MATHEMATICS IN PRIMARY SCHOOLS

Sue Harris and Zenta Henkhuzens

nfer

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Sue Harris

Zenta Henkhuzens

INVESTOR IN PEOPLE

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INTRODUCTION

This report describes research findings from the special focus of the third *Annual Survey of Trends in Education* carried out by the National Foundation for Educational Research (NFER).

The survey was conducted in autumn 1996 and consisted of a number of 'barometer' questions and a special focus. The barometer questions look at current issues in education and are included in each survey in order to monitor changes in schools' perspectives over time. The responses to the barometer questions in the 1996 survey can be found in *Digest Number 4, Changes over Time* (Henkhuzens, 1997). The special focus is changed each year as a result of requests from headteachers in previous years. In 1996, the focus was on mathematics and intended to find out how schools were delivering the mathematics curriculum following the Dearing Review.

The findings presented in this report include information collated from responses to the 1996 special focus questions. In addition, information collected as part of more detailed follow-up work focusing on mathematics in primary schools is included.

- **Part I** consists of a review of the current literature relating to the topic area. Issues discussed arose from both the literature and an examination of the questionnaire responses.
- **Part II** provides details of responses provided by the primary school headteachers who completed the questionnaire and an additional analysis of mathematics policy documents which were provided by a small number of schools.

The report is illustrated throughout by more detailed information about various practices in place in a small number of schools. These schools were identified from their responses to the questionnaire. Where they were willing to assist with the project, in-depth information was collected by either visits to the schools concerned, or telephone interviews with mathematics coordinators and headteachers. These were carried out during the summer term of 1997.

A total of 12 schools provided detailed information about their mathematics teaching. Six schools were visited (identified as Schools A–F), and interviews were held with mathematics coordinators and headteachers. Classroom observations of mathematics lessons were conducted in four of the schools visited. Staff from the remaining six schools participated in telephone interviews (Schools G–L). Evidence collected from these 12 schools can be distinguished from the main text as it is highlighted within individual boxes.

PART I:

CURRENT ISSUES

1.1 CURRICULUM DEVELOPMENT

The past ten years have been a period of dramatic change to the taught curriculum in schools in England and Wales. What follows is a brief account of the introduction and development of these changes within the mathematics curriculum leading up to the present day context within which this project was set.

1.1.1 The '80s

A number of developments of the early 1980s had a major impact on the changes that subsequently evolved in the mathematics curriculum in schools. Of these, the report of the Cockcroft Committee, *Mathematics Counts* (1982) emerged as the principal source of guidance on the curriculum and teaching styles of the time. The Committee had worked together for three years, compiling a well-received *'thorough survey and diagnosis of the problems of mathematics teaching and learning in England and Wales in about 1980'* (Shuard, 1986, p. 7).

In addition, the reports of, for example, the Assessment of Performance Unit (Foxman *et al.*, 1980; 1981; 1982 and 1985) and the Mathematics 6–13 Project (Shuard, 1986) evaluated on a large scale the practice of primary mathematics teaching, illuminating an array of 'good' and 'bad' practice (see Brown, 1992 for an interesting discussion of 'good practice'). Such reports highlighted the need for the use of a wide variety of teaching styles and gave primary importance to the role of language in mathematics. However, commentators such as Brown (1996) have suggested that despite the overall aim of the Government to monitor standards and focus on underachievement, the results of the Assessment of Performance Unit had little impact on the practice of teaching and learning mathematics at the time.

Meanwhile, a move towards graded criteria was gaining momentum, as was indicated by the White Paper of 1985, *Better Schools* (GB. Parliament. House of Commons, 1985). This was the first public document to refer to centrally determined targets for primary schools, and there was growing public concern that some schools were exploiting their freedom of curriculum choice. However, this freedom was soon to be brought to an end, and in July 1987, a Working Party was set up with the brief to advise the Government on appropriate attainment targets and a programme of study for mathematics.

The early stages of the development of the National Curriculum were not without turmoil. In particular, in the case of mathematics, there were obvious tensions amongst academics, and much debate (still apparent today) regarding the hierarchical organisation of mathematics for the purpose of teaching and learning (see, for example Noss *et al.*, 1989; O'Reilly, 1990; Kuchemann, 1990 and Prestage, 1996).

Noss (1990), in his critique of the Working Party Report for mathematics (GB. DES and WO, 1988), suggests that the contradictory nature of the report is illustrative of the lack of rationale behind the hurried implementation of the National Curriculum. He concludes that the overriding emphasis on ineffective assessment procedures is far removed from the enhancement of curriculum content and warns of the danger of replacing serious debate with *'tampering with the details of implementation'* (p. 28).

Indeed it would seem that the rapid implementation of the new proposals further fuelled the wrangles between educationalists and the Government as teachers hurried to produce new policies and schemes of work and get to grips with terminology and procedures.

1.1.2 The early '90s

The mathematics curriculum of 1989 consisted of 14 attainment targets, each representing a specific strand of mathematical development. Although the Working Party had insisted that no specific method of assessment should be imposed on teachers, the importance of the assessment of each statement of attainment was highlighted in all the publications of the School Examinations and Assessment Council (SEAC) at the time. This led to the inevitable upsurge of ticklists used by teachers in schools and added complications for test agencies developing both the Standard Assessment Tasks (SATs) and General Certificate of Secondary Education (GCSE). Further issues surrounding assessment practice are discussed in Section 1.4.

The sheer lack of manageability of the 14 attainment targets led to the announcement in 1991 that a second version of the curriculum in mathematics and science was to be prepared for implementation in 1992. The resulting curriculum consisted of five attainments targets in mathematics (which was to become four attainment targets in 1995). This was a seemingly more manageable amount, although, as Brown (1996, p. 27) has commented: *'A few statements were either transferred unaltered, or not reflected directly in the new structure. Thus the*

changes were cosmetic, the number of statements being reduced by about half, but each twice as broad.' However, the feeling of unrest amongst the teaching profession continued as they struggled to come to terms with the revised curriculum. In addition, the introduction of national tests took place in 1991, which resulted in further rebellion.

As Brown and Johnson (1996) have noted, the main source of contention during this time arose from primary teachers and their attempts to manage an overloaded curriculum. Indeed it would seem that despite the reduction in the number of attainment targets, the level of day-to-day bureaucracy had not diminished: *'Teachers were struggling to make sure all subjects were covered, and were under pressure to keep detailed "checklist" records and prepare for national tests in 1994'* (Brown and Johnson, 1996, p. 116). A resulting boycott of the assessment procedures in 1993 — the pinnacle of the years of resentment felt by the teaching force — forced the Government into prompting a task of rapid reconciliation. The Secretary of State announced a full review of the curriculum and testing procedures was to take place in an attempt to slim down the former and reduce the complexity of the latter. This was to be undertaken by a neutral ex-civil servant, Sir Ron Dearing.

1.1.3 The Dearing Review 1993

The appointment of Sir Ron Dearing and the decision to merge the two governing bodies (the National Curriculum Council (NCC) and the School Examination and Assessment Council (SEAC)) into one (the School Curriculum and Assessment Authority (SCAA)) which he was to lead came as a welcome breakthrough in the troubled educational climate of the time. Through a period of intensive consultation with both teachers and leaders of teachers unions, Sir Ron took on the task of regaining the trust of the profession.

The Dearing Final Report (1994) proposed a number of significant changes to the curriculum:

- the existing National Curriculum for 5–14-year-olds to be streamlined to release the equivalent of a day a week (20 per cent of teaching time) for schools to use at their own discretion;
- the ten-level scale to be kept but simplified and run only to the end of Key Stage 3;
- all National Curriculum subjects for 5–14-year-olds to be revised in one go for September 1995;

- Key Stage 1 tests in English and mathematics only, with the total test time for pupils cut by half and science covered by teacher assessment;
- Key Stage 2 tests to be treated as a voluntary national pilot in 1995;
- Key Stage 3 test time to be cut by half;
- Key Stage programmes of study (PoS) to replace level-related programmes — these set out what pupils should be taught;
- level descriptions to replace statements of attainment — these set out standards of pupil performance at the end of each key stage;
- levels 9 and 10 to be replaced by 'exceptional performance'.

The new mathematics Order (GB. DES and WO, 1995) is now in place and sets the context within which this present study is set.

1.1.4 Summary

There is no doubt that the last ten years have witnessed a period of great change in the ways in which teaching and learning is organised in schools. Indeed it would seem that the promise of no further major changes to the curriculum during the five years that follow the Dearing Review can be only welcomed by teachers as an opportunity to reflect on their own practice. Anecdotal evidence from this study (and from the Annual Survey data (Henkhuzens, 1997)) indicates that schools are experiencing a period of 'settling down' in terms of curriculum change. However, a recent change in government and ongoing pressure to raise standards look likely to maintain an increased emphasis on the basic core skills of literacy and numeracy in the curriculum and an array of new initiatives to achieve this goal.

1.2 PLANNING FOR MATHEMATICS

This section looks at some of the issues surrounding the long-term planning of mathematics and highlights a possible tension between subject-specific and topic-based work.

