by this review, 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.

Recommendation 7: Before any intervention programme is implemented, it is important that the child is committed to it and that the parents or carers are involved and understand the nature of the programme. These issues, and the question of the integration of intervention teaching and classroom teaching, should be considered in the development phase of Every Child Counts.

The logistics and costs of intervention

202. In conclusion, it is relevant to enquire about the practicality of delivery and 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 so, 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 hoped 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, which will be published shortly. 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. Indeed, for every pound spent on early intervention for the lowest-attaining pupils, something in the order of £12 will be saved on the long-term costs to the public purse of SEN, truancy and behaviour support, unemployment, poor health and crime (Every Child a Chance Trust, 2008)[28]. A corresponding study of the effects of literacy intervention suggests that the economic benefits to society vastly outweigh the costs of the programme.

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

- the cohort size (currently estimated at around 30,000–35,000)
- employment costs of the intervention specialist
- number of interventions per week / per year
- the number of children each practitioner works with
- 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 was identified in the interim report for the total *national* costs of the Every Child Counts programme of between £15 and £72 million a year. The total population of intervention specialists in this model, ideally, is approximately 1,500.

204. For the purposes of *illustrating* a possible financial model, it is assumed that the under-attaining children are more or less uniformly distributed across all schools, and no allowance is made for overcapacity. However, the National Strategies and local authorities are able to identify which schools are attended by under-attaining

children and with the benefit of this data, it is important to recognise that, in reality, there would be an unequal distribution between schools. As such, it will be important to ensure that the targeting of the intervention specialists is matched to local need. This then raises the question of the likely degree of built-in overcapacity and flexibility needed in the workforce of intervention specialists.

205. When an attempt is made to match the hypothetical population of intervention specialists (ca 1,500) to the total number of primary schools (17,361) and the under-attaining children (ca 30,000), then on average, each intervention specialist will be required to teach pupils in up to 10 schools. Put another way, each school will, on average, have between one and 10 under-attaining children, depending on its size. This would present serious logistical challenges.

206. This problem is exacerbated in the case of small and rural schools. In the discussion on the Mathematics Specialist, the impracticality of providing one specialist in every small and rural school was highlighted, and a sharing model was proposed. It would seem inevitable that a similar model would be necessary for smaller schools in the case of intervention specialists. The suggestion made in Chapter 2 was that in these schools, the Mathematics Specialist also assumes responsibility for intervention. If a 'small rural school' is arbitrarily defined as having up to 200 pupils, then in the 7,745 smallest schools just under 500 of the cohort of proposed Mathematics Specialists could assume this joint role on a shared basis between several schools. Alternatively, *all* Mathematics Specialists in such schools *could* assume responsibility for intervention. The latter proposition would appear to be more practical, but with clear implications for CPD.

207. However, this does not fully satisfy the need to match intervention specialists with under-attaining children in an efficient and cost-effective manner. Even in the 9,800 larger schools (with more than 200 children), a 'critical mass' of children (approximately 20 per school) requiring intervention is not guaranteed, and some form of 'pooling' of resources between schools appears to be essential, except in the very largest and most problematic schools.

208. Regarding these logistical issues, the following approach would seem a logical starting point for further, more detailed consideration, allowing at all times for flexibility in local decision making:

- In schools with fewer than 200 pupils the roles of Mathematics Specialist and intervention specialist should be combined.
- In larger schools, with more than 200 pupils, there is a need for dedicated intervention specialists, shared, in all but the largest schools, between a small group of schools.
- The local authority concerned must clearly take the lead in the complex coordination of intervention resources and teachers.
- Head teachers, once again, have a critical role in planning and management for the deployment of intervention specialists.

209. What, then, might be the implications for programme cost when the factors above are taken into account? Here, the review sees some obvious trade-offs. An immediately attractive prospect for the 'small and rural' cohort is that the CPD identified and costed in Chapter 2 for the Mathematics Specialist could include training for intervention. The head teacher in this situation may, however, be required to exercise judgement in the matter of increased non-contact time. On balance, this measure would seem to be highly cost-beneficial, with only modest marginal costs over and above those included for the Mathematics Specialist.

210. For the larger schools, however, dedicated intervention specialists would be required, with intervention-specific CPD, although in all but the largest schools these teachers could be shared. This cohort would number approximately 1,000 teachers, depending on sharing arrangements. It might therefore be anticipated that if this approach were to be adopted, the total costs estimated previously would have an upper bound of under £50 million, as opposed to the original figure of £72 million. It should also be noted that this would provide for QTS-led intervention for all intensive requirements.

211. 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 one-to-one sessions than the seven assumed above, without reducing the quality of the teaching. Clearly, costs are linearly proportional to this parameter, as is illustrated below – for the purposes of the model it is assumed that each intervention specialist can lead 25 children (or groups) a year, as opposed to 20. However, when considering the question of 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.

