

ACME

Advisory  
Committee on  
Mathematics  
Education

# Ensuring effective Continuing Professional Development for teachers of mathematics in primary schools



## POLICY REPORT

ACME PR/09

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## Foreword

Sir Peter Williams CBE FREng FRS,  
Chair of the Advisory Committee on  
Mathematics Education (ACME)

In May 2006 the Advisory Committee on Mathematics Education (ACME) published a position paper outlining key issues for the future of primary mathematics learning and teaching. ACME believes that these concerns can only be addressed in primary schools if there is suitable provision of Continuing Professional Development (CPD). In view of this, ACME commissioned a study into CPD for primary mathematics teachers, with the aim of exploring and recommending models of provision.

This report of the study asserts that the government, its agencies and primary school headteachers should collectively ensure that: the appropriate type of mathematics-related CPD is made available to primary teachers and there is the funding to go with it; primary teachers' mathematics subject knowledge is made generally more secure and supported by confident colleagues in their schools; and that the impact of existing and new models of

CPD, and its provision, on primary mathematics learning is properly evaluated. With the National Centre for Excellence in the Teaching of Mathematics recently launched, it is hoped that there will be a renewed focus on using mathematics-related CPD to reinvigorate the mathematics teaching in our primary schools.

ACME welcomes all views on this, its fifth self-initiated report, and is also pleased to receive feedback on any other issues that are of particular concern to the mathematics education community. Whilst we cannot undertake to act on every request or piece of information we receive, we do pledge that everything we do receive will be read, considered fully, and taken into account.

A handwritten signature in black ink that reads "Peter Williams". The signature is written in a cursive, flowing style.

The Advisory Committee on Mathematics Education (ACME) is an independent committee, based at the Royal Society and operating under its auspices, that acts as a single voice for the mathematical community on mathematics education issues, seeking to improve the quality of such education. ACME was established by the Joint Mathematical Council of the UK and the Royal Society, and is supported by the Gatsby Charitable Foundation. Details of ACME's current membership and activities are available at [www.acme-uk.org](http://www.acme-uk.org)

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## Contents

	<i>Page</i>		<i>Page</i>
<b>Executive summary</b>	<b>4</b>	<b>4. What might CPD in primary mathematics address?</b>	<b>22</b>
Introduction	4	Key areas needing attention	22
Funding CPD	5	Teachers' subject knowledge	22
Teacher subject knowledge	6	Knowledge of pupils' learning	23
The nature of CPD	6	Pedagogy	24
Evaluation of CPD models	8	<b>5. Practical and policy issues</b>	<b>26</b>
<b>1. Background to the study</b>	<b>9</b>	The National Centre for Excellence in the Teaching of Mathematics	26
<b>2. The extent and impact of current CPD provision</b>	<b>11</b>	Funding issues	27
What does the current 'landscape' of CPD in primary mathematics look like?	11	<b>Appendix</b>	
How do schools decide on CPD priorities?	14	Acme working group	28
Evaluation of the effectiveness of CPD	15	Organisations that contributed to the study	28
Views of effective provision	16	Acrouyms and abbreviations	29
<b>3. What do research findings indicate?</b>	<b>18</b>	Footnotes	30
Locating relevant research	18		
Research findings on relevant content for primary mathematics CPD	18		
Research findings on effective forms of CPD	20		

## Executive Summary

### Introduction

This report is about the Continuing Professional Development (CPD) of teachers of mathematics in primary schools and Early Years settings. A position paper was published by ACME in May 2006 to coincide with the Primary National Strategy's (PNS's) consultation on a revised *Framework for Teaching Mathematics*.<sup>1</sup> While the position paper recommended discussion by teachers about the use of more innovative curriculum planning and pedagogy in mathematics in primary classrooms, CPD was identified as a major issue requiring more detailed focus. This study has sought to find out: how primary teachers and their schools identify priorities for CPD in the subject, and how they measure its impact and effectiveness in the classroom; and areas that are well provided for, and those where there is a lack of appropriate provision. The significance of primary teachers' subject knowledge, their knowledge of a range of pedagogic models, and their abilities to plan for effective learning were also investigated. The report also expands on the evidence gained from ACME's 2005 feasibility study on how to ensure a high-quality, localised CPD infrastructure for teachers of mathematics.<sup>2</sup> Finally, it also seeks to inform the work of the National Centre for Excellence in Teaching Mathematics (NCETM) following its launch earlier this year.

The report identifies four key areas that need urgent attention if CPD for primary mathematics teachers is to have a positive impact on both learners and teachers. These are:

- Funding CPD
- Teacher subject knowledge
- The nature of CPD
- Evaluation of CPD models

The report makes recommendations for each of these areas to policymakers and key stakeholders concerned with the CPD of primary mathematics teachers, based on the principles below.

There is a need:

- for a larger pool of knowledgeable, excited and enthusiastic teachers of mathematics across the country and to ensure that there is one such teacher in every school;
- to ensure that there is a workforce of teachers with a sound mathematical knowledge, an understanding of how pupils learn and of related teaching practices;
- to provide CPD which seeks to develop and improve existing good practice as well as that which addresses 'weaknesses';
- to provide opportunities for those teachers who are keen to develop their own knowledge of mathematics and/or related pedagogy irrespective of the priorities of the school they are in;
- to sustain the supply of experts to move into Initial Teacher Education (ITE), Local Authority (LA) adviser and consultants posts, research, etc.;

- to develop a model of CPD which would focus on developing good teaching of mathematics to inspire others in order to raise expectations for all pupils and teachers;
- to engage teachers from all schools, including those in high-attaining ones;
- to review the use (and effectiveness) of Advanced Skills Teachers (ASTs) and the training and development for them and leading mathematics teachers;
- to raise teachers' awareness of progression in the subject and help them to see the 'bigger picture';
- to increase the number of models of CPD available – based on the range of identified needs;
- to rigorously review the evidence base for effective CPD and to encourage peer-reviewed research.

## Funding CPD

Since the implementation of the National Numeracy Strategy (NNS), subsequently incorporated into the PNS<sup>3</sup>, almost all of the 'formal' CPD to which teachers have had access has been funded and organised through the national strategies and has been thought of as being 'free' to schools. Provision of this kind has been used, and generally well received, by many primary teachers. However, this funding is now being absorbed into school budgets so that any decisions to direct funds towards CPD for mathematics will be within the remit of the headteacher.

Over recent years there has been an increase in collaborative working within and between schools and many respondents spoke of its success, but just as it became effective the funding ran out. The NCETM is proposing this as one possible model for further

exploration by schools. However, it is not clear that this will work for all teachers and all schools because it is heavily dependent on having teachers who are both willing and able to take the lead in developing work on identified themes and seeking appropriate resources such as materials, research findings, external experts and funding to allow the work to be sustained.

Very few primary teachers are participating in any sustained mathematics-based professional development, and there are insufficient incentives to persuade them to do so when they are required to contribute both time and funds. Most are not actively involved in professional mathematics subject associations sometimes because there is insufficient funding to buy memberships or send teachers on their annual Easter conferences.

### We recommend that:

- the Department for Education and Skills (DfES), the Training and Development Agency for Schools (TDA) and the NCETM review funding arrangements for primary mathematics CPD in terms of what is and what should be 'free', subsidised or full-cost, to schools and/or to individual teachers, especially in relation to the impact the current funding regime has had on the range of provision;
- the NCETM works with others, such as the TDA and the National College for School Leadership (NCSL), to ensure that headteachers understand the particular needs for subject-specific CPD in mathematics;
- the Association of Teachers of Mathematics (ATM) and the Mathematical Association (MA), along with other relevant subject associations, seek a solution to offer primary schools an affordable joint institutional membership;
- 'Specific initiative funding' is provided by the DfES through the TDA for a period of 8-10 years to ensure that all teachers

currently in the profession have access to sustained and high-quality CPD in mathematics, and also have an incentive to participate. This is essential if the DfES is serious about English primary-aged pupils matching the attainment of their peers in other countries and ensuring that significant engagement in CPD takes place;

- funding is provided by the DfES to continue the successful work taking place within learning networks and clusters of schools, especially for those teachers in Early Years settings. The PNS should implement this, and the NCETM should evaluate its effectiveness.

## Teacher subject knowledge

Many teachers in English primary schools hold the minimum qualification in mathematics for entry into ITE. In relation to most other countries that are comparable, where mathematics is studied by all to the age of 18+, and to past decades in England, our teachers on average are worse qualified in mathematics on leaving school and receive less initial training in the teaching of mathematics. CPD provision does not sufficiently address this weak subject knowledge, nor the related lack of confidence. The need is not for a superficial knowledge of more mathematics but for a more profound understanding of mathematics up to GCSE higher tier level, how it interconnects within the subject and how it relates to applications outside it. The report identifies this type of subject knowledge as an important contribution to effective teaching, and emphasises that this is an area that urgently needs to be addressed both in the design of CPD provision for serving teachers and in considering the entry qualification to ITE.