1.2.1 Introduction

The introduction of the National Curriculum and its assessment procedures have provided schools with an established framework within which to organise the teaching and learning of mathematics in the classroom. This was viewed by Her Majesty's Inspectorate (GB. DES. HMI, 1990) as having 'a positive influence on curricular planning' (p. 3), particularly in the core subjects. While planning has always played an important role in the work of primary school teachers, the implementation of the National Curriculum has increased the need for whole-school planning in the majority of schools (Burgess *et al.*, 1994; Osborn and Black, 1994). This in turn has brought about a significant change in the ways in which teachers are working, with a much greater emphasis now placed on collaborative teamwork.

1.2.2 Planning the curriculum

Curriculum coordinators play a major role in whole-school planning and the involvement of the mathematics coordinator in this process has been well documented (see, for example, Stow with Foxman, 1988; Stow, 1989; Winteridge, 1989 and Osborn and Black, 1994). In addition to raising awareness of subject matter and offering advice and support to colleagues, often a major task for mathematics coordinators is the production of a long-term plan for mathematics in their schools. While this shift in responsibility for long-term planning away from the classroom teacher may be perceived as a loss of autonomy, in general the majority of teachers have welcomed the move as an effective means of ensuring continuity and progression throughout the school (Osborn and Black, 1994), and many continue to contribute to the planning process via staff meetings and working groups.

SCAA (1995) recommends that long-term plans define the basic structure of the whole school teaching programme. The long-term planning of work in mathematics is likely to cover individual year groups, offering guidance to teachers in their own medium- and short-term planning in implementing schemes of work (commercial or school-produced) and assessment procedures.

SCAA (1995) cites the benefits of long-term planning as ensuring:

- **coverage** of all subjects and aspects of the curriculum (including the National Curriculum and religious education);
- **progression** in all subjects and aspects of the curriculum;
- **balance** within and between subjects and aspects of the curriculum;
- **coherence** within and between subjects and aspects of the curriculum;
- **continuity** between year groups and key stages.

In focusing on these issues, it would seem that consideration is needed for both coverage and progression *within* each subject and balance and coherence *between* subjects. In this way, subject-specific schemes of work fit together within an overall curriculum plan.

Staff in School F had started work on a 'curriculum map'. A long-term plan for English across the whole school had been produced two years previously by the English coordinator. The school had worked with this plan for a year before the introduction of science. The mathematics coordinator was planning a map for mathematics to fit in alongside the other core subjects. He commented that although the process was very time-consuming, there had been obvious benefits in having a map of this kind. The main benefits cited by the coordinator were:

- effective planning of resources across the whole school;
- an established framework for all teachers to refer to in their own planning/team meetings;
- a useful means of monitoring the progress of the curriculum;
- raised awareness amongst staff of other colleagues' work.

The coordinator in School A had produced a long-term plan using a local education authority (LEA) framework which had described in detail what is required of schools in covering the curriculum. She commented that the document had saved her a great deal of time in producing the long-term plan. More detailed planning of short- and medium-term goals was being carried out by teachers using individual planning sheets for each block of work. It is hoped that these will eventually form a detailed structure ensuring continuity and progression throughout the school while making use of a published scheme of work as a principal resource.

1.2.3 Topic-based or subject-specific mathematics teaching?

It has been widely acknowledged that the introduction of the National Curriculum has undermined the extent to which primary schools make use of topic work in their planning and delivery of the curriculum, in particular at Key Stage 2 (Dadds, 1993; Webb, 1993; OFSTED, 1996b). During the initial stages of its introduction, many teachers considered that they could continue to deliver the core subjects of the prescribed curriculum via their established practice of using topics (Webb, 1993). However, as the programmes of study for an additional six subjects became available, concern was expressed amongst the profession that the requirements for the teaching and assessing of individual subjects could no longer be met in this way.

During a small-scale study of the practice of topic work at Key Stage 2 in 1992, Webb (1993) identified a shift in emphasis in teachers' planning away from broad-based topics towards much more subject-specific work. The main reason for this move was to meet the teaching and assessment requirements of the National Curriculum. Webb noted that while this pragmatic shift has resulted in an assurance of coverage of curriculum requirements, it has been at the expense of a sense of enjoyment for many teachers and pupils in their experience of teaching and learning:

> *While teachers considered broad-based topics were inappropriate for meeting National Curriculum requirements, most teachers sadly regretted the loss of 'fun', 'exhilaration', 'stimulation' and 'motivation' that arose for teachers and children from pre-National Curriculum topics.* (p. 249)

The pressure of subject-specific teaching was further explored by Osborn and Black (1994), who identified a potential tension between the role of the generalist classroom teacher and subject specialism. Although most of the schools in their study planned on a topic basis, most were planning teaching programmes closely related to specific attainment targets and subject-specific advice was sought from curriculum coordinators.

Most of the schools visited during the project were making use of subject-specific plans and schemes of work for all subjects. There was a particular emphasis on the separate teaching of mathematics and English in the majority of schools, many of which were making a conscious effort to teach daily sessions of literacy and numeracy.

In addition to the requirements of the National Curriculum and recent developments in literacy and numeracy, schools might adopt a subject-based approach to planning to meet the demands of staffing arrangements.

The mathematics coordinator in School J, a suburban primary, commented that next year, an extra teacher is being brought in to reduce class sizes. The extra teacher will take out half classes for half days and the coordinator felt that this will demand a great deal more subject-specific planning to ensure that pupils receive the whole curriculum. She felt that this would threaten the existing practice of topic-based teaching which she had tried to maintain: *'I still try and teach through topics such as the Egyptians for maths, history and geography but I am always conscious of the fact that I have got certain subjects to deliver. At least now we're able to rotate certain subjects such as geography and history on a half-termly basis.'*

While the majority of primary schools have used a topic-based approach to planning for many years, this has largely been to the exclusion of mathematics (Burton, 1994). In 1996, the Office for Standards in Education (OFSTED) noted that *'pupils' knowledge of shape and space, algebra and data handling is often limited and they are given too few opportunities to use and apply their mathematical skills effectively. It is still rare for schools to plan opportunities for pupils to develop and use these skills in other subjects'* (OFSTED, 1996b, p. 4).

The legacy of textbook dependency in this country has played a part in the isolation of mathematics from the broader curriculum (Burton, 1994), and the role of textbooks will be explored later on in Section 1.3. However, with the increased emphasis on investigational work in the curriculum, there is ample opportunity for teachers to present mathematical ideas in a variety of contexts. Burton (1994) has presented a number of useful ideas for possible contexts, for example:

- an imaginative theme, e.g. Giants
- a game or puzzle
- an idea, e.g. circles
- an incentive, e.g. fund-raising
- part of the environment, e.g. Bridges
- a story
- a place, e.g. The Park
- a child's question.

She suggests that in presenting mathematical material in this way, the meaning is accessible to the child rather than superimposed by the teacher or textbook. New material is offered in a familiar context, thereby embedding learning into what is already known.

Staff in School E, a suburban infant school, had made a conscious effort to retain a whole-school plan based on termly themes. Long-term plans had been produced for each subject across all year groups under the same themes. Each theme identified a range of key subject areas, for example, Habitats: geography; Opposites: mathematics, etc. Subject coordinators had worked together in deciding the themes and matching suitable activities.

When questioned about the purpose of planning in this way, the head commented that the school had wanted to focus on the nature of a pupil's experience of the *whole* curriculum. Planning subjects in this way has identified curriculum links, thereby reinforcing the holistic aspect of the experienced curriculum.

Examples of such themes were:

- Fairy Tales
- Mr Men
- Old MacDonald
- Holidays
- Toys
- Celebrations
- Habitats
- Flight
- Ourselves
- Once upon a time...

Long-term planning for mathematics included these themes and outlined a school-produced scheme of work. Work was planned as both ongoing and blocked units and activities linked to the theme whenever possible. In the majority of cases, these activities were addressing Ma1: Using and Applying Mathematics (UAM).

1.2.4 Summary

The introduction of the National Curriculum has encouraged the collaborative work of teachers in the planning of the whole school curriculum. In most if not all schools, subject coordinators are responsible for the production of long-term plans defining the coverage and progression of their subject. Individual subject plans may or may not be linked to others by themes or a whole-school plan. Commentators have suggested that the introduction of the National Curriculum has encouraged subject-specific planning and a general move away from the traditional 'themes' or topic areas. While mathematics has often been planned in isolation from other subject areas, the need to address the issue of the application of mathematics in a wide variety of contexts is highlighted in Ma1, UAM (see Section 1.6). Planned in this way, mathematics might be experienced in the context of a number of potentially stimulating and engaging topic areas.

1.3 THE PUBLISHED SCHEME

There has been increased concern in recent years about the over-use of textbooks in the teaching of mathematics in schools in this country. Findings from recent research are presented in this section alongside possible choices available to schools in promoting a change in practice.