212. Taking all these factors into account and assuming that all intensive interventions will be led by a teacher with QTS, the following range of financial outcomes results (annual costs in £ millions):

Ratio	QTS with 20 pupils	'Small and rural' effect	QTS with 25 pupils	'Small and rural' effect
1:1	72	48	58	39
1:2	36	24	29	20
1:3	24	16	19	13

213. The cost per child per year would therefore lie within a range of around £400 to £2,000, depending on the approach taken. Early indications from more detailed estimates currently under evaluation by the ECC Development Group put the cost per child (local authority and in-school costs) at closer to £2,500.

214. 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 at 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. It is anticipated that this is an area in which teaching assistants will have a valuable role to play. Their CPD has not been covered in this report, but will clearly require careful thought and planning.

Conclusions and recommendations

215. Summarising the above, the review makes the following recommendation about the essential features of a successful intervention scheme. The review also notes that both Numeracy Recovery and Mathematics Recovery exhibit many of these features.

Recommendation 8: Intervention

The programme for intensive wave 3 intervention in 'Every Child Counts' should be based on the following characteristics:

(i) It should be led by a qualified teacher and should generally involve one child

(ii) However, the development phase of Every Child Counts should give adequate attention to assessing the benefits of small group working, particularly in pairs

(iii) In assessing the child for intervention, the teacher with direct contact with the child must take the lead in shaping the decision to intervene; the use of video techniques in this and in training should be investigated further

(iv) Appropriate diagnostic tools should be developed to assist in assessment and in measuring progress on exit from intervention

(v) Intervention in mathematics should be complete by the end of Key Stage 1; where a child needs intervention in both literacy and numeracy, both must be given equal priority over the course of Key Stage 1

(vi) A wide range of multi-sensory resources should be available to enable the child and the intervention specialist to select those appropriate to the specific circumstances

(vii) CPD programmes should be developed for both the intervention specialist and the LA intervention teacher leader

(viii) Consideration should be given to combining the roles of intervention specialist and Mathematics Specialist, depending on the size and circumstances of the school

(ix) Less intensive wave 3 and wave 2 interventions could be led by appropriately trained Teaching Assistants; consideration should be given to the training required and the use of interventions, with a robust evidence base of impact on learning and progress

(x) A longitudinal study should be commissioned to assess the long term benefits of intervention both at Key Stage 2 and, eventually, at GCSE level

Chapter 5: 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). It also considers further views and evidence submitted since the publication of the interim report about the transition from the EYFS coverage of mathematics to mathematics in the primary curriculum. Curriculum and pedagogy are treated together in this chapter as they are intimately interconnected. The following topics are addressed through the sections:

The primary mathematics curriculum

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

Transition from EYFS to Key Stage 1

This section examines transition and continuity in learning from the EYFS to KS1.

Features of effective pedagogy in primary mathematics

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 conclusion, the review recommends that:

Recommendation 9: 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 mathematical or other aspects of the curriculum need amendment.

Recommendation 10: This review recommends a renewed focus by practitioners on 'oral and mental mathematics'. Providers of ITT and CPD should ensure that this practice receives careful attention, both during ITT and in CPD programmes.

The primary mathematics curriculum

216. Irrespective of the age and 'stage' of a child, a high-quality curriculum and excellent teaching are twin conditions for successful learning. The challenge for settings and schools is to secure these two complementary attributes and to sustain them – that is to say, to establish continuity and progression in the teaching and learning of mathematics.

217. As with other subjects, the curriculum for mathematics is a set of decisions that determines the knowledge, skills and understanding deemed to be essential for *all* children. It is widely agreed that our mathematics curriculum must measure up to 'world class' standards as an entitlement for all children. Moreover, no matter how good the curriculum, it cannot benefit children in the absence of excellent teaching, which enables them to make as much progress as possible in the subject throughout the primary phase and thereafter.

218. Any proposals for curricular (and pedagogical) changes that may be necessary in primary mathematics should start by considering what is of proven worth in the content and teaching of the existing curriculum and build on it, rather than assuming that an entire overhaul is needed.

219. While it might be helpful to redistribute some aspects of mathematics content between Key Stages, as stated in the interim report, there is little to suggest that the National Curriculum Programmes of Study for mathematics for Key Stage 1 and Key Stage 2 need radical changes of content. In other words, the existing Programmes of Study are sufficiently well structured for schools to develop most children's mathematical knowledge, skills and understanding flexibly and incrementally, at a pace that takes account of their different rates of learning. Further, the review panel believe that this is a familiar and valid structure for lesson planning, as well as for achieving continuity and progression in teaching and learning.

220. Within the primary curriculum there is a clear and logical pattern, which builds on the EYFS, through number and counting to more complex and abstract concepts in mathematics. This approach has much to offer and, where it is implemented well, builds children's confidence so that they feel *'at home with number'*. However, some schools have developed schemes and use programmes that first stress the *concrete*, *abstract* and *algebraic* aspects of mathematics, and then apply them to understanding number and calculation. All the programmes of this nature that were observed to be successful invariably gave the children a considerable amount of practical experience with structured materials. For example, 'Cuisenaire' resources were used very effectively in one school visited by the panel, where the defining criteria for success were undoubtedly the enthusiasm and expertise of the head teacher and the staff for this approach.