It is very important that all primary schools should contain one or more teachers who are enthusiastic about mathematics and knowledgeable about the teaching and learning of mathematics. Since few primary teachers have mathematics as a specialism in their

education and training, good quality and sustained CPD is required to achieve this aim. The leadership role of these teachers will be critical in raising the quality of teaching by all teachers in their schools.

### We recommend that:

- the DfES with the TDA research the appropriateness of the current ITE entry requirement in the light of the new GCSE testing arrangements (which will allow a grade C to be awarded on the new foundation tier) and the need to improve teachers' subject knowledge;
- the DfES with the TDA set out a requirement for widespread provision of sustained CPD which improves subject knowledge and teachers' own confidence in, and attitude to, the subject;
- the DfES, the TDA and the NCETM work together to ensure that, wherever possible, each primary school has at least one teacher who is enthusiastic about mathematics and knowledgeable about the teaching and learning of mathematics (and can enthuse and inspire others), and prioritises support for any teacher who wishes to develop his/her subject knowledge as part of improving the quality of his/her teaching of mathematics.

## The nature of CPD

Research findings indicate that in order to improve the long-term quality of teaching, or the professional development of teachers, there is a need to strengthen not only the depth of knowledge about the subject but also knowledge about different pedagogies and ways of presenting specific topics, and knowledge about the ways pupils learn, including how this knowledge can be applied in practice. The evidence from the most recent international Trends in Mathematics and Science Survey (TIMSS), that attitudes of pupils to primary mathematics have deteriorated significantly since 1995,

should alert us that attitudes are important as well as attainment. CPD in mathematics teaching and learning also needs to take into account recent initiatives such as improving pupils' skills in 'learning to learn' and teachers' use of 'assessment for learning'.

### We recommend that:

- the DfES with the TDA set out a requirement that CPD be provided for primary teachers that raises their awareness and understanding of, and practices in, matching lesson structures and pedagogic styles, both to intended learning outcomes and to research about mathematical learning;
- CPD is provided that will help teachers to critically evaluate and adapt the mass of teaching materials that are now freely available through the Internet;
- the NCETM, when mapping out the breadth of current provision of CPD in primary mathematics, considers the impact of CPD on pupil attitudes and test results as well as how to incorporate 'learning to learn' skills and 'assessment for learning' within mathematics lessons. Any perceived gaps should be identified and the NCETM should take steps to support CPD providers in addressing them.

The range of readily available CPD needs to be such as to enrich and to meet the needs of every primary teacher of mathematics. The current provision is focused on single sessions or short (5 day) courses. While these may support the short-term aims of raising test results, they do little to help teachers in the sustained development of their own personal skills in relation to mathematics teaching.

Because the national strategies have set priorities for CPD which have tended to focus on raising test results at Key Stage 2, teachers in schools where the test results are high are now less likely to attend any courses or to be able to draw on any in-school support. They and other teachers may not be given support for

access to any mathematics CPD because it is not judged to be a priority for the school.

Prevalent current types of CPD thus do not meet the development needs of either the leading teachers in each school, or those of many other teachers. In the longer term this lack must affect also the mathematical development of their pupils. This also means that we are failing to provide for the next generation of leaders in primary mathematics – such as LA consultants and advisers, teacher trainers and researchers – as well as failing to support adequately those who are anxious about their grasp of the subject and their ability to teach it.

A further unintended consequence of a strong focus on standards attained in national tests is a loss of vision about the purpose of primary mathematics.

### We recommend that:

- the PNS and the NCETM initiate jointly a debate among primary teachers about the purposes of primary mathematics education, which explicitly acknowledges that educational experiences should be valuable and engaging in their own right and at the time they are encountered. As well as laying foundations for later study this would inform the nature of CPD;
- the NCETM monitors CPD provision to help ensure that a broader 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 or more;
- the NCETM, in its audit of current provision of CPD, identifies the longer-term needs of teachers and schools and examines particularly the extent to which there is provision for raising the 'ceiling' for mathematics teaching as well as the 'floor' level;

- the NCETM, in its audit of current provision of CPD, includes CPD available to primary mathematics CPD providers such as advisers, consultants, Leading Mathematics Teachers (LMTs) and ASTs;
- the NCETM takes steps to achieve a higher profile with teachers in the Foundation Stage and Key Stages 1 and 2 by appointing a primary/Early Years specialist to its senior team.

There has been a huge reduction in the involvement of Higher Education Institutions (HEIs) in CPD, and this is considered to be a loss to the system since it denies teachers direct access to research and the expertise of those involved over many years in initial training.

It is also unclear whether good use is being made of the few ASTs and of teachers who have been deemed to be LMTs in primary mathematics.

#### We recommend that:

- the NCETM encourages a greater involvement of HEIs in CPD for teachers of mathematics and a closer interaction between HEIs and schools;
- the NCETM, in consultation with the PNS and the TDA, is given sufficient resourcing to review the use and effectiveness of ASTs alongside the training and development for them and for LMTs.

## Evaluation of CPD models

Finally the report highlights the limited extent of evaluation of CPD provision both at school level in terms of impact on learning and

more generally in terms of the effectiveness of different models. The report notes that in some other countries CPD models are based on agreed and researched principles about mathematics education and evaluated through independent and peer-reviewed research. It is essential that evaluation of the effectiveness of CPD is viewed with equal importance with the level of provision and access to it. It is also essential that we use the research information we have to make decisions in the future.

#### We recommend that:

- NCETM should use its first three years to encourage the development of a culture of CPD that is based in explicit theory and grounded in research evidence. Such provision should be empirically researched, with funding specifically provided for this by government in partnership with educational research funding bodies;
- NCETM ensures that models of CPD are carefully and independently evaluated in terms of the longer-term effects on teachers and pupils;
- NCETM works with the NCSL to provide support for leaders in evaluating the impact of CPD on learning and teaching.

## 1 Background to the study

- 1.1 As its fifth proactive project, ACME sought to focus on primary mathematics education. Members of the mathematics community were invited to comment on possible questions to be addressed; a small ACME group, involving primary teachers, headteachers, researchers and an LA primary adviser, identified key issues for the future of primary mathematics learning and teaching. An ACME position paper was published in May 2006 to coincide with the PNS's consultation on a revised *Framework for Teaching Mathematics* and concentrated on curriculum planning and pedagogy.<sup>4</sup>
- 1.2 Subject-related CPD was also identified as a major issue by the group: this study was set up as a consequence. It expands on the evidence gained for ACME's 2005 feasibility study on how to ensure a high-quality, localised CPD infrastructure for teachers of mathematics as part of the then planned NCETM.<sup>5</sup>
- 1.3 This primary mathematics education study sought to find out how primary teachers and their schools identify priorities for CPD in the subject, and how they measure its impact and effectiveness in the classroom. It also sought to find out areas that are well provided for, and those where there is a lack of appropriate provision.
- 1.4 The significance of primary teachers' subject knowledge, their knowledge of a range of pedagogic models, and their abilities to plan for effective learning were also investigated.
- 1.5 The study was carried out from May to June 2006 as initial work was taking place by the NCETM to develop a mathematics CPD framework. In its 2005 CPD report, ACME recommended that a CPD culture should be created for all involved in the teaching of mathematics; specific points for the primary phase also emerged at that time. These are highlighted and expanded in this report, which raises issues for further investigation by the DfES, the NCETM, the PNS and the TDA.
- 1.6 The views of teachers and headteachers were sought through organisations as well as individually. This was achieved through questionnaires, meetings and telephone interviews. Meetings were held in four different geographical areas (Greater Manchester, Hull, East Kent and London), to which teachers and headteachers, as well as representatives of HEIs and LAs were invited. Information was also gathered through attendance at conferences. The Appendix gives a full list of contributors to this study.
- 1.7 Relevant evidence on the Early Years and Key Stages 1 and 2 received for the 2005 CPD study was also taken into account, as was ACME's original report on CPD<sup>6</sup>. A review of research was carried out and information was received from school inspectors based on Ofsted inspection findings.
- 1.8 This report focuses on four questions:
- What sort of CPD is currently provided and taken up, and what is its impact?
  - What do research findings indicate?
  - What might CPD in primary mathematics address?
  - What are the implications for mathematics CPD in primary schools?

The first question is answered in Section 2 which describes the evidence collected about the extent and impact of current CPD provision. Section 3 deals with research findings and thus answers the second question and also informs the third. Section 4 focuses on the third question. Finally, Section 5 raises some practical and policy issues in relation to the fourth question, while recommendations for action are embedded throughout the report.