1.3.1 Introduction

Commercially produced schemes of work dominate the teaching and learning of mathematics in the majority of schools in this country (OFSTED, 1995). Stow with Foxman (1988) noted that in 1965, the Nuffield Foundation Primary Mathematics Teaching Project was set up and resulted in the production of a comprehensive mathematics course for 5–13-year-olds. The years that followed witnessed a growth in the development of a significant number of textbooks including the introduction of individualised schemes. In addition, the implementation of the National Curriculum has instigated an upsurge of commercially produced mathematical materials including schemes of work, investigational and practical activities and, more recently, free-standing tests to establish National Curriculum levels.

1.3.2 Content of published schemes

Unlike other European countries, mathematical textbooks in England do not require official approval. It is not, therefore, surprising that there is a wide variation in the content of such publications and their coverage of the curriculum (Bierhoff, 1996). While some schemes claim to ensure adequate coverage of the entire curriculum, others place particular emphasis on, for example, investigational work or numeracy skills.

Bierhoff (1996), in a comparison study of primary school mathematics textbooks in Britain, Germany and Switzerland, found major differences between published materials. In particular, she noted that the allocation of time to number work was significantly less in England — roughly 50 per cent — than in German and Swiss textbooks (over 80 per cent). In addition, the rate of change of topics was found to be far greater in English textbooks than in those in the other two countries. Although basic concepts reappeared frequently in English textbooks, Bierhoff has suggested that often insufficient time was given for the consolidation of these concepts and often more advanced concepts were introduced before the basics had been mastered.

Although teachers in all three countries relied upon textbooks in their teaching, Bierhoff suggested that in Germany and Switzerland, teachers followed a textbook more closely, *'knowing that it provides a sound and officially approved structure for their teaching'* (p 5). However, in England, she has argued that in schools where the provision for teaching is not so adequate, the problem is exacerbated by the use of *'widespread "individualised" teaching methods which require children to learn by themselves for a great proportion of the time. English teachers spend most of their time in class dealing with pupils individually; each pupil consequently has very limited contact-time with the teacher and benefits from no more than a few minutes of direct teaching in each lesson'* (p 4). Issues surrounding whole-class teaching and teacher-pupil interactions will be explored in Section 1.5.

1.3.3 The use of published schemes

There has been, in recent years, an increased concern about the over-reliance on commercial schemes in the planning of mathematics in schools (see, for example, Millet and Johnson, 1996; Burton, 1994; Bierhoff, 1996). In a review of recent inspection findings, OFSTED (1995) reported that: *'....too many pupils in Key Stage 2 spend a lot of time working individually through texts with little direction from or interaction with the teacher. This frequently results in a mismatch of work in terms of pupils' previous achievement and no progress in learning taking place'* (p. 10, para. 12). Burton (1994) has argued in support of this, suggesting that the over-use of published schemes forces the teacher into the subservient role of a 'helper' and invokes negative learning experiences.

A wide-scale study of the implementation of the National Curriculum (Johnson and Millett, 1996) focused on the use of commercial schemes in the planning of the mathematics curriculum. In their study, although Key Stage 1 teachers were less reliant on schemes than those at Key Stage 2, one-third claimed to have used a commercial scheme for more than half of the work in mathematics in their classrooms. This figure doubled at Key Stage 2, where almost 60 per cent of teachers said that they had made use of a commercial scheme for more than half of the work in mathematics.

Data from the research indicated the major role played by the commercial scheme in decisions teachers made about planning. While often the use of such a scheme was thought to solve a range of problems identified by teachers (coverage of the curriculum, incorporating UAM, etc.), the research findings suggested quite the reverse; *'Teachers will not necessarily solve their problems and may, in fact, exacerbate them by turning uncritically to commercial schemes'* (p. 73). The researchers concluded that for some teachers, feelings of their inadequacy in mathematics or a lack of subject knowledge has often increased the

pressure to turn to a published scheme of work. Yet on the other hand, they suggest that *'low scheme use may not necessarily be associated with good practice'* (p. 72), especially where teachers may be lacking in confidence.

1.3.4 Teachers' adaptation of schemes

Johnson and Millett's study also highlighted the fact that for some teachers, the introduction of the National Curriculum had made them think more carefully about the role of published schemes in meeting the needs of their pupils. As a consequence, they had selected material from a range of published texts, enabling them to meet the needs of individuals (Millett *et al.*, 1995). The researchers suggested that *'used in this way, with the teacher rather than the scheme firmly in control of organising the mathematics work to include a variety of whole-class, group and individual teaching situations, commercial mathematics materials have much to offer, not only organisationally but also as a source of ideas for teachers to use, develop and extend'* (p. 17). These teachers tended to make more use of National Curriculum documents as a framework in their planning and were developing their own schemes of work.

School A, a rural primary, had changed its published scheme of work in recent years to meet the demands of the National Curriculum. The present published scheme had been chosen by the mathematics coordinator *'because it provides a good balance of work — practical, investigational, written, opportunities for AT1 and consolidation and games'.*

Every member of staff has a teacher's resource file and, initially, they were given the freedom to use the scheme as they chose. However, the coordinator commented that many staff very quickly became 'book-bound' and this has since been recognised in the school policy: *'The school has adopted the published scheme as a core scheme, but we are aware that this must always be seen as a resource to aid teachers in their delivery of the curriculum, rather than an inflexible structure which the teacher feels bound to follow rigidly.'*

This problem has since been lessened by the long-term planning of mathematics for the whole school into blocks which are repeated on a yearly cycle. This enables teachers to use their own methods and resources for teaching a particular topic while ensuring adequate coverage of the curriculum and an effective means of sharing resources across the whole school: *'It's great because it means that every child can have a metre ruler when they need one'*, commented a Year 5/6 teacher. In this way, the long-term plan is the outline of the syllabus and the published scheme is the principal resource, supplemented by other material.

Staff in School K, an inner city primary, had evaluated the whole mathematics curriculum recently. Having reviewed their existing published scheme, they subsequently produced their own scheme of work to 'fill in the gaps' of the published material. Used in this way, the published scheme is the principle resource but no longer dictates the order of topics in the long-term planning of mathematics.

However, while it might be desirable for teachers to develop their own schemes of work, the need for both time and effective coordinator leadership in carrying out such a task has been noted:

> *Until teachers see the value of alternatives to the commercial schemes upon which they depend, there is not likely to be significant change in their use. The time needed to develop a scheme of work within a school which could be the basis of teachers' planning should not be underestimated, and maths coordinators and HoDs will need to have time to set aside to facilitate such developments.*
>
> (Millett and Johnson, 1996, p. 73)

This view has been echoed by Winteridge (1989), who notes that developing a scheme of work *'can be a rewarding task but it requires confidence, expertise and an enormous time investment from teachers'* (p. 102). He continues by identifying the two main choices faced by teachers in promoting change to a scheme of work: whether to produce a school-based scheme or purchase a new published scheme. Of course, it is possible that a school might consider both options and purchase a new scheme with a view to using it as a main resource in the formulation of their own scheme of work.

Staff in School L, a suburban primary, had spent some time recently reviewing a range of published schemes and had decided to purchase one in the autumn. However, implementation of the scheme will be delayed until the school's own scheme of work for mathematics has been produced based on the chosen published material.

1.3.5 Choosing a new scheme

With such a wide range of published schemes currently available, schools are having to make careful considerations when choosing new schemes. Winteridge (1989) offers some guidance for schools in choosing a new published scheme. This includes:

- a description of the scheme
  – e.g. range of materials, mode of use, cost;
- the pupils' materials
  – e.g. opportunities, presentation;
- assessment material
  – e.g. purpose, record-keeping;
- readability
  – e.g. appropriateness;
- teacher guidance
  – e.g. information, ideas.

Bierhoff (1996) has noted that the criteria most commonly used by English teachers in their assessment of the suitability of commercial schemes include, among others:

- the coverage of the National Curriculum;
- suggestions for 'stimulating' activities and investigations;
- the number of consolidation exercises;
- the presentation of mathematics as a 'fun' subject.

Half of the NFER case-study schools had changed their published scheme within the last four years or were about to do so. The main reasons cited by coordinators for the change were to:

- meet the requirements of the National Curriculum, in particular in practical and investigational work;
- ensure coverage of the curriculum;
- provide adequate levels of differentiated work (including extension activities).

Staff in School C, an inner-city primary, spent some time reviewing published schemes four years ago and chose their present scheme '*because it offered the best coverage with adequate differentiation*'. The coordinator felt that, in general, most Key Stage 2 teachers were happy with the scheme whereas Key Stage 1 staff found it more difficult to use (they claimed that coverage was inadequate in certain areas of the curriculum) and tended to make use of their own resources.

However, the decision to purchase a new published scheme will without a doubt have financial implications for a school. Winteridge (1989) notes that this is not necessarily the sole total cost of equipping the whole school with the scheme (which may be possibly managed over time via a gradual introduction) but may also include recurrent expenditure (in particular where individual work books are concerned).