221. In addition, it is important to teach children about the precision needed to learn mathematics. This includes the need to record, draw diagrams, and use with understanding images, graphs, tables and symbols. These aspects of teaching and learning are important and should be built around good teaching practice, that has a secure foundation of oral and mental skills to support it.

222. In all cases, parents rightly expect that their children should be well taught in what are traditionally regarded as the 'basic skills' of mathematics and number. It is important to reassure parents and the public at large that the primary curriculum as a whole, and the ways in which it is taught, will ensure that children are able to command facility with these basic skills by the end of Key Stage 2.

223. There are widespread concerns, which are discussed in more detail below, about important aspects of pedagogy. The foremost concern, drawn from Ofsted and Primary National Strategy (PNS) findings, is the need to strengthen teaching that challenges and enables children to use and apply mathematics (UAM) more often, and more effectively, than is presently the case in many schools. Ofsted evidence submitted to the review also shows that there is a lack of attention to these aspects of pedagogy in the Foundation Stage, despite the prominence of 'using and applying mathematics' in the EYFS areas of learning and experience (though it should be noted that the EYFS does not come into statutory force until September 2008).

224. A closely allied concern is that too little attention is paid to building good attitudes to mathematics. Clearly, if children's interests are not kindled through using and applying mathematics in interesting and engaging ways, and through learning across the full mathematics curriculum, they are unlikely to develop good attitudes to the subject.

225. Opportunities for children to engage with the cultural and historical story of both science and mathematics could have potential for building their interest and positive attitudes to mathematics. Comparatively minor amendments to include this in the primary curriculum could have an impact, and should be considered by the forthcoming Primary Curriculum Review.

Recommendation 9: 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 mathematical or other aspects of the curriculum need amendment.

Transition from EYFS to Key Stage 1

226. There are semantic differences between the way that mathematics is described and construed in the new EYFS framework and in the National Curriculum, which tend to make for discontinuity between the Foundation Stage and 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. In the Statutory Framework for the EYFS, mathematics is described as 'Problem Solving, Reasoning and Numeracy'. Seven of the 12 early learning goals for problem solving, reasoning and numeracy are about 'number'. The others relate to the ability to recognise patterns, use mathematical ideas to solve practical problems, and being able to describe shape, size and positions – all of which are also important parts of children's mathematical development. The concept of a curriculum is therefore replaced with areas of learning and development with entirely different connotations, which this review supports.

227. However, 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. In effect, having areas of learning and development for

young children, as opposed to a curriculum, simply makes it easier to think about age-appropriate content. There is then a need for a coherent approach overall to the progression from EYFS to Year 1, and it is essential that the momentum in learning in mathematics is maintained through this transition. This makes it all the more important that more attention is given to this question of continuity and that the forthcoming Primary Curriculum Review should address this.

228. One further point concerning continuity is worthy of note. There are deep pedagogical differences in the approaches to problem solving, reasoning and numeracy in the EYFS, and to mathematics in primary. Play-based learning is extensive in the former, and during the course of this review practitioners have often stressed the abrupt nature of the transition from this to a more formal approach in KS1, at a time when many children may not be ready. A case can be advanced for slightly more emphasis in Reception and Year 1 on play-based learning, with a focus on extending the use of more structured activity to prepare children for this transition. The review would wish to see attention given to this issue in the Primary Curriculum Review.

Features of effective pedagogy in primary mathematics

229. 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.

230. It is widely recognised that a teacher's own enthusiasm for, and knowledge of, mathematics, as well as their beliefs about teaching and learning, will impact on their classroom practice, regardless of the external constraints on curriculum and lesson design. The most often quoted review of research into this subject is A Thompson's work on 'Teachers' beliefs and conceptions: a synthesis of the research'. Other evidence supports this finding – for example, Jesse Wilkins' recent work[29] concluded that:

> *'Teachers with more positive attitudes toward mathematics were more likely to believe in the effectiveness of inquiry-based instruction and use it more frequently in their classroom. Teacher beliefs were found to have the strongest effect on teachers' practice.'*

231. In addition, Liping Ma's work looking at the difference between effective Chinese and American primary teachers concludes that a teacher's attitude towards mathematics and self-confidence in their own mathematical abilities are important factors in effective teaching. However, even following the implementation of the recommendations of this review in full, there will remain many non-specialists in schools with limited knowledge of mathematics. A critical task facing the Mathematics Specialist proposed in Chapter 2 will be to improve the practice and performance of other teachers and teaching assistants – and a robust pedagogy is essential for them to accomplish this.

232. Any meaningful discussion of pedagogy also needs to be based in a model of learning. The notes provided by the National Strategies about pedagogy do not do this explicitly, but implicitly appear to adopt a broadly constructivist view

(i.e. knowledge is constructed in an active process in the mind of the learner, not passively received from the environment), an approach the review supports.

233. In seeking to identify 'the most effective pedagogy', as set out in the remit from the Secretary of State, a starting point for the review is that effective pedagogical practice is not confined to any single approach. Rather, it stems from a principled selection from a wide repertoire of techniques and organisational arrangements designed to match teaching to the developing learner.