## 2 The extent and impact of current CPD provision

### What does the current 'landscape' of CPD in primary mathematics look like?

- 2.1 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 the teaching of classes. Many schools buy in a private consultant, or someone from the LA, to lead a session in the school at a time when all teachers are available. This is perceived as being cost effective; also, the person is seen to be more credible than one of the school's own teachers reporting back from a course they have attended, although this depends on the reputation of the consultant. There was little mention from those interviewed of provision of CPD by ASTs, perhaps because there is reluctance in some schools to have an 'expert' colleague from another school working alongside teachers.
- 2.2 Many schools have also moved to regular twilight sessions, giving teachers time off in lieu. This means that sessions are invariably short and are suitable for updating and sharing information – and ensuring that all relevant staff are involved – but they give little time for discussion and reflection; there is no time for informal chats afterwards.
- 2.3 The provision for mathematics varies between LAs depending on the level of advisory staffing as well as their experience and expertise; many LA advisory services 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. Some small LAs have successfully worked together to provide a wider range of courses than they could do independently. These, and many other LAs, have tried to provide a broad balance of mathematics CPD but are under pressure because of their own targets. So, although they might have a clear vision of the type of CPD they would like to provide, if schools are paying, then the provision has to be attractive in terms of meeting their perceived needs. Hence topics such as 'raising national test results', 'gifted and talented (G&T)', and 'creativity' are popular and other courses dealing with more proactive provision focusing on other important aspects of mathematics education do not run because of a lack of response. Across the system there has been a worrying move away from subject specialism. Many LA advisers have become general school improvement inspectors and, although they retain responsibility for mathematics, they have little time for the subject. This change of emphasis is also affecting their professional development; some advisers said they could not get funding for the annual conference held by the National Association of Mathematics Advisers (NAMA) because 'mathematics' was not in their job title. The regional directors for the PNS have also changed from having subject specific to generic roles, though it is understood that there is a move to reverse this.
- 2.4 Much of the current provision relates to the need for all in the school to keep up to date with developments in the PNS and to address 'weaknesses' identified in end-of-key-stage assessments and the optional tests and tasks. There is little evidence of provision being made for teachers who want to raise the bar of their expectations for themselves and their pupils. As such, the focus on school improvement in general is on the lowest achievers and the need to 'bring up the bottom end'. One CPD provider with a particular interest in G&T claimed that one impact of attending to the gifted and talented in classrooms was to raise standards for all pupils and that this was more effective than focusing on 'pulling up' the lower attainers. Adopting a similar approach to CPD

might be helpful; this would focus on developing good mathematics teaching as a model to inspire others.

### Recommendation 1

The NCETM, in its audit of current provision of CPD, should identify the longer-term needs of teachers and schools and examine particularly the extent to which there is provision for raising the 'ceiling' for mathematics teaching as well as the 'floor' level.

- 2.5 An unintended consequence of a strong focus on standards achieved in tests is a loss of vision of what primary mathematics is about. Teachers feel under pressure 'to get to a level', so want professional development that helps in the short term. One of the comments frequently made by those interviewed was that teachers mainly concentrate on the mathematics they need for their year group and do not have much sense of progression. They are, for example, unaware of the benefits of introducing an area model for multiplication which can later be used for multiplication of fractions or algebraic expansion. It is simply seen as a 'stepping stone' to the standard algorithm for long multiplication. Changes to curriculum guidance and documentation that increase the number of bulleted teaching and learning objectives only serve to decrease the ability of teachers – especially non-specialists – to see this bigger picture. There is a need to raise teachers' awareness of progression in the subject.
- 2.6 It is rare for people to talk about mathematics in terms of a subject for its own sake. Frequently the work in schools is seen only as giving pupils the necessary understanding and skills for future work. It is important that a debate be initiated about the purposes of primary mathematics that explicitly acknowledges that educational experiences should be valuable and engaging in their own right, and at the time they are encountered, as well as laying foundations for later

study. Schools and teachers would then be able to examine the breadth and choice of CPD in the light of such vision, going beyond simply attending to test scores.

### Recommendation 2

The PNS and the NCETM should initiate jointly a debate among primary teachers about the purposes of primary mathematics education, which explicitly acknowledges that educational experiences should be valuable and engaging in their own right and at the time they are encountered. As well as laying foundations for later study this would inform the nature of CPD.

- 2.7 One large LA offers provision for a range of mathematics courses designed to encourage teachers to look beyond the immediate concerns for the PNS, but take-up is limited, and the cost of mounting them makes such provision difficult to sustain. As already noted, a group of LAs annually mount a week of mathematics CPD in order to provide variety and expertise that would not be viable for an LA on its own. Whether such collaborative provision would be effective everywhere is open to investigation.
- 2.8 Since the implementation of the NNS, there has been at times a greater focus on CPD for subject leaders as opposed to other teachers; this may have resulted in far too few primary teachers experiencing any professional development outside their school. The subject leaders have worked very hard to help colleagues to improve their planning, their use of resources and to implement school policies consistently. However, the expectation that they should be able to support the mathematical development of colleagues is too burdensome for many as they, themselves, are not 'mathematicians'. Headteachers are not necessarily strong mathematically, so it is hard for them to identify weaknesses in the subject knowledge of their colleagues.

- 2.9 Few primary teachers or schools are actively involved in professional mathematics subject associations, despite the wealth of CPD opportunities these provide in courses and publications. There are virtually no opportunities for those teachers who are keen to develop their own knowledge of mathematics and/or related pedagogy irrespective of the priorities of the school they are in. The country needs a pool of excited, enthusiastic and knowledgeable teachers, so keen teachers must be encouraged and supported. ACME's 2005 CPD report ended with this statement: "The Smith report highlighted the failure of the curriculum to excite students post-14. If this issue is not addressed from 4–19, and teachers are not excited by the mathematics they are teaching, progress will be limited".
- 2.10 This highlights a need to ensure that, wherever possible, there is at least one teacher in the school who is knowledgeable and enthusiastic about mathematics and who can act in a leadership role. However, even this teacher cannot be expected to be solely responsible for the development of the mathematics subject knowledge of all his/her colleagues. Thus there is also a need for access to external support for those teachers who want some assistance in raising the quality of their mathematics teaching.

### Recommendation 3

The DfES, the TDA and the NCETM should work together to ensure that, wherever possible, each primary school has at least one teacher who is enthusiastic about mathematics and knowledgeable about the teaching and learning of mathematics (and can enthuse and inspire others), and that each primary school prioritises support for any teacher who wishes to develop his/her subject knowledge as part of improving the quality of his/her teaching of mathematics.

### Recommendation 4

The ATM and the MA, along with other relevant subject associations, should seek a solution to offer primary schools an affordable joint institutional membership.

- 2.11 Strategy consultants and other LA staff spoken to, felt there was insufficient support in enhancing and deepening their subject knowledge, as well as for their knowledge of research about children's learning. Over the years, the courses provided by the PNS have been much appreciated, but some headteachers have reported on the provision being 'tired' because it has not changed much over the years. This is clearly variable across the country but illustrates the need to keep the trainers 'fired up'. There is also a need for new consultants to be trained as trainers. Similarly, there appears to be little provision available for LMTs and ASTs to keep up to date or move on in their development.
- 2.12 Specifically in relation to mathematics teaching in the Early Years, in the period from September 2003 to April 2005, Ofsted reports that "although the quality of teaching has improved overall, there has been a disproportionate occurrence of unsatisfactory lessons in reception and nursery classes more recently".<sup>7</sup> Research into why this is happening is an urgent priority of the NCETM and should inform a renewed emphasis on CPD for teachers and teaching assistants in this phase.

### Recommendation 5

The NCETM should, in its audit of current provision of CPD, include CPD available to primary mathematics CPD providers such as advisers, consultants, LMTs and ASTs.