School I, a rural primary, had made use of their present mathematics scheme for the past five years. The coordinator commented that although the scheme was fairly well differentiated, it was lacking in suitable extension activities. This was of particular concern as the schools was criticised by OFSTED recently for not challenging able pupils. Having reviewed the range of schemes available, she had identified a suitable replacement but said that the school did not have the necessary funding to purchase it at present.

In managing to budget the cost implications of the introduction of a new scheme, School F had 'phased in' the scheme initially with Reception and Years 1 and 2 and next year will continue with Years 3, 4, 5 and 6. However, the supplementary individual workbooks need replacing every year, and it is hoped that these will eventually be phased out when the school's own scheme is finalised and they can be replaced with worksheets.

1.3.6 Summary

Commercially produced mathematics schemes of work have played a major part in the teaching and learning of mathematics for some years. While many commentators have criticised the over-use of such schemes, recent research suggests that some teachers are using published material selectively, supplemented by other materials, and on occasions, are developing a school-produced scheme. However, this cannot be developed without time and effective coordinator leadership.

1.4 ASSESSMENT

This section focuses on the importance of consistency of assessment practice in schools and presents a range of recent research findings and guidance on teacher assessment.

1.4.1 Introduction

Since its implementation in 1988, the National Curriculum has prompted the development of a range of new procedures for assessing, monitoring and reporting on the progress of pupils. A framework for a system of national assessment was initiated by the report of the Task Group on Assessment and Testing (TGAT) (GB. DES, 1988), which advocated the use of criterion-referenced assessment across the curriculum. The report made reference to the two major forms of assessment which have since been clearly established; the end-of-key-stage 'standardised assessment tasks' (SATs) and more formative 'teacher assessment' (see Gipps *et al.*, 1995, for findings from an in-depth study of Key Stage 1 teachers' assessment practice during the early '90s).

1.4.2 National Curriculum tests

The initial run of the National Curriculum tests in 1991 was not without difficulties (Gipps, 1992; Gipps *et al.*, 1995; Sainsbury, 1996), and many teachers felt that the tests were unmanageable and heavily overloaded. Following a national boycott of SATs at Key Stages 1 and 3 in 1993, Sir Ron Dearing was appointed to review and streamline the National Curriculum. The review resulted in the total test time for pupils at Key Stage 1 being cut by half in mathematics and English, with science to be covered by teacher assessment only. Key Stage 2 tests remained as a statutory national pilot, although the majority of schools took part (Dearing, 1994).

Recent research of assessment practice carried out by Gipps *et al.* (1995) indicates that despite a move away from the practical assessment tasks of 1991 towards the more formal 'paper and pencil' tests, by 1994, there was still considerable variability amongst teachers in their organisation and presentation of assessment material and the effects of testing on classroom practice.

Coordinators in the schools visited expressed a variety of opinions concerning the use of SATs. In general, the majority felt that there had been a period of 'settling down' in recent years, although one coordinator commented that while Key Stage 1 teachers were now *'taking them in their stride'*, at Key Stage 2 *'there was still a fear of the unknown'.*

Most of the coordinators felt that the publication of results had little effect on teaching practice, although one felt that SATs were clearly a driving force in the school: '*SATs govern what we teach because our results are published.'*

A coordinator in School D, an urban junior school, felt that while SATs were *'a useful standardised measure, pupils do the most silly things in tests and we are all aware of that'.*

At the time of writing, tests in English and mathematics are statutory at Key Stages 1 and 2 with the addition of science at Key Stage 2. In addition, a voluntary national pilot of a mental arithmetic test has taken place at Key Stage 2. There has also been a pilot of tests in the three core subjects for pupils in Year 4 with a sample of schools, and these optional materials are now available for all schools.

1.4.3 Teacher assessment

The emphasis on formative teacher assessment in the TGAT report was generally welcomed by teachers and educationists and reduced an innate fear that testing at 11 would replicate a system of 11+ examinations (Gipps *et al.*, 1995). In addition, Circular 2/96 (GB. DfEE, 1996) states the statutory requirements for schools in reporting to parents, which now includes end-of-key-stage teacher assessments in the core subjects.

Since the Dearing Review, end-of-key-stage teacher assessment and SATs results have had equal status in schools' reporting to parents and others. The SCAA guidance (1995) on consistency in teacher assessment defines the formative nature of the process:

> *'Statutory teacher assessment involves teachers using the knowledge gained from everyday assessments to make and record their judgements on pupils' overall attainment at the end of a key stage'* (p. 4).

The revised curriculum (GB. DES and WO, 1995) includes *level descriptions* which define standards against which pupils are measured. A '*best fit*' approach is advocated, encouraging teachers to choose which level description most closely describes a child's performance at the end of a key stage.

However, there are, as yet, no other requirements of teachers in terms of how the decision of a teacher-assessed end-of-key-stage level is made or how they make or record judgements on pupils' progress. It would, therefore, seem to be important that schools address issues surrounding moderation of teacher assessment, thereby ensuring consistency in assessment procedures amongst teachers and year groups.

SCAA (1995) cites the benefits of consistency in teacher assessment as:

- fairness for all pupils within different classes, schools and key stages;
- confidence given to headteachers, governors, teachers, parents and pupils in the variety of judgements reached in schools;
- the enhancement of teachers' knowledge and increased confidence in their own assessments;
- an establishment of trust in the judgement of other teachers, thereby resulting in a greater willingness to value and acknowledge previous assessments of pupils;
- a promotion of collaborative work amongst teachers, thereby reducing individual burdens and developing planning and assessment procedures throughout the school.

Commentators such as Gipps *et al.* (1995) have argued that the lack of an audit of teacher assessment will result in much inconsistency which will '*effectively downgrade the status*' (p. 15). However, others, such as Goldstein (1990) have expressed a reservation concerning the level at which teacher assessment should be standardised. He has argued that a centralisation of teacher assessment would restrict its diagnostic purpose to the limits of standardised assessment tasks and merely serve the purpose of public reporting. In his view, it is the sheer localised nature of teacher assessment which makes it valuable in terms of contributing to the provision of teaching and learning in a school.

Evidence from visits to schools suggests that schools (and individual teachers within schools) are making use of a whole range of procedures to decide on a particular level. These include work sampling, teacher-produced tests, free-standing commercial tests and classroom observations. Where attempts at moderation had been made, this had most commonly taken the form of 'work sampling meetings' between teachers of similar age classes.

When asked about teacher assessment, a coordinator in School I (a rural primary) commented that '*it has a lot to do with the experience of the staff*'. She expressed particular concern for a member of staff in his second year of teaching who had been '*overwhelmed*' by a teacher assessment sheet. There had been a number of attempts at the moderation of teacher assessment within the school using work sampling but she felt that it would take some time to improve.

The coordinator felt that the issue remained contentious, in particular, between schools. Although she had attended a number of meetings with coordinators from nearby schools, she said that '*the whole thing was very subjective and a number of people got upset when people disagreed with their marks*'. Similar comments were made by a number of other coordinators interviewed in this study.

Issues relating to assessment were investigated as part of a recent NFER study exploring wider matters concerning continuity and progression (Lee *et al.*, 1995). The researchers found that case study primary schools were attempting some level of moderation, particularly in core subjects. However, the report noted that although teachers made use of National Curriculum levels in reporting to parents, many felt that other forms of reference had been more informative.

1.4.4 Child-centred assessment

While all teachers assess informally most of the time, it is the relationship between the assessment procedure and the whole curriculum which lies at the heart of effective monitoring and evaluation of a child's progress. Statutory end-of-key-stage assessments provide a 'snapshot' of a child's performance at any one moment in time. However, many (for example Burton, 1994 and Clarke and Atkinson, 1996) argue that learners constantly engage in self-evaluation, and informal assessment procedures should build on existing strategies to suit the needs of their users.

Clarke and Atkinson suggest that a child-centred approach to assessment offers a welcome deviation away from the standard criterion-referenced assessment while meeting the statutory requirements for assessment procedures and retaining the programme of study (PoS) requirements in the planning of tasks. They offer various strategies for identifying and monitoring 'significant achievement' in the classroom as the main focus of a framework for ongoing assessment. There is much emphasis on assessment dialogue between teacher and pupil. The underlying principles for this framework are:

- *The assessment process must include the child, aiming for the child to become part of the evaluation process.*
- *The assessment process must enhance the child's learning and the teacher's teaching.*
- *The assessment process should be manageable.* (p. 7)

The use of evaluation as part of the learning process is further explored by Burton (1994), who argues the importance of creating an expectation in the classroom that learning is to be 'challenging'. It is then most likely that *'failure is not a personal disaster, but an opportunity to have another try from a different angle, or to compare with others and see what can be found out'* (p. 136). Burton suggests that continuous reflection should form an integral part of the learning process and that pupils themselves (even the very young) should take responsibility for their own questioning. In this way, assessment is essentially formative rather than summative.

1.4.5 Assessment informing practice

Whatever the nature of the assessment process, whether formative or summative, the result may play an important role in identifying the specific needs of an individual pupil or a group of pupils. Once needs are identified, the teacher might modify the teaching programme for those pupils experiencing difficulties. In this way, the results of assessment are being used to inform future practice.