234. First and foremost, pedagogy must 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 a broader adoption of Assessment for Learning (AfL), as considered below. It must be truly interactive, giving children time, for example, to think, to question as well as answer, to discuss and to try out their own ideas and strategies. The 'tempo' observed in successful lessons during this review had been well judged to achieve these outcomes. Equally, the review panel have observed numerous examples of undue haste on the part of practitioners during their discussions with children – in some cases even delivering the answers to their own questions before the child has had time to formulate his or her thoughts. Related recent research on this issue in the context of Early Years by Iram Siraj-Blatchford and Laura Manni[31] noted the following:

> *'… it was found that 94.5% of all the questions asked by the early childhood staff were closed questions that required a recall of fact, experience or expected behaviour, decision between a limited selection of choices or no response at all. Only 5.5% were open ended questions, which provided for increased encouragement (to speculate and trial and error) and/or potential for sustained, shared thinking/talking.'*
>
> Further, in her conclusions she says:
>
> *'The 5.5% of open questions that we have identified compares poorly with the 9.9% of open questions used by Key Stage two teachers in the ORACLE primary school study (Galton et al. 1999[32]) (which is already disappointingly low). The research therefore shows a clear need for further training and emphasis on these skills.'*

235. In particular, during the course of visits, the review observed that in-class provision is sometimes not stretching enough for the gifted and talented pupils. This view is confirmed by Ofsted's evidence that has been submitted to this review. Part of the reason why in-class provision might not be stretching can be attributed to teachers' lack of knowledge of what might be possible and of the types of activities that would allow the most able to flourish, for instance open-ended investigative tasks. In discussion with Ofsted, it has become clear that many primary teachers lack confidence at this level of mathematics and are often unaware of the bigger picture and network of interrelationships. As such, the review believes that the Mathematics Specialist (described in Chapter 2) may have a role to play in the provision for gifted and talented pupils in their school. This would of course need to take account of the school's existing and wider provision, and would need coordination with the school's Gifted and Talented coordinator.

236. More generally, AfL seeks to establish an evidence base to assess all 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 child'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 3. More recently, "Assessing Pupils Progress'[33] (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 were published in the National Strategies' Primary Framework in January 2008. 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 Government with additional funding over the next three years. During a National College for School Leadership (NCSL) 'Hotseat period', following the publication of the interim report, it was interesting to note that a number of head teachers commented on the helpfulness of the APP and AfL materials.

237. The critical importance of engaging children in discussing mathematics is widely recognised. This, of course, includes learning and using mathematical language. Many practitioners and teachers have grasped this point and, for example, regard number as a building block of mathematics that should be used copiously in daily discourse with children. Talking mathematics should not be seen simply as a rehearsal in class of the vocabulary of mathematics, novel and important though that may be for the young learner. It should extend to high-quality discussion that develops children's logic, reasoning and deduction skills, and underpins all mathematical learning activity. The ultimate goal is to develop mathematical understanding – comprehension of mathematical ideas and applications. Excellent examples of such discussions were observed during visits, which serve to illustrate the influence of pedagogical expertise on children's learning. The implications for ITT and CPD for developing this expertise are profound, if obvious: the potential for material that helps develop such pedagogies for mathematical argumentation, topic selection, classroom discussion and leadership is clear and requires development. Video techniques and above all in-school mentoring by fellow teachers can play a vital role in developing related pedagogies.

238. The allocation of time and the 'pace' of lessons need to be flexible enough to allow for different kinds of interaction and activity (whole class, pairs, groups, individuals). For example, there should be scope for children to engage in extended problem-solving activities that extend across lessons to give children time to use their knowledge and explore the problem in full. In short, best practice in pedagogy is observed when the teacher exercises judgement regarding the implementation of the primary framework for mathematics.

239. The link between the curriculum and pedagogy is also critical, as is repeatedly stressed by this review. In particular, the curriculum content should be presented in ways that emphasise the connections between mathematical ideas. Mathematics has a broadly hierarchical structure, but not necessarily (in fact rarely) a linear one. The challenge in planning learning for children is to provide the interlinked 'bigger picture' as well as the detail, to enable children to recognise how their learning fits together rather than appearing to be piecemeal. However, the review has observed during its visits a tendency to compartmentalise the curriculum, and then to combine topics in a rather arbitrary way to construct two-week segments. This may suit class

planning, but it in no way reflects the optimum manner in which mathematical concepts should be introduced.

240. It must be more widely recognised that mathematics is a complex subject, and in some respects different from other subjects. It cannot be arbitrarily compartmentalised, nor can the time required for specific topics always be known in advance. Some excellent examples were observed by this review of teachers consulting 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. The obvious need is stressed for flexibility and for clear authority for such decisions to be placed with the classroom teacher. 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 adaptability in meeting nationally prescribed curriculum goals.

241. During the course of the review, a number of mathematics lessons that encouraged the use of mental mathematics in an interactive way were witnessed. This model of teaching was a cornerstone of the National Numeracy Strategy when it was introduced into schools. This is an important part of the mathematics pedagogy skill-set that teachers should possess – indeed, DCSF research in the report, *Keeping Up: Pupils who fall behind in KS2* 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 learning' and guided practices to address this.