## How do schools decide on CPD priorities?

- 2.13 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. However, some schools and LAs say they have used general national initiatives, such as the Primary Learning Network and Thinking Schools, for valuable subject specific CPD. The NCSL's mathematics material, for example, is reported to have aided valuable collaborative practice.
- 2.14 Because the need to raise test results at the end of Key Stage 2 is being taken very seriously by schools and is reflected in the current CPD emphases, there is a danger that other CPD needs may be ignored as a result of this narrow focus. Many schools now track pupil progress through levels in relation to test results, in order to see whether they can identify pupils who are not progressing as fast as expected. Some schools also use a wider range of information, such as a regular analysis throughout the school year of the work of a few pupils in each year group. Such an analysis of work helps the teachers to focus on the progress being made by these pupils and on the strategies needed to improve this if necessary. This analysis, helpfully, focuses firstly on the learning (and the learner) and then on the teaching strategies to be used. This work has led to meaningful discussions between headteachers and individual class teachers, which have focused on pupils and their achievements and has led to the identification of training and development needs for both the individual and the school.
- 2.15 Performance management interviews are the usual way of identifying the needs of individual teachers. These needs are usually addressed through a specific course but sometimes by collaborative working with a colleague or a numeracy consultant from the LA. However, the support for individuals is almost always linked to the school's priorities expressed in its development plan. Keen and interested teachers, for example, are not always able to attend the Easter conferences of the subject associations, or other mathematics education courses, because their school does not have mathematics (or the particular focus of the course) as a high priority and therefore will not release the funding to attend such events.
- 2.16 Teachers in high-attaining schools can often not become engaged in CPD if course provision focuses only on improving underachievement. Although attainment might be high in these schools, the learning is often not as exciting and effective as it could be.
- 2.17 The attitudes of headteachers are key, as they ultimately make the decisions about priorities and spending. Some have complained about the number of initiatives hitting schools, such as Assessment for Learning, Extended Schools, and workforce reform, and the need to keep staff informed. They say that while schools can identify needs, priorities are often dictated by the government; other aspects frequently have higher priority even though the headteachers know about the importance of both English and mathematics.
- 2.18 Headteachers, justifiably, complain about being bombarded by information about courses and they frequently have no idea about the track record of those advertising courses. Indeed some respondents to our study indicated that choice of whether or not to attend CPD often depended on whether they knew the presenter had a good reputation, rather than on the content. It is important that within the new structure of the NCETM, some form of kite marking is developed. Currently the information does not filter through to those who might benefit. Frequently teachers do not see information about courses because the headteacher does not pass it on. Several respondents have noted that communicating with headteachers can be 'a nightmare'. One large LA has decided that the most effective way of advertising courses and development opportunities is to

have face-to-face contact with heads. This is done through a short slot at a regional meeting of headteachers and is followed up by an email or printed information. It is important that the NCETM finds out about effective practices used within LAs to engage with headteachers, and then shares the information widely.

### Recommendation 6

The NCETM should work with others, such as the TDA and the NCSL, to ensure that headteachers understand the particular needs for subject-specific CPD in mathematics

### Evaluation of the effectiveness of CPD

- 2.19 Judging the effectiveness of CPD in schools is variable, and many schools admit to not doing this as systematically or rigorously as they should. Where schools have identified needs through analysis of test results, they look to improved results. More generally, the effectiveness is judged informally through the monitoring and evaluation of lessons.
- 2.20 Headteachers and subject leaders monitor teaching and learning but often there is a lack of clarity about the expected 'success criteria' when the CPD is set up. For example, a school may highlight 'problem solving' as an issue to be addressed but is not really clear what is meant by the phrase and how 'success' is measured. Frequently, 'problem solving' and 'solving problems expressed in words' are taken to be the same.
- 2.21 Some schools ask pupils and their parents, through questionnaires, about mathematics in the school and this sometimes raises attitudinal issues. This approach may provide identification of further learning needs, and possibly CPD required to deliver this, as well as evaluation data on the impact of CPD on pupils' learning.
- 2.22 LAs get feedback from schools about their involvement and this is usually very positive. This is particularly true when numeracy consultants work in schools, but some LAs are aware that the schools can become too dependent on the consultants so that they do not think for themselves sufficiently. Whether current CPD 'develops capacity' and helps teachers to be more confident professionals is more difficult to determine. The fact that relatively few teachers and headteachers responded directly to this project is a concern. While some would say that pressure of time is an issue, there is also a feeling that many do not believe that they have anything to say of worth. This lack of self-belief and confidence is a matter which needs to be addressed in CPD provision.
- 2.23 It is unclear how much LAs assess the impact of ASTs and the related value-for-money issue: given the large funding commitment to these posts it would be useful to know the impact that primary mathematics AST's are having on teachers and the learners in their classes they support.

### Recommendation 7

The NCETM, in consultation with the PNS and the TDA, should be given sufficient resourcing to review the use and effectiveness of ASTs alongside the training and development for them and for LMTs.

### Recommendation 8

The NCETM should work with the NCSL to provide support for leaders in evaluating the impact of CPD on learning and teaching.

## Views of effective provision

- 2.24 People working with children in Early Years are said to have benefited from working with other settings in their cluster, and have particularly learned from visiting other sites to look at and discuss the mathematical environment that has been created. Discussion with others and the sharing of practical ideas that have worked for them have increased their confidence. They have become enthusiastic about the mathematics through the children's own excitement and enthusiasm about the mathematical tasks. Similarly positive responses about the usefulness of observing practice and resulting discussion were reported in all phases, and especially so where the teachers do not feel confident in the subject. Any growth in confidence, enthusiasm and knowledge is more likely to happen over time, and with CPD that builds in time for discussion, rather than on a one-or-two session course that 'tells' teachers what to do.
- 2.25 Successful CPD with Early Years practitioners has started with the aspects of their general teaching with which they feel comfortable, such as story telling or outdoor play, and has built on this in relation to mathematics. The teachers and practitioners are also helped to think about the balance of teacher-initiated work and that which they draw out from the children's activities and responses. Generally, they are good at drawing out literacy aspects of the natural activities taking place, but have found it more difficult to identify and to create mathematical opportunities. Many practitioners have had extremely negative experiences of mathematics. This means that successful Early Years CPD retains a strong focus on child development and involves people with recognised expertise in the Early Years, rather than in mathematics teaching at primary or secondary level.
- 2.26 One large LA, which has an experienced advisory team, puts emphasis for primary teachers on the CPD experiences being 'self-sustaining'. Teachers are encouraged to work collaboratively, either in their own school or with others in

neighbouring schools. One teacher spoke of the success of such a collaborative inter-school group which produced written guidance for all teachers on a specific area of focus.

- 2.27 Many longer-serving teachers, when asked about the factors that had most affected their own classroom practice, stated that involvement in curriculum development projects, or courses that took place over time, enabled them to reflect on their practice and have time back in school working with colleagues and/or pupils from different age groups. Several people have mentioned the impact of initiatives such as teacher research bursaries and, more recently, the learning network monies, but funding for each were said to have ended just when the initiatives were beginning to have an effect.

### Recommendation 9

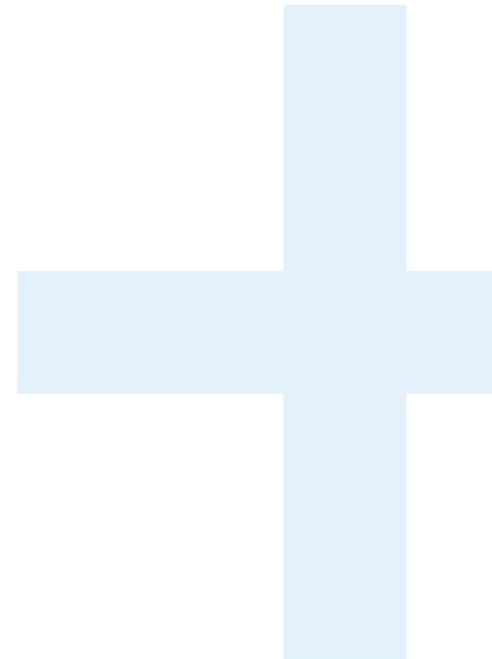
Funding should be provided by the DfES to continue the successful work taking place within learning networks and clusters of schools, especially for those teachers in Early Years settings. The PNS should implement this, and the NCETM should evaluate its effectiveness.

- 2.28 The number of models of CPD provision has diminished over the years. The major support for primary mathematics subject leaders has been provided through the NNS/PNS since the demise of the DfES designated 10-day and 20-day courses. The link with HEI that characterised these DfES courses has disappeared and vital expertise has been lost. HEI staff involved in ITE have said that they gained much from also working with practising teachers who continue their professional development in mathematics education at institutions where they first trained. Where there is a long history of working with local schools and LAs, some HEIs are still able to do this. HEIs have reported that while Masters programmes focused on school leadership and management are flourishing, numbers of primary teachers studying mathematics education for a higher degree is falling and is

now very low. This means that there is a current and impending shortage of teachers with expertise in depth in primary mathematics who are well-qualified for posts in LAs, HEIs and government agencies.