In a recent review of inspection findings in mathematics, OFSTED (1995) noted that *'few schools have devised policies which make clear how the data collected on pupils' attainments could guide teachers in modifying their future planning for individuals and classes and, in the longer term, to ensure continuity and progression'* (p14, para. 26).

On a larger scale, primary schools are being encouraged to monitor systematically and make use of the results of standardised tests, baseline assessments and SATs as indicators to set targets for future performance (OFSTED, 1996a) (see Section 1.5 on raising achievement).

A range of strategies to make use of assessment results to inform practice had been employed by schools visited during the project. For the majority of schools, these were in the early stages of development, but it was evident that they were being given increased consideration.

The following three examples illustrate the range of such strategies; each one had been implemented within the last two years.

Evidence from the questionnaire in this survey indicated that a significant number of schools have purchased externally produced tests (in particular at Key Stage 2; see Section 2.2, Table 2.8), and one of the schools visited had made use of such tests to identify weaknesses in pupils' knowledge.

School I, a rural primary school, made use of a range of externally produced mathematics tests. The coordinator commented that the staff had been disappointed with the previous year's SATs results, and this year they had been working hard to feed back diagnostic information from the tests into the curriculum via an analysis of the results. The coordinator had made use of a spreadsheet accompanying an externally produced Year 4 test to identify areas of specific weakness in the curriculum. For example, it was noted that the topic of 'averages' had a low mean score across the year group and so there had been increased emphasis on that topic area this year. In this way, test results were being analysed to inform the planning process.

Schools are increasingly being encouraged to raise standards, in particular in numeracy. One of the schools visited during the study had designed a range of 'numeracy profiles' as a tool for assessment within a whole-school numeracy initiative.

School B, a suburban first school (Reception – Year 4), had recently introduced a numeracy initiative to raise standards across the whole school. An important part of the monitoring and assessment of standards of numeracy across the whole school and the impact of the initiative was the use of a set of Numeracy Profiles. Staff got together to discuss desirable outcomes for each year group in numeracy, thereby setting targets for the end of each year.

Each profile takes the form of a list of learning outcomes for pupils in each year group. Teachers highlight each outcome as and when it is achieved.
For example, part of the numeracy profile for Year 1 includes:

Numbers 1–10: count; read; write; conserve; order; etc.

Language: set; add; plus; count on; subtract; take away; minus; more; less; fewer; equal; same as; estimate; guess; etc.

The head felt that the continuous use and updating of profiles had facilitated both collaborative work amongst staff and a means of ensuring continuity and progression in numeracy across the whole school. The profiles are used at the beginning and end of each year to promote the discussion of staff expectations and reflect on practice which the head felt was both useful and morale-boosting:

This blitz can do wonders for staff morale and enthusiasm.

In addition to 'snapshot' assessments, schools may be monitoring the pattern of results over time. Another form of monitoring might involve the tracking of individuals, as was being developed by one of the schools visited.

The coordinator in School E, a suburban infant school, had been allocated some time to work with a number of identified pupils in an attempt to track their progress in mathematics throughout the school.

Work began in September 1996, when two pupils (average ability) were chosen from each of three reception classes. The coordinator worked with them for three sessions over the year (one each term) in addition to looking at their baseline scores (LEA assessment material).

Session 1 (autumn term)
This was essentially an informal chat with structured play activities (beads, cubes, etc.). Pupils were also asked to write down as many numbers as possible (starting with 1), and she was surprised to find that some could go on up to 19.

Session 2 (spring term)
Pupils were reassessed using baseline criteria. All had progressed in at least one area and some areas had stayed the same. It is interesting to note that when asked to perform the Session 1 written task (writing down numbers), some of the pupils could not write down as many as before. This was thought to be a result of both the emphasis on numbers 1–10 in the curriculum and the pupils having to cope with other subjects.

Session 3 (summer term)
The investigation was extended to the use of shapes and money.

Results of each session were recorded on a tracking sheet comprising a simple line for each attainment target.

During the second year of the exercise, six new reception pupils will be identified. Selection of these pupils will be slightly delayed to allow the class teacher to identify a pupil who has made significant progress and very little progress since the start of the term. The coordinator said that she would like to use the monitoring to identify key factors which have contributed to the progress/lack of progress for each individual. Work will continue with this year's sample, and the problem of manageability will have to be addressed. The coordinator anticipated that it will be possible for monitoring to take place at a distance (i.e. class teacher feeding back results of specific assessments) in Year 1 and eventually Year 2.

Findings similar to those in the example above were found by MacNamara (1995), who identified a regression in pupils' ability to perform particular mathematical tasks after a term of initial teaching. MacNamara attributed this regression to the reinforcement of other counting skills in the textbooks used by the class teacher.

1.4.6 Summary

The introduction of the National Curriculum and its assessment procedures has established two principal forms of assessment: the standardised assessment tasks and the formative teacher assessments. As the Government continues to initiate a drive to raise standards and schools are under pressure to perform against each other, there has never been a greater emphasis on the reporting of results to parents and others. While schools are being encouraged to analyse systematically the results of assessment procedures and identify specific targets, few have formalised this process. Clearly, there is a need for further guidance for schools in this area of work. What remains clear is the importance of teachers working collaboratively to ensure optimum consistency in assessment procedures throughout their school, thereby considering the relationship between their own assessment procedures and the whole curriculum.

1.5 RAISING ACHIEVEMENT

Attention to 'standards' in education has provoked much controversy in recent years. This section outlines recently developed initiatives, both nation-wide and within schools, designed in an attempt to assist with pupils who appear to be underachieving in literacy and/or numeracy skills.

1.5.1 Introduction

There has been increased concern in recent years about the need to improve standards in education, not least in mathematics and, in particular, in the areas of literacy and numeracy (Brooks *et al.*, 1995; OFSTED, 1997; Reynolds, 1997; Straker, 1997). Within one week of entering government during May 1997, Ministers began work on the most swiftly produced White Paper in the history of education, *Excellence in Schools* (GB. Parliament. House of Commons, 1997).

On 13th May 1997, the Secretary of State for Education and Employment, David Blunkett, set national targets for English and mathematics to be achieved by the year 2002:

- *75% of 11 year olds will be reaching the standards expected for their age in maths, and;*
- *80% of 11 year olds will be reaching the standards expected for their age in English.*

DfEE News 96/97

With just over 50 per cent of 11-year-olds reaching the expected standards in these subjects in 1996, the target is an ambitious one. The Annual Report of the Chief Inspector of Schools (1997) has, for two consecutive years, criticised the lack of pupils' progress in both literacy and numeracy. In the teaching of number, Woodhead argued that there has been too much emphasis on repetitious written exercises involving individual methods of working. Furthermore, results from The Third International Maths and Science Study (TIMSS) (Harris *et al.*, 1997) indicate that pupils in England in Years 4 and 5 scored below the international averages in number work.

At the time of this study, the increased concern for standards of literacy and numeracy across the country has encouraged the Government to set up two 'task forces' to review the teaching and learning of these subjects (the final report for numeracy is due in January 1998). In addition, in the case of numeracy, the teaching methods of other countries deemed to have performed well in international studies will also be considered in an attempt to identify potentially effective practice to be trialled in this country (Reynolds, 1997).

Research into the transfer of teaching methods from another country into English classrooms has been carried out by the National Institute for Economic and Social Research (NIESR). Having identified that Switzerland was the most successful European country in mathematics in recent international studies, a research team set up a project in the London Borough of Barking and Dagenham with the aim of introducing Swiss methods of teaching arithmetic (Prais, 1996).

The project began in 1995 in six schools and at the time of writing involves 27 schools. Teachers in the schools involved in the project visited schools in Switzerland during a week-long study of teaching methods. In general, they found much emphasis on whole-class interactive teaching and, in mathematics, an early focus on mental arithmetic skills. Each lesson is carefully planned with clear objectives. Pupils sit in a horseshoe formation to maximise teacher–pupil interaction. The results have been very encouraging, in particular, in raising the achievement of low attainers. However, there has been some concern over the potential extrapolation of such methods from such a small trial sample of schools (Foxman, 1997).

In addition to the proposed review of the teaching and learning of literacy and numeracy, the Government has recently set up two National Literacy and Numeracy Projects. At the present time of writing, the National Numeracy Project has been set up in more than 400 schools across 15 nominated LEAs. Centres have been established to support teachers within nominated schools, and these will be subject to an evaluation. The White Paper, *Excellence in Schools*, suggests that the work of these centres will be extended to all schools, who will be encouraged to devote a structured hour a day each to literacy and numeracy.

1.5.2 Strategies for raising achievement

In this section, three particular approaches to the issue of raising achievement in mathematics are presented, together with evidence from schools using these approaches.

1.5.2.1 Target setting

The National Curriculum aims to raise educational standards by defining set targets for pupils' attainment in each subject. In addition, schools have, in recent years, been encouraged to set up systems to monitor and review their performance and establish priorities for teaching and learning. The use of target setting to assist in defining these priorities has been suggested as one way in which schools can promote changes to their practice and raise standards of achievement (OFSTED, 1996a).