Recommendation 10: This review recommends a renewed focus by practitioners on 'oral and mental mathematics'. Providers of ITT and CPD should ensure that this practice receives careful attention, both during ITT and in CPD programmes.

242. This recommendation has considerable implications for ITT and CPD. In order 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 than the extent of knowledge or competence is that the mathematics is understood *in sufficient 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 ratio, division, proportion 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.

243. As noted in a previous chapter, ITT cannot provide enough time for most student teachers to develop this depth of knowledge across the whole of the primary mathematics curriculum, alongside other equally vital issues such as classroom management and understanding children's learning. Understanding of this 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 and mathematical subject knowledge.

Future challenges

244. The National Curriculum Programmes of Study for mathematics are intimately interlinked with (i) the pedagogy and framework to promote it effectively, (ii) the education and training of practitioners, (iii) the need for evaluation and inspection of their and their schools' effectiveness, and (iv) the assessment of children's learning and progress. In an ideal world this linkage would optimise each child's progress through the primary phase and beyond. Indeed, much has been seen during this review to show that this can be the case in primary mathematics.

245. The organisation of teaching groups continues to generate considerable debate and contention. Primary school mathematics 'lessons' are generally taught to mixed-ability classes, with scope for teaching children as a whole class, in small groups, and for giving individual support to children who need it, be they 'gifted and talented', falling behind or progressing too slowly. Other arrangements include 'setting' by ability across more than one class, depending on the size of the school. All forms of grouping appear to have limitations as well as strengths, so it is important for teachers and schools to be aware of the opportunity costs of how they choose to group children.

246. Some schools, for example, are dedicated to 'setting' because they claim it is more manageable in allowing the size of sets to be adapted – say, to form smaller sets for children who need most help – and to match work more effectively to children's developing abilities. They often produce data on pupil performance to show the efficacy of this form of grouping. However, one risk inherent in setting for mathematics is that children may languish in lower sets and experience a restricted version of the curriculum.

247. That said, some form of differentiation almost certainly will be necessary given the range of ability in the typical primary class, but setting is only one of several options for differentiating work to match children's differing but developing abilities. Guided group work in mathematics, where teachers work with smaller groups of children within the class, offers an organisational approach where attention can be given to particular children who may require additional support or challenge to ensure they continue to progress in learning. Working with a group can provide assessment information that is more difficult to capture in the whole-class context; it provides an opportunity to discuss the mathematics in more detail with individuals in the group. The focused attention given to a group helps to inform future planning and teaching. It also gives children who are not active contributors in the whole class the opportunity to participate more directly, share their ideas and extend their learning within a small group of peers.

248. An explicit stance is not adopted on the question of setting by this review – except that it appears best to leave decisions on such matters in the hands of head teachers and practitioners and their principled judgements of what is best for their children. The problem is that forms of grouping can easily be misinterpreted as categories of children, rather than tailored provision designed to aid all children's progress. Good ITT and CPD should help teachers to recognise the difference, to be aware of the risks as well as the opportunities associated with different forms of grouping, and to make sure children's progress is furthered and not fettered by whatever form of grouping they choose.

249. 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. The very considerable support that the original Primary Frameworks brought to the classroom teacher is noted above; indeed, visits showed many classrooms in which these frameworks continue to form the bedrock of primary pedagogy. However, widespread concern has been expressed about the recent revision of the Primary Frameworks in Literacy and Mathematics, both with regard to the increased range of materials placed on the website and the complexity of the Interactive Planning Tool (IPT).

250. This calls into question the effectiveness of the revised Frameworks when compared with the preceding versions, and suggests that they should be reconsidered to achieve a more suitable, user-friendly form. In light of the fact that they are for the use of very busy practitioners, it is essential to ensure, for example, the easy navigability of the complex CD and web-enabled tools. IT-based approaches often run the risk of introducing a kaleidoscope of new information, which can excite and motivate skilled practitioners but is daunting for those who are far less skilled with such approaches. Once again, the importance of ITT and CPD in these aspects of pedagogy and practice has to be noted, although this review would again wish to stress the need for focus on the learning and teaching-related content in ITT and CPD as the top priority, rather than its means of delivery.

251. These views have been made clear in constructive discussions with the National Strategies. Indeed these issues are reflected in their own survey data. A process for improving the Primary Framework, based on these findings, is already underway and will be in place by the summer of 2009.

Chapter 6: 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, with a focus on their child's mathematical development. The following areas 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.

Current good 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.

Introduction

252. Parents are a child's first and most enduring educators, and their influence cannot be overestimated. Parents should be at the centre of any plan to improve children's outcomes, starting with the early years and continuing 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.

253. 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[35]. The 2006 document, *Every Parent Matters*,[36] 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[37]. Furthermore, most parents believe that responsibility for their children's education is

shared between parents and schools[38]. 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[39].

254. 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

255. 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*[40] (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

256. During the review a number of themes around parenting have emerged. On visits to early years settings and 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. It is important that practitioners are encouraged to work with parents to bring them up to date with the methods currently used to teach mathematics, so that parents can support their children effectively. A number of schools already run evening sessions for parents to help them with this. Others invite parents into school to work alongside their children. An outstanding example of this type of work is the Ocean Mathematics Project in Tower Hamlets (see the case study below).