### Recommendation 10

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



## 3 What do research findings indicate?

### Locating relevant research

- 3.1 In carrying out a brief review of research findings into primary mathematics CPD, the main criteria for determining whether or not an initiative had been 'researched' was the publication of findings in peer-reviewed journals and books. If, as a profession, we are to take seriously injunctions to become 'evidence-based', with medical research held up as the gold-standard, then peer-reviewed reports are a reasonable expectation. It would be a foolish doctor who adopted a new drug, research on which had not been peer-reviewed.
- 3.2 A striking feature of the research into mathematics CPD is the paucity of it in the English context. As found in previous reviews of research there is a lack of peer-reviewed studies into the effectiveness of CPD initiatives in England.<sup>8</sup> Halpin et al. (1990) note that there is a lack of 'empirically or theoretically generalisable' evidence of the effectiveness of in-service training, and this seems a reasonable statement.<sup>9</sup> While many English initiatives have published evaluation findings, these have more often been 'in-house' than in peer-reviewed journals.

### Recommendation 11

The NCETM should use its first three years to encourage the development of a culture of CPD that is based in explicit theory and grounded in research evidence. Such provision should be empirically researched, with funding specifically provided for this by government in partnership with educational research funding bodies.

### Research findings on relevant content for primary mathematics CPD

- 3.3 In contrast to England, North America has a long tradition of CPD providers researching their programmes. A major USA report on research into elementary (primary) mathematics – *Adding It Up* – provides a comprehensive overview of the literature and breaks down the three aspects of subject knowledge, pupil learning and teaching practices into component aspects:

#### Mathematics subject knowledge

- Facts, concepts, procedures and their relationships
- Ways of representing mathematical ideas
- The discipline of mathematics, including how mathematical knowledge is produced, norms and standards of evidence for proof and argument
- Nature of discourse in mathematics
- Goals of mathematics teaching and the basis for choosing priorities from these goals

### Pupil learning

- How mathematical ideas develop in general and what is typical for given ages
- How to determine where individual pupils are in their development, common difficulties, and misconceptions, and likely sources

### Teaching approaches

- Goals and curriculum
- Tasks, tools and resources
- Promoting and managing classroom discourse and learning activities so that “everyone is engaged in substantive mathematical work”<sup>10</sup>

3.4 A difficulty with lists such as this is that they do not stand in isolation from ideology: the *Adding It Up* report is very much in the spirit of ‘constructivist’ views of learning and the ‘reform’ movement in the USA, with teaching approaches based around reasoning and discussion. But if the major aim of primary mathematics is seen as proficiency in standard methods of written calculations then classroom norms are going to be very different. While understanding and skills should not be opposing aims, what still seems to be lacking in England is an agreed vision of the goals and purposes of primary mathematics that is linked to learning and teaching approaches. Then appropriate CPD might be developed.

3.5 American and European developers and providers of CPD place more emphasis on researching their programmes and reporting on them in peer-reviewed journals. One outcome of this is that the theoretical basis for designing CPD is explicitly articulated. Thus, for example, the Cognitively

Guided Instruction (CGI) work of Carpenter et al. (1982) or the Dutch Realistic Mathematics Education (RME) work set out principles based on theories of teaching and learning, enabling the interested teacher both to make an informed decision about the quality of the CPD and to understand, if they wish, the basis on which it was developed.<sup>11</sup>

3.6 So although subject knowledge, knowledge of students’ learning, and teaching approaches may be ‘self-evidently’ the core areas of CPD, the argument is largely rhetorical. Empirical evidence that these aspects are the ones to concentrate on is harder to find.

3.7 There is, for example, limited research evidence for a relationship between teachers’ mathematical knowledge and pupil attainment, and what exists is contradictory. So, there is some evidence of a ‘threshold’ of knowledge required for supporting pupil learning, but diminishing returns after a certain point.<sup>12</sup> However, research by Rowan et al. (1997) does indicate a positive relationship between learners’ achievement and teachers’ performance on mathematics tasks set within a teaching context.<sup>13</sup>

3.8 In England, the TDA funded ‘Effective Teachers of Numeracy’ (ETN) project found that there was a slightly negative association between teachers’ level of formal qualification in mathematics and pupil performance on tests, but a positive association, in terms of the complexity of understanding of the primary mathematics curriculum that the teachers demonstrated in a mathematics interview.<sup>14</sup>

3.9 In terms of researching the links between teachers’ mathematical knowledge and teaching practices, most research has been in the form of case studies of fewer than 10 teachers, usually involving only one to three. Findings point to the difficulties that teachers with weak understanding of the mathematics have in that they tend to teach in a more procedural way rather than teaching for both understanding and skills. However, the converse is not

true: teachers with strong mathematical knowledge do not necessarily teach it in less procedural ways. Again this is consistent with the ETN findings: teachers with strong mathematics did not always appear to understand why pupils may have difficulties and often would simply re-teach in the same way.

## Research findings on effective forms of CPD

- 3.10 A second major difference between CPD here and elsewhere is the sustained nature of developing and refining the CPD. CGI and RME have long established track-records extending back many years, but they have not ossified, instead building on experience, developing programmes and documenting approaches so that others may emulate them. Here, CPD initiatives barely have time to be run through twice before being replaced. The major exception is the Cognitive Acceleration work which is referred to later in this section.
- 3.11 Recently, researchers have been turning their attention to investigating what forms of primary mathematics CPD are 'generative'; that is, those that continue beyond the 'life' of the professional development. Collaborative CPD with colleagues would seem to be one approach, as Ashton & Webb (1986) argue that collaboration encourages risk taking, learning from mistakes and sharing strategies.<sup>15</sup> This has arisen from concerns that:

*"Opportunities for teacher learning focus almost exclusively on activities or methods of teaching and seldom attempt to help teachers develop their own conceptual understanding of the underlying mathematical ideas, what students understand about those ideas, or how they learn. ... Programs that provide readymade, worked-out solutions to teaching problems should not expect that teachers will see themselves as in control of their own learning".<sup>16</sup>*

- 3.12 The authors go on to argue that rather than being set up to solve teachers' problems, CPD should help teachers come to view teaching as involving problem solving and support teachers in addressing such problems in "reasonable and intelligent ways". Although this is a comment on American CPD, given the responses that we have had, it would also seem to reflect the state of primary mathematics CPD in England: that teachers are often being given 'prescriptions' for teaching rather than being encouraged to develop a breadth of knowledge that would help them devise their own solutions to the issues that they face.
- 3.13 While many respondents have spoken very positively of the impact of projects such as Low Attainers in Mathematics Project (LAMP), Raising Attainment in Mathematics Project (RAMP), Primary Innovations in Mathematics Education (PriME) and the 20/10-day courses, there is, sadly, scant peer-reviewed research on the effectiveness of these. The most notable set of studies in England – both in terms of length of development and peer-reviewed publication of research findings – are those involving the Cognitive Acceleration developments.<sup>17</sup> These include, specifically in primary mathematics, Primary Cognitive Acceleration in Mathematics Education (P-CAME).<sup>18</sup> Findings from these projects have been disseminated through peer-reviewed journals and books. They demonstrate the power of well-documented CPD programmes which are theoretically grounded and researched over several years, standing in marked contrast to the short courses that predominate through time or cost constraints and perceived needs.<sup>19</sup>
- 3.14 Askew et al. (1997a) report on extended CPD (of at least 14 days) as having a statistically significant effect on teachers' beliefs and practices and on children's learning.<sup>20</sup> (This finding is reinforced by CAME and PCAME). More recently, findings from the Leverhulme 5-year longitudinal study of primary mathematics teaching and learning drew attention to the limited impact of 5-day training courses.<sup>21</sup>

**Recommendation 12**

The NCETM should ensure that models of CPD are carefully and independently evaluated in terms of the longer-term effects on teachers and pupils.

- 3.15 Adey and his colleagues, reporting on 15 years of research in Cognitive Acceleration, provide evidence that three key variables have to be in place for CPD to be effective: the nature of the innovation, the elements of provision and the change environment. They further argue that three aspects of the nature of the innovation need to be explicit in order to help teachers choose appropriate provision.<sup>22</sup> These aspects are: that there is a clearly articulated theoretical base; that the providers have empirical evidence that it will have an impact; and that it involves “generative activities”, which encourage teacher ownership rather than the ‘adoption’ of curricular materials.
- 3.16 Three essential elements of provision are also identified. Firstly that there must be “longevity and intensity”. In line with other researchers, Adey has found that at least 2 years is needed for real change to come about, and that new classroom practices only become embedded after around 30 hours of trying them out. Secondly that the CPD teaching methods need to mirror those being advocated for classrooms. Thirdly that coaching and opportunities for reflection need to be built in.<sup>23</sup>

**Recommendation 13**

The NCETM should monitor CPD provision to help ensure that a broader 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 or more.