Target setting has been defined as *'taking action by setting specific goals and targets designed to raise educational standards'* (OFSTED, 1996a, p. 5).

A recent survey of target-setting initiatives of primary and secondary schools (OFSTED 1996a) revealed that a number of schools have made use of target-setting strategies related to priorities as a means of raising achievement across the curriculum. Key findings from the research suggest:

- Target setting was most effective when it resulted from self-critical reflection and analysis of performance.
- Many schools use data to monitor and review performance. In addition, some schools use these data to predict potential performance and make use of target setting to focus effort and resources on pupils who are underachieving or being insufficiently challenged.
- Successful target setting is carefully planned, focused on improving attainment and measurable results, and broken down to the level where particular teachers can take responsibility for setting and achieving the targets.
- Strategies adopted for achieving targets are generally structural or organisational in nature. They often place greater onus on pupils to do better than on teachers to improve their effectiveness.
- Raising standards of achievement is dependent upon a wide range of factors, including both the leadership and philosophy of the school as well as the target-setting strategies adopted.

Effective leadership has been recognised as essential in promoting change and development in primary schools (Lofthouse, 1991; Osborn and Black, 1994; OFSTED, 1996a). Promoting change may be threatening to teachers, and duty lies with the head and senior management team in a school to offer support (Lofthouse, 1991). Lofthouse offers various strategies for headteachers to consider in the implementation of curricular change and long-term development plans. The use of target setting may offer an additional focus for this long-term planning and help schools identify key areas of concern.

School L, a suburban primary school, had identified strategies as part of an action plan to raise achievement in mathematics and improve SATs results. The headteacher had a background in mathematics and was concerned about the low SATs results in 1996, in particular at Key Stage 2 in mathematics. With the coordinator, he decided to try to identify why some pupils had underachieved in the tests (the results did not reflect their ability in many cases). Meetings were held with all the staff to identify strategies for an action plan, and this comprised a number of curricular and assessment initiatives:

Curriculum review

The school had a long tradition of topic-based work, and thematic planning was in place for the whole school. This was implemented through an integrated day for all pupils, and it was felt that there had been a loss of focus on the core subjects. The plan is currently being updated with a view to formalising the daily teaching of English and mathematics during the morning and continuing with the topic-based approach to work in the afternoon.

Schemes of work

A new published mathematics scheme has been purchased to be used as the basis for a school-produced scheme of work to be produced in the autumn term. Time has been allocated for a series of after-school meetings involving all staff; so as to maximise curriculum impact, half will work on a mathematics scheme, the other half on an English scheme.

Assessment

It was felt by staff that, in general, pupils were unfamiliar with test material and formal test conditions and therefore lacked in ability to apply their knowledge in a formal situation. As a result, the school had purchased a number of external mathematics and reading tests for use with pupils in Years 3, 4 and 5. These tests are used halfway through the academic year, enabling teachers to use the results

diagnostically and evaluate teaching programmes accordingly. They will also be used to track the progress of individuals throughout Key Stage 2, enabling teachers to identify and meet the needs of those pupils who are underachieving.

Training
A number of training initiatives took place as part of the action plan. A two-day residential course focused on the issues of problem-solving and the use of published schemes. In addition, coordinators have attended 10- and 20-day mathematics courses and subsequently disseminated aspects of their work on these courses to other members of staff.

The action plan as a whole had obvious implications for resources, and the demand was met by the loss of a 0.4 floating teacher who was employed to provide cover for non-contact time. However, the head stressed the importance of this if coordinators are to have any non-contact time whatsoever. The majority of the funding for the training had come from Grants for Education Support and Training (GEST) sources, and this was supplemented by a priority from the school's general budget. The purchasing of the new mathematics scheme had been a considerable expenditure, but one that was felt to be necessary.

The head commented that by using the above strategies, the school had achieved its target increase in results in mathematics in the SATs the following year.

1.5.2.2 Whole-class teaching

Whole-class teaching dominated the structural organisation of teaching and learning in the majority of schools in this country until the late 1960s (Merrett, 1994). Change was brought about by a number of reports, beginning with the Plowden Report of 1967, advocating a new form of 'child-centred' or 'progressive' teaching and recommending the use of individualisation in teaching and the teaching of small groups. However, there has been increasing concern in recent years that the loss of whole-class teaching in many schools has contributed to the underachievement of pupils in numeracy, in particular, in relation to other countries as highlighted by international comparisons.

Data from the Third International Maths and Science Study (TIMSS) (Mullis *et al.*, 1997) revealed that in English schools participating in the survey, over half of the pupils in Year 5 worked individually in

mathematics lessons the majority of the time, while just over ten per cent experienced whole-class teaching for most of the time. This was compared with, for example, Korea (where pupils in classes equivalent to both Year 4 and Year 5 in England achieved significantly higher scores than their counterparts in England), where almost 80 per cent of nine-year-old pupils experienced whole-class teaching most of the time. Interestingly enough, in analysing the mean percentages achieved by pupils across different subject areas within mathematics, pupils in England in Years 4 and 5 scored below the international average in number-related tasks and significantly above the international average in geometry tasks (Harris *et al.*, 1997). On the other hand, pupils of a similar age in countries employing predominantly whole-class teaching strategies performed consistently well on these number-related tasks. It would seem, therefore, that one might possibly be able to identify certain areas of mathematics work which lend themselves more effectively to whole-class teaching, and others which lend themselves to individual and/or group work.

However, one must pause for a moment here and consider the definition of the term *whole-class teaching.* In the majority of the research reviewed so far, little has been said about the potential fundamental differences between *instructive* whole-class teaching (for example, teacher presenting an idea to the whole-class and then setting tasks for individuals with no discussion/questioning or answering) and *interactive* whole-class teaching as recently defined by the Chief Inspector of Schools and the National Numeracy Project.

The annual report of the Chief Inspector of Schools (OFSTED, 1997) advocated the use of interactive whole-class teaching as an effective means of facilitating good practice involving the questioning of the pupils by the teacher and differentiated work. *'In schools where a substantial amount of mathematics is taught directly to the whole teaching group or class and pupils regularly undertake oral and mental work, standards are generally higher than where the approach is overwhelmingly that of individual work'* (p. 12). In addition, schools were encouraged to place a greater emphasis on mental arithmetic work on a regular basis.

This view has been reinforced by the Director of the National Numeracy Project (Straker, 1997), who has argued that *'individualised work minimises rather than maximises opportunity for interaction and direct teaching'*. Suggested lesson models for the project have included oral question-and-answer sessions with the whole-class at the beginning and end of lessons encouraging the participation of every pupil.

Concern has been expressed by Straker (1997) about the often wide range of abilities of pupils in primary classes and the extent to which differentiation is possible or desirable within whole-class teaching. This has been taken into consideration in the structure of the suggested lesson models adopted by schools participating in the project, which include a middle section devoted to manageable differentiated tasks. The teacher is encouraged to plan work for four groups numbering from six to eight pupils across three levels of ability and sit with each group in turn. In this way, the needs of individuals are met while retaining the *'all important direct teaching'*.

The notion of *interactive* whole-class teaching has evolved in recent months to define the practice of teaching as described by commentators such as Woodhead (OFSTED, 1997), Straker (1997) and Reynolds (1997). Indeed, this practice is very different from the *instructive* whole-class teaching experienced by the majority of pupils in English classrooms before the mid 1960s. It is important to note that in reviewing the literature and results of international comparisons, commentators do not always distinguish between the two very different practices. In TIMSS, data differentiated between three main organisational methods: working together as a class; working individually; and working in pairs or small groups. Each of these main methods was subdivided to define more specifically the teaching approaches, so that, for example, *working together as a class* was subdivided into two approaches: firstly, *with pupils responding to each other*; and secondly, *with the teacher teaching the whole class* (see Keys *et al.*, 1997, p.17). However, the subtle difference between these two approaches is not always acknowledged, with the consequence that 'whole-class teaching' might be identified as contributing to the effectiveness of pupils' performance without any clarification of the exact nature of the practice.

There is little doubt that attention has been given increasingly in recent years to the effects of whole-class teaching on pupils' achievement. While the nature of classroom organisation remains at the discretion of the teacher, this has many implications for the methods of teaching employed. If teachers are to maximise opportunities for interactions with their pupils in their teaching and assessment procedures, then there may be a need for further guidance on the manageability of such a task.

School B, a suburban first school (Reception – Year 4), had implemented a numeracy initiative during the previous two years in an attempt to raise standards across the whole school. Previously the school had been criticised by OFSTED (in 1994) for having numeracy standards 'below national expectations'. The headteacher therefore decided to work with the mathematics coordinator and other members of staff to construct an action plan. This numeracy action plan fitted in alongside the mathematics component of the whole-school development plan.