257. Going further, teachers need to recognise the wealth of mathematical knowledge children pick up outside of the classroom, and help children to make links between 'in-school' and 'out-of-school' mathematics. For example, simple activities such as cooking at home with a child can support their mathematical development with tasks such as sharing out and cutting up food or weighing and measuring. Work at the University of Bristol (2007) on a project on home-school knowledge exchange activities promoted connections between the two with good effect. The evaluation of this work recommended that these types of activities should form an integral component of mathematics teaching in primary schools[41].

Parental involvement at the Deans Primary School

At the Deans Primary School in Swinton, staff firmly believe that family involvement in their children's education has helped to raise standards in their school and improve attitudes to learning. Initially, to help build the important bridges between home and school, Deans Primary School held a series of workshops for parents on how mathematical games and investigations could be used at home as well as how they taught the four mathematical operations. This was to help give confidence to parents who wanted to help their children but did not know how.

Every half term, each class receives an open-ended mathematics challenge or investigation as well as a target booklet of mathematics objectives. This includes suggestions of games and puzzles that could be played at home. The school has found that this helps the children's thinking skills and mathematics understanding as they are sharpened by using them in different situations with different people.

All classes set weekly mathematics homework activity that allows the children to reinforce the knowledge and understanding which had originally been introduced in the class.

Deans Primary School believes that the involvement of parents has helped the school to achieve the best KS2 SATs results in the country in 2007, with 93% attaining Level 5 in mathematics.

258. 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[42].

259. It has already been observed in this 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.

260. 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[43]. However, attitudinal and cultural change is not enough here; there are 6.8 million adults in England who struggle with numbers. There is clearly a link between parents with low-level skills and their children's under-attainment in mathematics – and a risk, therefore, of perpetuating a cycle of low achievement. The Government's renewed focus on numeracy in existing Family Learning Programmes is timely and welcomed in this regard.

261. Early years settings and 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 Sure Start 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.

Current good practice

262. The most successful educational settings are embracing these principles already. These settings are usually in a local authority that is committed to championing parenting work.

263. 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

264. We acknowledge the excellent work going on currently through government-funded projects including Bookstart, Early Learning Partnerships Project, Transition Information Sessions and Parent Support Advisers. One particular focus that has arisen during the consultation phase is a question

Ocean Mathematics Project

The Ocean Mathematics Project (OMP) has been developed over the last seven years in a deprived housing estate in East London. It has successfully managed to engage 'hard to reach' parents in their children's mathematical development, having a significant impact on attainment plus a wider impact on parents' skills and school-parent relationships.

The project seeks to change attitudes and practice in schools, among pupils and families, and in the wider community, to raise expectations and attainment. It aims to improve (i) parental confidence and participation, (ii) pupils' attitudes, behaviour and progress, and (iii) the work of schools, both in mathematics teaching and in school/community relations.

The project focuses on a number of key features:

Workshops – One workshop per term is delivered during school hours in schools. The workshops encourage parents and children to engage in practical and enjoyable mathematics activities together.

Homework – This is specially designed for parents and children to share. It is fun, accessible and challenging, and supports the learning that has gone on in school and encourages 'mathematical talk'.

Teachers – Teachers receive training in how to deliver workshops that will support parents to help their children.

Through its monitoring and evaluation, the Ocean Mathematics Project found that through regularly consulting key stakeholders, they have been able to make significant improvements. For example, they changed the workshop from a 'parent only model' to a 'parent and child model'. Staff at the Ocean Mathematics Project believe that the engagement of the head teacher is crucial, to allow for training time for teachers as well as to really 'sell' this to the parents.

Lissa Samuel, Head Teacher, Cayley Primary School said:

'The effect it has had on the children's attainment is significant. We were in our mid 30 per cent of children achieving level 4 and above when we started the Ocean Maths project and now we are in the 90 per cent bracket, and also a lot more children are attaining level 5 and above... from the point of view of involving parents, it has exceeded our expectations.'

on how mathematical activities could be included in the Bookstart project (which universally provides free books for all young children at three stages between six months and three years). This is an option the Government should explore in the future.

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[44] 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 their numeracy and literacy skills. 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

265. 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.

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 4 considered the issues concerning the need for intervention in Key Stage 1 for under-attaining children in mathematics. Most of the various intervention programmes, which are outlined briefly below, have been observed in practice by the review panel.

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 involves 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.