- 3.17 Finally they argue that none of the above will succeed without a “supportive change environment”. This means there must be collegiality among the teachers, the support of school management and, again, a strong sense of ownership. They also note the fragility of sustained change in schools with high teacher turnover.
- 3.18 The work of Joyce and Showers (1995) addresses similar issues to those identified by Adey.<sup>24</sup> Although the bulk of their work is in literacy, some is in mathematics; they are keen to link CPD with learning outcomes and they have a long track record of researching what makes development ‘stick’. They argue that for CPD to be effective “first and foremost school and staff development has to be based on pupil achievement” and that goals must be directed towards affecting both pupil learning and their ability to learn. They also argue that in order to keep the focus on pupil achievement, staff have to decide what sort of data to collect and how often and regularly to review this. Again, the important thing is not just ‘learning outcomes’ but progress on ‘learning to learn’.
- 3.19 Evidence for this ACME project suggests that primary schools are paying attention to learning outcomes through test analysis, but that the emphasis on how to enable pupils to become effective learners is not being given equal attention. Part of this may be to do with the lack of a clear view among educational stakeholders in England of what it means to do and learn mathematics. Some respondents spoke of the willingness of teachers to work on speaking and listening and discussion-based learning in many aspects of the curriculum, but did not perceive such approaches as relevant to the mathematics lesson. This points again to the need to broaden teachers’ understanding both of the nature of the subject and how children come to understand it.

## 4 What might CPD in primary mathematics address?

### Key areas needing attention

4.1 As indicated already, the literature on primary mathematics CPD frequently presents the following three areas as requiring attention: mathematics subject knowledge; knowledge of pupils and how they learn; and pedagogy. Respondents to this project generally concurred with these emphases.

4.2 Inspection evidence and responses from others suggest that the following areas need further attention in CPD programmes. Currently there is:

- too much use of worksheets that emphasise the acquisition of skills at the expense of developing understanding (the emphasis is normally linked to the perceived requirements of the statutory tests and assessments);
- insufficient challenge for the more able;
- insufficient attention paid to 'Using and Applying Mathematics' in the National Curriculum;
- too little emphasis on the application of numeracy skills;
- too little attention to cross-curricular opportunities;
- a lack of robust monitoring of the progress of pupils across the school and the related quality of teaching and learning; more attention needs to be given to formative assessment over and above test scores.

4.3 This list reinforces the recommendations from the literature that subject knowledge, knowledge of pupils and teaching practices are inter-related and that effective CPD needs to address all three.

### Teachers' subject knowledge

4.4 Many of the matters raised above link to a lack of confidence on the part of teachers. Lack of subject knowledge was given as an issue by many respondents, including headteachers.

4.5 Schools and teachers are firmly committed to the 'raising standards' agenda. However, the low number of students pursuing mathematics at higher levels suggests that attitude as well as attainment is an issue and that this is not only confined to secondary schools. The most recent report from the TIMSS shows that the proportion of Year 5 students with positive attitudes to mathematics in England has dropped by 10% since 1995.<sup>25</sup> One LA has been conducting surveys of pupils' attitude to mathematics in primary schools and many have reported being bored and expressed a wish for "teachers to talk less, and let us get on and do some maths".

4.6 The highest subject qualification for most English primary teachers is now only a grade C or above at GCSE or its equivalent, which may be gained on the intermediate tier of GCSE (or from September 2006 the foundation tier). This is much lower than for their counterparts in countries that are ranked higher than England in international assessments of mathematics, where all students are normally required to continue with the study of mathematics to age 18. For students following the new specialist diplomas in England, whether at school or college, continued study of at least functional mathematics is likely to become a requirement, but this may not be the case for students studying for GCE A and AS levels, a group that is likely to include most prospective primary teachers.<sup>26</sup> Moreover as ITE for primary teachers is now normally only a one-year PGCE course, it

allows very little time to be devoted to development of subject knowledge. Thus if entry-level requirements remain like this in England, then this has continuing implications for CPD in terms of improving teachers' subject knowledge.

- 4.7 The government has made it clear that it believes that subject knowledge and a positive attitude to the subject are keys to success. In a document published by the DfES in March 2003 the then Secretary of State for Education and Skills stated:

*"Our very best teachers are those who have a real passion and enthusiasm for the subject they teach. They are also deeply committed to the learning of their students and use their enthusiasm for their subject to motivate them, to bring their subject alive and make learning an exciting, vivid and enjoyable experience. (Para 1)*

*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 of attainment in our schools. The aim is not to produce individual pockets of excellence but to enhance professionalism across the school. (Para 8)<sup>27</sup>*

### Recommendation 14

The DfES with the TDA should research the appropriateness of the current ITE entry requirement in the light of the new GCSE testing arrangements (which will allow a grade C to be awarded on the new foundation tier) and the need to improve teachers' subject knowledge.

### Knowledge of pupils' learning

- 4.8 The 20-day courses were able to address knowledge of how pupils learn mathematics: teachers carried out tasks in school that allowed them to focus on children's learning. There was also a requirement to tailor work on subject knowledge to individual teacher's needs (made possible through the understanding and trust built up over time between course provider and course participants); different teaching practices were also addressed. While current emphases have raised teacher's knowledge of expected learning outcomes, this should not be conflated with knowledge of how children learn mathematics, nor expect this necessarily to lead to understanding of how these learning outcomes build into a coherent knowledge of mathematics.
- 4.9 Some respondents expressed concern at the increasing frequency with which pupils were being labelled as 'dyscalculic' or 'attention-deficit' to account for poor progress in mathematics, but without these pupils' knowledge and understanding being accurately assessed. Developing teachers' understanding of the processes of learning mathematics and the difficulties that many pupils face might help to make this assessment more accurate and so ensure that pupils receive the appropriate level of support.
- 4.10 Assessment information, such as the analysis of test results, is generally used positively. However, teachers create too few opportunities from formative assessment, which requires them to make time to listen to pupils and hence be able to assess their understanding.
- 4.11 There is little assessment relating to the attitudes of either teachers or their pupils to mathematics, both of which would seem to be key in the improvement of learning.

### Recommendation 15

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

### Recommendation 16

The NCETM, when mapping out the breadth of current provision of CPD in primary mathematics, should consider the impact of CPD on pupil attitudes and test results as well as how to incorporate 'learning to learn' skills and 'assessment for learning' within mathematics lessons. Any perceived gaps should be identified and the NCETM should take steps to support CPD providers in addressing them.

### Recommendation 17

The DfES with the TDA should set out a requirement that CPD be provided for primary teachers that raises their awareness and understanding of, and practices in, matching lesson structures and pedagogic styles both to intended learning outcomes, and to research about mathematical learning.

## Pedagogy

4.12 The new PNS *Framework for Teaching Mathematics* will encourage teachers to 'loosen up' on the three-part lesson, but there does not appear to be a great deal of provision for introducing teachers to alternative ways of constructing mathematics lessons, or sequences of lessons. In contrast to this, a handbook of different models of teaching intended for American teachers runs to some 600 pages and provides over thirty models for structuring lessons.<sup>28</sup> The research behind the recommendations for the three-part lesson is included, but occupies only one small section. While not suggesting that teachers here need to be familiar with such a thorough review, they should at least be aware of the different models of lessons and how the evidence relates to their comparative effectiveness.

4.13 Clearly there are tensions between the current emphasis on work/life balance and time for teachers to plan lessons that they have ownership of and which are likely to be effective. While on the one hand reducing planning demands may be helpful, research evidence shows that the idea of lesson 'trajectories' in terms of thinking about how a lesson might unfold is an important aspect of teaching that needs to be thought through at the planning stage. As Noddings states:

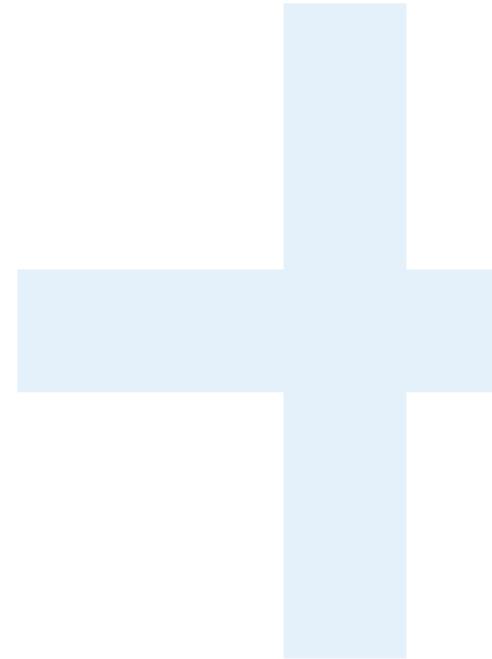
*"Planning can be an effectively rich part of teaching. ... I over-plan and much of what I read will not appear in a particular day's lesson. Instead it will join a collection that provides a wonderful storehouse of material to be used spontaneously over a long period of time. Planning prepares not just the lesson, but, more importantly, the teacher."*<sup>29</sup>

4.14 Many LA respondents and others expressed concern at the amount of material that teachers are downloading from the Internet – both lesson plan and worksheets – and using uncritically with pupils. An issue here would be not to expect teachers to plan lessons from scratch, but to have sufficient subject and pedagogical knowledge to be able to critically assess materials, choose sensibly and modify appropriately for the needs of their pupils. European neighbours, most notably the Netherlands, have a much more co-ordinated approach to curriculum revisions. Policy makers, researchers

and publishers work to an agreed timetable of revision, long enough for research to identify needs and for well developed curriculum materials to be published in line with revisions. It takes a long time to write and trial good curriculum materials; when the curriculum keeps changing too frequently, publishers do not have the time to do this or the incentive to invest sufficient money for a few years of life.