The implementation of daily interactive whole-class numeracy sessions lay at the heart of the drive to raise standards across the whole school. A range of whole-class mental arithmetic activities was used including number games and teacher–pupil or pupil–pupil questioning. In these sessions, pupils were encouraged to listen to each other and explain their own methods of working. Often pupils were seated on the floor in front of the teacher, enabling her to explain new concepts to the whole-class or invite individuals to indicate an answer on a board.

There was a great deal of encouragement for those pupils who were less confident or unable to articulate their answers, and the majority of pupils clearly enjoyed the challenges posed to them. They were remarkably confident in questioning and answering each other (a common strategy employed after teacher–pupil dialogue) in front of the rest of the class. In a Year 2 class, pupils were seated in a circle and stood up two by two to question and answer each other, completely uninhibited. In this way, the use of pupil–pupil working appeared to capitalise on the widespread experience that one of the best ways to consolidate new learning is to explain or teach it to someone else.

In general, both the headteacher and coordinator felt that there had been a marked improvement in pupils' work and confidence in their own ability in mathematics.

1.5.2.3 Setting

While the majority of primary schools operate mixed-ability classes, a growing number are considering or implementing the use of setting for mathematics (Hewitt, 1997). A recent survey of over 1000 primary schools carried out by *The Times Educational Supplement* (1996) found that almost half of primary schools set classes by ability for some subjects, most frequently for mathematics and English and more commonly at Key Stage 2.

One of the main reasons for setting often mentioned by teachers is a reduction in the range of ability of a particular class, thereby enabling

the teacher to set work more appropriately to meet the needs of individuals. However, Hewitt (1997) has argued that every class is mixed-ability since *'the grouping of students into sets does not change the fact that there are mixed abilities within the class and these need to be catered for'*. He continues by suggesting that mathematics can lend itself to mixed-ability teaching without the necessary provision of individualised schemes of work.

Askew and Wiliam (1995), in their recent review of research on attainment grouping, found that the benefits of such grouping for pupils are relatively small. Moreover, they cite evidence from the research reviewed concerning the attitudes of pupils towards their experiences of attainment grouping. The main points cited from the review were that:

- *attainment grouping improves pupils' attitudes towards subject, but does not affect attitude towards school;*
- *any effects on self-esteem are small: positive for low-attainers and slightly negative for others.* (p. 40)

One of the benefits of attainment grouping identified in the review was related to the progress of high-achieving pupils. However, it was also noted that these pupils gain from mixed-ability collaborative work as much as any other pupils. The authors suggest that, in general, *'grouping by attainment may mean that particular expectations are set up from which pupils will have great difficulty breaking free'* (p.41).

The most recent review of research to date on the effects of grouping pupils by ability, carried out by Harlen and Malcom (1997), concluded that *'the research at primary/elementary level provides no evidence that achievement of pupils is raised either by streaming or setting within the school'* (p. 38). The authors highlighted the fact that the research reviewed indicated that it was what happened in a class and not how a class was constituted that was important. Interestingly enough, within-class ability grouping was identified as having the strongest effect on the progress of pupils of all abilities in mathematics alone compared with 'whole-class teaching'. This was thought to be due to the provision of grouping enabling teachers to offer appropriate challenges and support for individual pupils.

The authors conclude that it is the provision of differentiated learning experiences which is important, and ability grouping is one way of achieving this. They argue that teachers interact differently with pupils of differing abilities in heterogeneous groups and this can be to the detriment of the less able. However, they continue by highlighting the disadvantages of ability grouping, noting that it can introduce some of the social effects of streaming such as the less able pupils working less

effectively as a group and on tasks which are less stimulating than those of more able groups. They therefore suggest that the provision of pupils working within ability groups is restricted and that teachers '*use such grouping as little as possible and at other times to ensure that pupils have the benefits of working with others both more and less able than themselves*' (p. 40).

While there is currently little research evidence to suggest that setting, particularly in mathematics, is effective in raising the levels of achievement of pupils, the recent Government White Paper, *Excellence in Schools*, suggests that '*in some cases, it is worth considering in primary schools*' (para. 3, p. 38). Once again, if schools are considering changes of any kind to the organisation of pupils for teaching and learning, there is a need for clear guidance and support for staff at all levels.

School A, a rural primary school, had introduced setting arrangements in mathematics in September 1996 as a result of pre-inspection advice from a County Adviser who felt that the standards of mathematics were poor and teachers were struggling with large classes of a wide range of ability. This was exacerbated by the mixed age classes at Key Stage 2 comprising three classes of Years 3/4 pupils and three of Years 5/6 pupils. He therefore recommended that these classes were divided, forming three ability groups across each of the Years 3/4 and Years 5/6 band. Key Stage 1 pupils remained in mixed-ability classes.

The coordinator felt that the setting had been a success, although, on reflection, she commented that there had been obvious advantages and disadvantages in organising classes in this way:

ADVANTAGES OF SETTING

Pupil confidence

The children seem to be more confident and enjoy mathematics at their own level.

Differentiation

This is further implemented within each group, enabling the teacher to target individual needs much more effectively.

Teacher confidence

All of the teachers said they were much happier teaching classes of a smaller ability range. One teacher with 20 years' experience said: '*I've actually enjoyed teaching mathematics for the first time.*'

Class size

This can be controlled to a certain extent, allowing for smaller classes at the lower ability end.

Resources
Can be more effectively targeted, again towards the lower ability. Often two topics are taught over two weeks so that the teachers can work together in sharing resources.

Team work
Because all teachers within a team are teaching the same subject at the same time, they are able to vary individual approaches to suit a group's particular need while sharing effective teaching strategies or resources.

Pupil movement
Many of the pupils (80 per cent) have a different teacher for mathematics from their own classroom teacher. This also means that they have to change classrooms, promoting a sense of responsibility (ensuring they have the required books and equipment with them) and preparing them for secondary school.

Standards
These have already risen in the past two terms, and the coordinator feels confident that they will improve further (looking at the progress of the upper-ability upper juniors). Indeed, another primary school in the area has begun setting pupils for mathematics, and the coordinator had heard from colleagues that there are plans for a third to do the same.

DISADVANTAGES OF SETTING

Timetabling
There is a need to plan alongside access to the hall for all pupils for physical education. The timing of lessons is important. Each of the three classes must start and finish simultaneously and this can sometimes be restricting for the class teachers.

Borderline pupils
There are always those pupils who do not fit into any particular group. The system has to be very flexible and needs to address problems early on. If pupils need to be moved, the staff will aim to move a few together to avoid the singling out of any individual child.

Parental pressure
Although most parents have fully accepted the scheme, there have been grievances from a small minority who have objected to the choice of group made for their child. In these cases, staff have worked with parents to justify their decision and cited the benefits for the child. There have been no other problems.

Staff communication
For each band of pupils (Years 3/4 and 5/6), three class teachers teach three ability groups (upper, middle and lower). Therefore, the majority of pupils are experiencing a different teacher for mathematics and it is essential that staff are continuously communicating with each other about the progress of their pupils.

Parents' evening
There is no time for staff to see parents of both the children in their own class and those in their mathematics class. Alternative arrangements need to be made if parents have particular concerns about their child's mathematics.

'Labelling' of groups
Although there has not been any problem with this during the first year of setting, staff are well aware that it may develop in time and will ensure that it is kept to a minimum.

Cross-curricular work
With setting in place, it is very difficult to pay attention to cross-curricular issues and the sheer nature of the system lends itself to subject-specific teaching. Some may find this an area of concern.

1.5.3 Summary

The increased concern in recent years over standards of literacy and numeracy in this country has prompted Government Ministers to take action in an attempt to address the issue and promote changes to the education system to improve results. As there is increasing pressure on schools to raise standards and improve examination results, many are adopting a variety of new curricular and organisational strategies in an attempt to meet the demand. If the Government are to continue to suggest approaches to teaching and learning in an effort to raise standards in schools, then they must ensure that, in promoting change, there is continuous support and guidance provided for teachers.

1.6 USING AND APPLYING MATHEMATICS (UAM)

The increased emphasis on the application of mathematics to everyday problems and thought processes has prompted a series of changes to teachers' classroom practice. Issues surrounding the teaching and assessment of UAM are presented here alongside a review of guidance material.

1.6.1 Introduction

The mathematics curriculum of the last decade has experienced a definite change in focus away from specific numerical operations towards attention to problem solving and thought processes. The introduction of the National Curriculum included a separate attainment target (Ma1) devoted to Using and Applying Mathematics (UAM). This has placed further emphasis on work of this nature in schools and encouraged teachers to use a much more open-ended variety of activities in their classrooms. While this move has been welcomed by many, it has not evolved without contention, not least in the way in which it has been incorporated into the present day curriculum: *'The most controversial aspect of the consultation in the initial stages of developing the new mathematics Order was whether or not the process aspect of UAM (Ma1) should be integrated into other ATs — and there would no longer be a separate target'* (Brown and Johnson, 1996, p. 123).