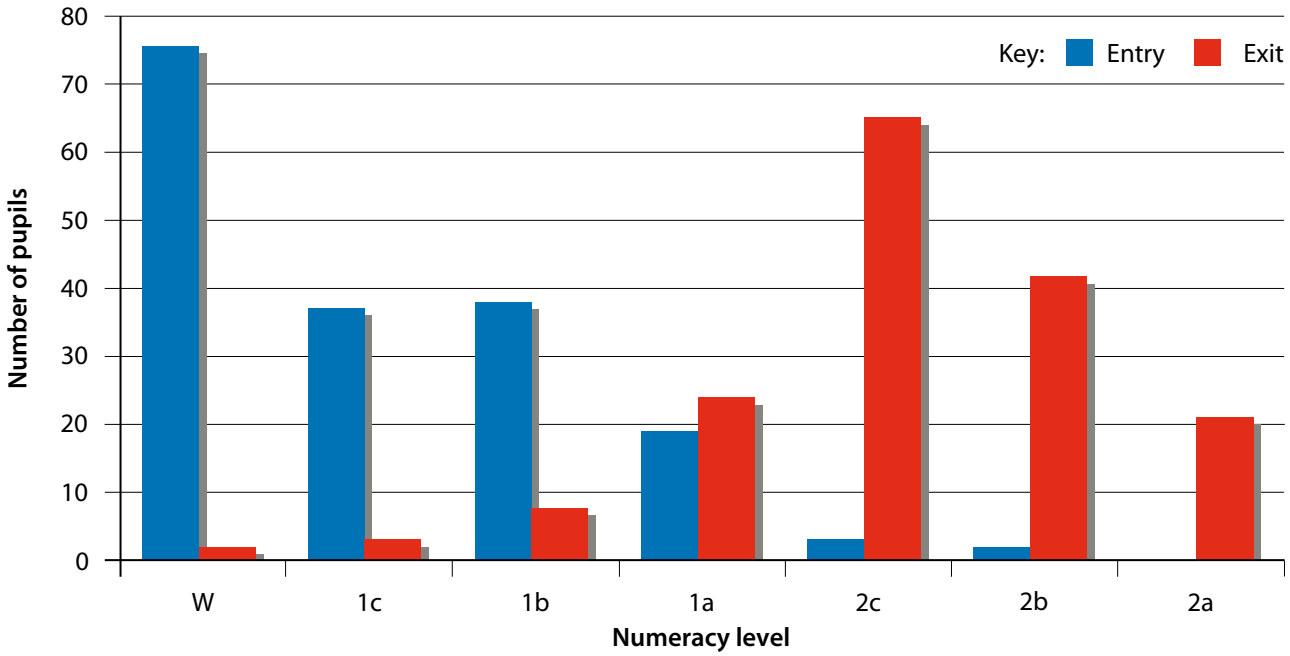
Children with mathematics learning difficulties are carefully identified using NfER tests at the end of Year 1 and the intervention programme is then delivered in Year 2. The involvement of parents is seen as essential and is sensitively handled by the school.

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

Numeracy Recovery – Progress



Mathematics Recovery

This intervention approach has its origins in a research and development programme in Southern Cross University in New South Wales from 1992 to 1995, 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).

It should be noted that Numeracy Recovery (above) has features which are very similar to Mathematics Recovery, in particular with regard to its 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 to 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 mathematics 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.

Making Maths Make Sense

This multi-sensory approach to early learning in mathematics uses three-dimensional objects (cups) as opposed to Numicon tiles (set out below). 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').

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.

Maths Extra

Maths Extra and the National Centre of Excellence in the Teaching of Mathematics (NCETM) are currently collaborating in a small three-year study that involves two mainstream primaries and two special schools in the Folkestone area. Maths Extra provides information and training in the use of the Structural Arithmetic multi-sensory mathematics system, as invented by Dr Catherine Stern. Maths Extra believes that multi-sensory materials are of paramount importance for children with SEN, and are equally important in an early years setting. Stern pattern boards (pictured below) were manufactured in the 1960s and their function is to introduce children to familiar facts seen with the number blocks. Although the panel were unable to see this being used in practice, evidence submitted to the review suggests this resource is having impact on children with SEN.