### Recommendation 18

CPD should be provided that will help teachers to critically evaluate and adapt the mass of teaching materials that are now freely available through the Internet.



## 5 Practical and policy issues

### The National Centre for Excellence in the Teaching of Mathematics

- 5.1 The remit for the NCETM is to work with relevant partners to co-ordinate the provision of CPD and to identify and fill gaps, as well as ensuring that all teachers of mathematics have access to high-quality CPD at a local or regional level.
- 5.2 It was a surprise that many of those interviewed from schools had not heard of the NCETM. Some thought it was only concerned with secondary schools and this view was strengthened by the lack of a primary school in the 'schools in focus' part of the NCETM's website. There is clearly a need for the development of a higher profile in Early Years settings and primary schools. This could be aided by the appointment of a primary specialist with experience of Early Years to its senior team and aiming to make primary teachers aware of the existence of the NCETM and the role it can play for them.

#### Recommendation 19

The NCETM should take steps to achieve a higher profile with teachers in the Foundation Stage and Key Stages 1 and 2 by appointing a primary/Early Years specialist to its senior team.

- 5.3 In order to build confidence as well as knowledge in the subject for teachers and practitioners working with young children, the NCETM needs to explore ways of engaging more of them in mathematics-related CPD.

- 5.4 There are many issues about mathematics CPD that are quite specific to primary schools and/or Early Years settings. It is important that NCETM is aware of these in formulating its policies and activities for primary and Early Years teachers.
- 5.5 A particular and rather obvious but important fact about primary schools is that all of the teachers are teachers of mathematics. They also teach the other subjects in the statutory curriculum and need to keep abreast of them as well. In many schools, especially in inner-city areas, literacy has a higher priority than numeracy. Teachers and practitioners in Early Years teach all six areas of learning and they have a very important role in helping children in the first steps of learning in mathematics.
- 5.6 Being away from your class is very hard in primary schools, especially small ones. It is harder still in the Foundation Stage. Even in a four-teacher school it is hard to have many half or full days away from the class. Some small schools have been imaginative and have bought in very specific help while a teacher is away for a few days on a course. This has involved an art or music specialist, for example, to cover areas of the curriculum in which the school's own teachers are not specialists. This is a very good example of forward planning that ensures that the pupils do not have a poorer deal because their teacher is out of school. The NCETM could spread knowledge of creative overall school management practice which enables staff to participate in CPD.
- 5.7 Foundation Stage practitioners receive less training than Key Stage 1 teachers and are more likely to be part-time. It is often difficult to disseminate information to part-time staff; they work shorter hours, are not always easy to contact, and the timing and length of courses often makes it hard to meet their needs. Questions have been raised about remuneration for attending CPD sessions, particularly for those who need to make arrangements for childcare.
- 5.8 There are particular issues about those teachers and

practitioners working with young children, and also those working in small primary schools where individual teachers, out of necessity, carry responsibilities for several National Curriculum subjects. In the new management structures, this will increasingly be the case in larger schools; Senior Management Teams (SMTs) will have responsibility for broad issues such as 'teaching and learning' and 'assessment', and subject responsibility will come lower down the management structure, if it appears at all. For example, one school described a management structure that involved appointing three assistant headteachers with responsibility for different age phases but not having the teacher with responsibility for mathematics on the SMT. We do not have evidence for how widespread such structures may be: the DfES needs to examine this.

## Funding issues

- 5.9 Funding CPD and finding satisfactory supply cover can be difficult and are both significant issues to be considered by those determining policy. The good practice of sending two people on a course has almost ceased because of the cost and the need for cover. Funding is an issue for both schools and LAs.
- 5.10 The funding arrangements for the PNS 5-day courses is changing in September 2006 and concern has been expressed that they may lead to less involvement in mathematics. In the past the money available to provide cover has been held by the LA on behalf of the PNS and released to schools after teachers have been on the courses. From September 2006 the money will be in the school's own budget so nothing can be claimed back. The PNS courses will no longer be thought of as 'free' and this could lead to fewer schools releasing teachers to go on them. There will be no way of checking that all this funding which was earmarked for mathematics will be spent on subject-related development. This was highlighted as a risk in the 2005 ACME CPD report and still remains one.

### Recommendation 20

The DfES, the TDA and the NCETM should review funding arrangements for primary mathematics CPD in terms of what is and what should be 'free', subsidised or full-cost, to schools and/or to individual teachers, especially in relation to the impact the current funding regime has had on the range of provision.

### Recommendation 21

'Specific initiative funding' should be provided by the DfES through the TDA for a period of 8-10 years to ensure that all teachers currently in the profession have access to sustained and high-quality CPD in mathematics, and have an incentive to participate. This is essential if DfES is serious about English primary-aged pupils matching the attainment of their peers in other countries and ensuring that significant engagement in CPD takes place.

## Appendix

### ACME working group

Laurie Jacques (lead committee member)  
 Professor Margaret Brown (committee member)  
 Colin Matthews (committee member)  
 Kathleen Cross, retired HMI (lead consultant)  
 Professor Mike Askew (consultant)  
 Nick von Behr and Jenita Chelva (committee secretariat)  
 Helen Williams, independent Early Years adviser

### Organisations that contributed to the study

Individuals from the following schools, LAs and other organisations contributed to the study:

Ashfield Junior School (JS), Workington, Cumbria  
 Association of Teachers of Mathematics  
 Barrowford Primary School (PS), Barrowford, Lancashire  
 BEAM (mathematics education publishers)  
 Bignold First School and Nursery, Norwich, Norfolk  
 Canon Barnett PS, Aldgate, London  
 Coates Lane PS, Barnoldswick, Lancashire  
 Cranbourne PS, Bracknell Forest  
 Croydon LA  
 East Anglia University  
 Frith Manor School, Barnet  
 Grayrigg Church of England PS, Cumbria

Hampshire LA  
 Hanover PS, Islington, London  
 Harmans Water PS, Bracknell Forest  
 Hawkinge PS, Kent  
 Hertfordshire LA  
 Hertfordshire Deputy Heads  
 Hull LA  
 Hull University  
 Kent LA  
 Kingsley PS, Northamptonshire  
 Manchester University  
 Manchester Metropolitan University  
 Mathematical Association  
 National Association of Mathematics Advisers  
 Nuffield Continuation Project in the North West (NORMAC)  
 Ofsted  
 Oliver Goldsmith PS, Southwark, London  
 Open University  
 Owlsmoor PS, Bracknell Forest  
 Primary National Strategy  
 Rotherfield PS, Islington, London  
 Kingston upon Thames LA  
 Salford LA  
 Sandwell LA  
 Stockport LA  
 St Edmund's Nursery School, Bradford  
 St Jude's and St Paul's PS, Islington  
 St Mary Magdalene PS, Milton Keynes  
 St Mary's Catholic PS, Chipping, Lancashire  
 St Mary and St Michael Catholic PS, London  
 St Peter's Brafferton Church of England PS, North Yorkshire

Sunnymede JS, Essex  
 Tameside LA  
 The Churchill School, Kent  
 Ullapool PS, Scotland  
 Westfield Nursery and PS, Workington, Cumbria

## Acronyms and abbreviations

ACME	Advisory Committee on Mathematics Education
AST	Advanced Skills Teacher
ATM	Association of Teachers of Mathematics
CAME	Cognitive Acceleration in Mathematics Education
CE	Church of England
CGI	Cognitively Guided Instruction
CPD	Continuing Professional Development
DfES	Department for Education and Skills
ETN	'Effective Teachers of Numeracy'
G&T	Gifted and Talented
GCE	General Certificate in Education
GCSE	General Certificate in Secondary Education
HEI	Higher Education Institution
ITE	Initial Teacher Education
JS	Junior School
LA	Local Authority
LAMP	Low Attainers in Mathematics Project
LMT	Leading Mathematics Teacher
MA	Mathematical Association
NAMA	National Association of Mathematics Advisers
NCETM	National Centre for Excellence in the Teaching of Mathematics
NCSL	National College for School Leadership
NNS	National Numeracy Strategy

Ofsted	Office for Standards in Education
PCAME	Primary Cognitive Acceleration in Mathematics Education
PGCE	Post Graduate Certificate in Education
PNS	Primary National Strategy
PrIME	Primary Innovations in Mathematics Education
PS	Primary School
QCA	Qualifications and Curriculum Authority
RAMP	Raising Attainment in Mathematics Project
RME	Realistic Mathematics Education
SMT	Senior Management Team
TDA	Training and Development Agency for Schools
TIMSS	Trends in Mathematics and Science Survey

## Footnotes

- <sup>1</sup> ACME, 2006. ACME Position Paper: *key issues for the future of primary mathematics learning and teaching*. London: The Royal Society. [http://www.royalsoc.ac.uk/acme/ACME\\_position\\_paper\\_May-06.pdf](http://www.royalsoc.ac.uk/acme/ACME_position_paper_May-06.pdf)  
For more on the PNS Framework for Teaching Mathematics see <http://www.standards.dfes.gov.uk/primary/>
- <sup>2</sup> ACME, 2005. *Ensuring a high quality, localised infrastructure for the Continuing Professional Development of teachers of mathematics*. London: The Royal Society. [http://www.royalsoc.ac.uk/acme/ACME\\_CPD\\_feasibility\\_study\\_report.pdf](http://www.royalsoc.ac.uk/acme/ACME_CPD_feasibility_study_report.pdf)
- <sup>3</sup> The NNS came under the umbrella of the PNS when the Secretary of State for Education and Skills launched *Excellence and Enjoyment – A Strategy for Primary Schools* in May 2003.
- <sup>4</sup> Op.cit. note 1. See also the Qualifications and Curriculum Authority's (QCA's) *Curriculum Guidance for the Foundation Stage*. <http://www.qca.org.uk/5585.html>
- <sup>5</sup> Op.cit. note 2.
- <sup>6</sup> ACME, 2002. *Continuing Professional Development for teachers of mathematics*. London: The Royal Society. [http://www.royalsoc.ac.uk/acme/Acme\\_CPD\\_report.pdf](http://www.royalsoc.ac.uk/acme/Acme_CPD_report.pdf)
- <sup>7</sup> Ofsted, 2005. Mathematics in Primary Schools. [www.ofsted.gov.uk/publications/annualreport0405/4.1.7.html](http://www.ofsted.gov.uk/publications/annualreport0405/4.1.7.html)
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- <sup>10</sup> National Research Council, 2001. *Adding it up: Helping children learn mathematics*. Washington DC: National Academy Press.
- <sup>11</sup> Carpenter T. P., Moser J. M. & Romberg T. A., 1982. *Addition and subtraction: A cognitive perspective*. Hillsdale, NJ: Lawrence Erlbaum Associates. Also Gravemeijer K., 1997. Instructional design for reform in mathematics education. In M. Beishuizen, K. Gravemeijer & E. C. D. M. Van Lieshout (Eds.), *The role of contexts and models in the development of mathematical strategies and procedures*. Utrecht: Freudenthal Institute.
- <sup>12</sup> Begle E. G., 1979. *Critical variables in mathematics education: Findings from a survey of the empirical literature*. Washington DC: Mathematical Association of America and National Council of Teachers of Mathematics.
- <sup>13</sup> Rowan B., Chiang F. S., & Miller R. J., 1997. *Using research on employee's performance to study the effects of teachers on student achievement*. Sociology of Education, 70, 256-284.
- <sup>14</sup> Askew M., Brown M., Rhodes V., William D., & Johnson D., 1997. *Effective teachers of numeracy: Report of a study carried out for the teacher training agency*. London: King's College, University of London.
- <sup>15</sup> Ashton P. & Webb R., 1986. *Teachers' sense of efficacy, classroom behavior, and student achievement*. In P. Ashton, & R. Webb (Eds.), *Making a difference: teachers' sense of efficacy and student achievement*. (pp. 125-144). New York: Longman Inc.
- <sup>16</sup> Adding it up. Op. cit.
- <sup>17</sup> Shayer M. & Adey P. (Eds.), 2002. *Learning intelligence: cognitive acceleration across the curriculum*. Buckingham: Open University Press.
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- <sup>19</sup> Bottery M. & Wright N., 1996. *Cooperating in their own deprofessionalisation? On the need to recognise the 'public' and 'ecological' roles of the teaching profession*. British Journal of Education Studies, 44(1), 82-98.
- <sup>20</sup> Askew M., Brown M., Rhodes V., William D., & Johnson D., 1997a. *The contribution of professional development to effectiveness in the teaching of numeracy*. Teacher Development, 1(3), 335-355.
- <sup>21</sup> Millett A., Askew M., & Simon S., 2004. *Reponses of teachers to a course of intensive training*. In A. Millett, M. Brown & M. Askew (Eds.), *Primary mathematics and the developing professional* (Vol. 1, pp. 127-154). Dordrecht/Boston/London: Kluwer Academic Publishers.
- <sup>22</sup> Adey P., 2004. *The professional development of teachers: practice and theory*. Dordrecht: Kluwer Academic Publishers.
- <sup>23</sup> Ibid.
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- <sup>25</sup> Mullis I.V.S, Martin M.O, Gonzalez E.J. & Chrostowski S.J., 2004. *TIMSS 2003 International mathematics report: findings from IEA's Trends in International Mathematics and Science Study at the fourth and eighth grades*. Boston: International Association for the Evaluation of Educational Achievement.
- <sup>26</sup> "In addition, there will be an entitlement to study functional English, functional maths and functional ICT to age 19 until at least level 2 is achieved. This may be as part of a Diploma programme, within an Apprenticeship or a general programme, or separately." DfES, 2005. *14-19 Education and Skills Implementation Plan*. Nottingham: DfES.
- <sup>27</sup> DfES, 2003. *Subject Specialism: Consultation Document*. Sudbury: DfES.
- <sup>28</sup> Joyce B., Weil M., & Calhoun E., 2004. *Models of teaching*. Boston: Allyn & Bacon.
- <sup>29</sup> Noddings N., 1996. *Stories and affect in teacher education*. Cambridge Journal of Education. 26 (3), 435-447.

## ACME and Royal Society / JMC mathematics education reports

### Mathematics in Further Education colleges

(38 page report of ACME's fourth self-initiated project, July 2006)\*

### Making Mathematics Count – Two Years On

(30 page report of an ACME conference, June 2006)\*

### '14–19 Mathematics Pathways'

(12 page report of an ACME workshop, December 2005)\*

### Ensuring a high quality, localised infrastructure for the Continuing Professional Development of teachers of mathematics

(24 page report of a feasibility study, July 2005)\*

### Assessment in 14–19 Mathematics

(12 page report of ACME's second self-initiated project, January 2005)\*

### Continuing Professional Development for teachers of mathematics

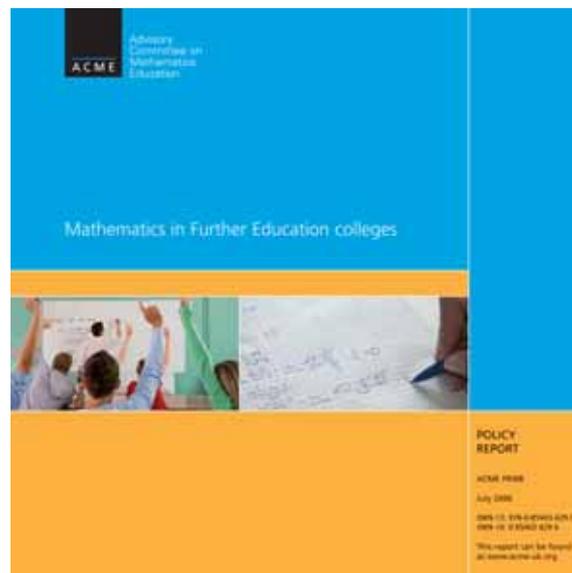
(15 page report of ACME's first self-initiated project, December 2002, 2 page summary also available)\*

### Teaching and learning geometry pre–19

(88 page report of a Royal Society / JMC working group, July 2001, 3 page summary also available)\*\*

### Teaching and learning algebra pre–19

(72 page report of a Royal Society / JMC working group, July 1997, 4 page summary also available)\*\*



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This report was reviewed by a panel chaired by Professor Martin Taylor FRS, Vice President, the Royal Society, and including Professor Patrick Dowling FRS, Chair of the Royal Society's Education Committee and Professor Bernard Silverman FRS, Chair of the Joint Mathematical Council of the UK.

\* Full text of this report can be found on ACME's webpages at [www.acme-uk.org](http://www.acme-uk.org)

\*\* Full text of these reports can be found on the Royal Society's website at [www.royalsoc.ac.uk](http://www.royalsoc.ac.uk)

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