Stern Pattern Boards

Wave 1 materials also used in intervention

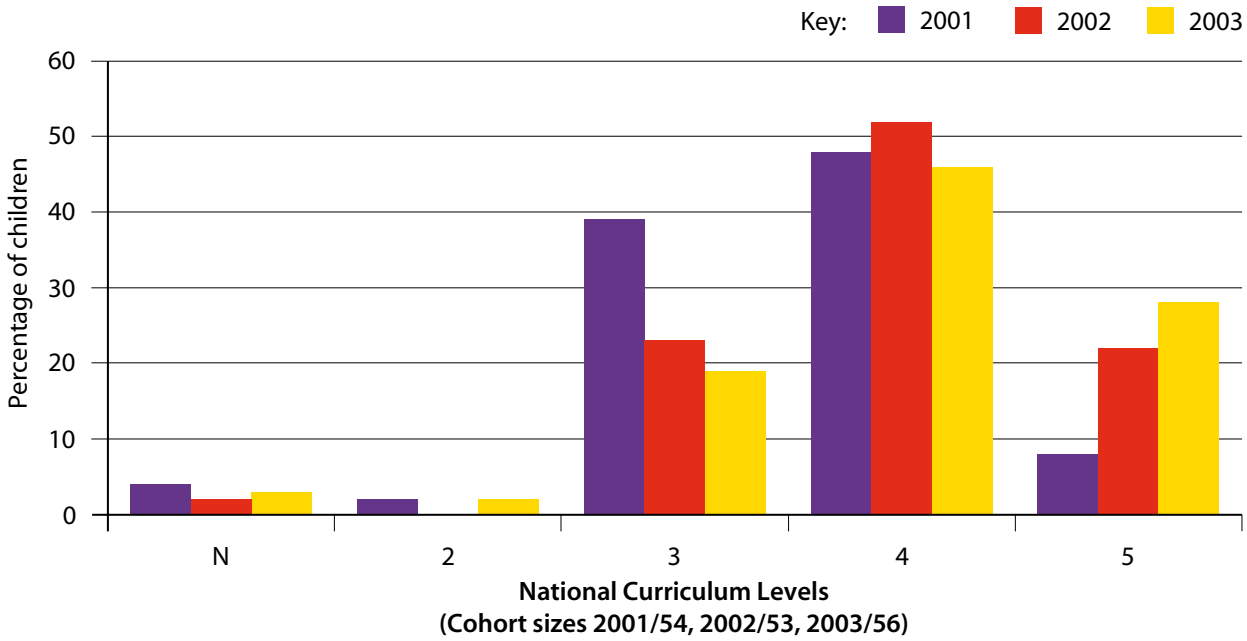
Numicon

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 – which is essentially a wave 1 material, but which is used in wave 3 interventions – represents numbers in the concrete 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

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



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.

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 (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.

Appendix 3: Members of the review panel and evidence gathering process

The members of Sir Peter Williams' review panel were:

- **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 announced in the Department's *Children's Plan* (published in December 2007).
- **Brenda Spencer** – Member of the Early Education Advisory Group.

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, and
- intervention and Every Child Counts.

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
- from a DCSF-sponsored consultation event
- from a DCSF-sponsored six-week written consultation period
- from a National College for School Leadership (NCSL) Hotseat (a two-week online question and answer session).

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. There has been a

six-week written consultation in March and April, since the publication of the interim report, which generated approximately 100 responses.

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, Hungary, Scotland, Barnsley and Manchester. During these visits, the panel has spoken to pupils not only in early years settings and primary schools, but also in secondary schools.

Members of the review panel have spoken at conferences, including the QCA Mathematics Stakeholder Day, the National Centre for Excellence in the Teaching of Mathematics (NCETM) Conference, the joint mathematical subject association conference, and at a Foundation for Science and Technology debate. There have been presentations and discussions with the Early Childhood Forum, with the Social Partners, with the Department's Primary Head Teachers Reference Group and with the NAHT Primary Head Teachers Group. During the course of the review, meetings and discussions have been held with approximately 100 head teachers and 200 teachers and practitioners.

As readers will note, there is no chapter specifically dealing with the second term of reference, which is concerned with the 'gifted and talented' pupil and the 'pupil who is not progressing fast enough to reach national expectations'. The review panel have addressed these issues implicitly in Chapter 2 on the teacher, Chapter 4 on intervention and Chapter 5 on curriculum and pedagogy.

Appendix 4: High-level findings from the written consultation on the interim report

In the main, respondents (97 in total) were either 'strongly supportive', or 'supportive' of most of the recommendations and proposals emanating from the Interim Report of the Review of Mathematics Teaching in Early Years Settings and Primary Schools. There was minimum opposition to most issues.

While some respondents thought that the minimum level requirement for entry into the profession should remain at GCSE grade C, there were others who thought that the standard should be set at a higher level. There was some concern about the existing level of mathematics understanding and knowledge in the teacher/ practitioner workforce and that it was important to address this.

Respondents were of the opinion that continuing professional development (CPD) and Initial Teacher Training (ITT) had an important role to play in developing the quality of primary and early years mathematics teaching and learning. It was felt that to be fully effective in teaching mathematics at primary and early years level, practitioners must themselves have a good basic knowledge of mathematics, along with a sound grasp of early mathematical understanding, and comprehension of the pedagogical approaches needed to deliver it successfully.

The proposal to establish a National Register of Professional Development for Teachers met with a slightly more mixed reaction, with some seeing this as another possible layer of bureaucracy, but with others commenting on what they saw as the potential benefits.

While most respondents thought that some form of incentive or support was needed to encourage participation in CPD or long-term CPD programmes leading to Masters degrees, a minority thought that financial incentives were not necessary.

Whilst more than half of the respondents agreed with the proposal that intervention programmes should be completed by the end of Key Stage 1 (KS1), some respondents considered that certain children may need intervention *again* in Key Stage 2.

In answer to questions on issues surrounding the transition between the Early Years Foundation Stage (EYFS) and KS1, there was support for the idea of extending the Foundation Stage (FS) approaches and attitudes to other key stages of the primary curriculum. Respondents thought this might be helpful in supporting continuity and progression, and might prove effective in aiding teachers and practitioners with delivery.

The overwhelming majority of respondents favoured the promotion of open discussion and mental calculation in the classroom as a means of developing mathematical understanding.

Respondents also agreed that it was important to work with parents and carers to bring them up to date with current mathematics teaching methods, and to encourage participation in their child's mathematics education.

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- 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.
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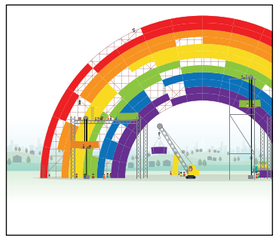

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