This inherent conflict becomes apparent when one considers the sheer nature of this attainment target, which, unlike the others, focuses on mathematical *processes* rather than *content.* In this way, although the attainment target is set out separately, it is intended to be integrated with each of the other content-based targets. However, during the revision of the existing 1991 Order (GB. DES and WO), concern was expressed (by leading mathematical organisations such as the Joint Mathematical Council) that if formal integration occurred, there was a danger that teachers would lose sight of the need to concentrate on the processes of problem-solving techniques behind a focus on the techniques themselves. Hence, in the revised Order (GB. DES and WO, 1995), the separate attainment target was retained.

1.6.2 The implementation of UAM

It is, therefore, not surprising that both the teaching and assessment of this attainment target have been challenging. The first annual review of OFSTED inspections noted that '*the extent to which schools are implementing AT1 (using and applying) into their teaching and learning programmes is unacceptably varied. In a significant proportion of schools, work in AT1 is not planned at all, and very little occurs incidentally*' (OFSTED, 1995, para. 33). This was also noted in a recent NFER study of systems of teacher assessment (Sizmur *et al.*, 1994), which identified UAM as the most problematic area of assessment in mathematics.

The results of a recent wide-scale study of the implementation of the National Curriculum (Askew, 1996) revealed that teachers' interpretation of UAM varied considerably by paying attention to particular parts of the Order. It was noted in this study that teachers would often perceive that children were necessarily engaging in UAM if they were working on a practical task or 'real life' problem. As a result, there was an underlying assumption that work in UAM was continuously taking place.

1.6.3 Planning for UAM

Reference is made to the application of mathematics to both practical tasks and 'real life' problems in the programme of study for both Key Stages 1 and 2:

> Strand 1: Opportunities
>
> *Pupils should be given opportunities to use and apply mathematics in practical tasks, in real-life problems and within mathematics itself.* (GB. DES and WO, 1995)

However, while these activities may be worthy and may offer a suitable vehicle through which UAM may be assessed, OFSTED (1995) found that, frequently, they are presented in isolation from other mathematical content, and little attention is paid to the overall range of tasks and progression within them.

Evidence of this was found during this project's visits to schools. In the majority of cases, UAM was seen to have been delivered via the use of isolated practical tasks and individual investigations. Ideally, such activities need to be planned as an integral part of the curriculum. When questioned about teachers' use of investigations, most of the coordinators interviewed commented that teachers were left to decide on which were the more appropriate with little or no consideration being paid to the issues of continuity and progression of such tasks within the school as a whole.

The Non-Statutory Guidance accompanying the initial Order (NCC, 1989) states the three main objectives of UAM as:

- using mathematics;
- communicating in mathematics;
- developing ideas of argument and proof.

It suggests that these strands of mathematical activity '*should underpin pupils' work across all the areas of mathematics in the programmes of study at every stage*'. These strands can be found in more detail in the programme of study for each key stage. OFSTED recommended that more attention needs to be given to the teaching of these strands instead of using UAM tasks for assessment purposes only.

To ensure that schools give adequate opportunity for pupils to use and apply their knowledge of mathematics, there is no doubt that careful attention must be paid to the planning of such opportunities in support of the work in other attainment targets and subjects. Evidence from the literature reviewed suggests that, all too often, there has been little or no provision made for the planning of UAM in schools and no training specifically related to planning for coordinators. If schools are misinterpreting the Order and focusing on the title of 'using and applying' rather than the content of the programme of study, then the attainment target is only being partially integrated (Askew, 1996) and there is a need for further support and guidance for teachers in their work in this field.

1.6.4 Classroom practice

A wealth of useful publications has emerged in recent years offering strategies for teaching and assessment and resources for the implementation of UAM (see, for example, NCC, 1992a; 1992b; Straker, 1993; Burton, 1994; Mason, 1995 and Comer, 1996).

The emphasis on thought processes rather than the 'right answer' has a number of implications for teachers in encouraging pupils to tackle investigational tasks. Firstly, pupils need support in learning how to approach a specific task. Comer (1996) offers a hierarchical 'structure for solution' for pupils to support their working in this way:

- *be methodical;*
- *make a plan and write it down;*
- *use sketches or diagrams where they are helpful;*
- *try simple cases first;*
- *set out the results clearly (in a table or a chart);*
- *look for a pattern and describe it;*
- *draw conclusions;*
- *make a general statement;*
- *explain the reasoning.* (p. 31)

Secondly, teachers may need to question pupils either to overcome difficulties, or extend their level of investigation further.

The coordinator in School I, a rural primary commented that she had experienced *'some difficulty in getting children in tune with AT1'*. Many pupils were *'reluctant to explore — they wanted to tackle a question with a definite right answer'*. However, this had been resolved by introducing investigational methods of working much lower down in the school, starting in Year 1. In this way, they are trained to approach investigations during their early years and have more confidence later on.

Comer (1996) suggests that whole-class sessions can offer much opportunity for the exploration of problems, with the added benefit of pupils being able to communicate ideas with each other and with their teacher (a significant part of the programme of study). He continues that too often, pupils are working alone (particularly on investigations) and are deprived of the opportunity to discuss their findings.

Evidence from the school visits suggests that many teachers lack confidence in their ability to manage UAM in the classroom. Where training had taken place, it had often consisted of 'hands on' sessions whereby the coordinator (or adviser) had distributed a number of investigations to staff. While this has obvious benefits in promoting discussion and providing new resources, there seemed little evidence to suggest that specific strategies for working with pupils had been covered. This was with the exception of one coordinator who had arranged a number of training sessions focusing on the questioning of pupils.

The coordinator in School H, a rural primary school, had recently demonstrated UAM to every teacher in the school. She had started by looking at UAM and '*what it actually meant*' and, in turn, had demonstrated examples of teaching strategies to every class teacher via a lesson with their class. This enabled her to illustrate particular techniques of questioning pupils in relation to particular investigations.

She commented that, in practice, many teachers were carrying out investigations and making use of work sheets but were not realising the full potential of the material. She thought this was mainly due to their inability to ask open-ended questions or take note of specific mathematical patterns, a combination of both subject and teaching knowledge. In addition, she felt that often, a lack of teacher confidence needed to be addressed:

> *All teachers need to be reassured that they have been doing UAM work all of the time and that it is accessible to them. They don't need fancy resources or way-out ideas; they already have the material at hand. It's how they use it that counts. I believe that if children don't understand then they cannot go on. However, they need to be ale to find out for themselves. In this way, the teacher is a facilitator.*

1.6.5 Recording and assessment

The difficulties inherent in the implementation of UAM have already been discussed and, not surprisingly, have implications for assessment procedures. As Hargreaves (1996) has noted, the lack of a 'right answer' and emphasis on thought processes has severe implications for the reliability of assessment practice. It also presents difficulties in producing guidance material for teachers on assessing children's responses. Moreover, there is a danger that the focus of the assessment is the content area within which UAM is presented at the expense of the application of the techniques and thought processes used to solve problems.

The strategies demanded by the assessment of UAM can be rather time-consuming, often involving observations and questioning of pupils in a variety of contexts rather than the marking of their written work. Mason (1995) recommends that this should be carried out with a very small number of children at any one time, and careful consideration should be paid to the quality of questioning and the timing of the assessment. Observation sheets are recommended as a useful tool for gathering evidence in a classroom setting.

The recording of evidence from assessment sessions over a period of time is also important when teachers come to make a judgement, and difficulties may arise from children's inability to formalise their own ways of working. Burton (1994) has noted the importance of making the links between children's informal and formal recordings (in particular in number) explicit. She offers a variety of strategies to assist in '*pursuing a challenge*', including effective questioning and organising of groups.

Within the present context of the National Curriculum, it has been argued that the '*best fit*' model of formative assessment is a concept particularly suited to the skills in 'using and applying mathematics' (Hargreaves, 1996). As Mason suggests, the classroom teacher needs to have established quite clearly the meaning of the programmes of study and level descriptions before an assessment is carried out.

Issues surrounding the consistency of teacher assessment have been discussed in Section 1.4 on assessment but can be seen as particularly important in UAM, where reliability is jeopardised by the lack of a 'right answer'. Once again, to ensure reliability, teachers need continuous support and guidance from colleagues and their coordinator in their decision-making.

1.6.6 Diagnostic information

Pupils may appear to 'underachieve' in UAM for a variety of reasons. As was noted earlier, pupils may need time to develop suitable approaches to investigations. As Comer (1996) suggests, even if pupils have a clear understanding of the content of a mathematical operation, they may be unable to translate it into a practical problem and select the appropriate process for solution. Pupils need to have regular opportunities to apply their knowledge of mathematical content and check the reasonableness of their solutions.

However, often pupils will underachieve in UAM because of their lack of knowledge of the mathematical content (Mason, 1995). To overcome this, Mason suggests that children should have experienced the mathematical content of the activity at one level **higher** than the processes involved. *'For instance, if the classroom activity is mainly focused on level 3 then it is worth ensuring that the mathematical content has been taught to level 4. This will, to a large extent, help to avoid the situation where children's difficulties with the mathematical content of the activity obscure their process skills'* (p. 113).

1.6.7 Summary

There is little doubt that the nature of UAM as a focus on mathematical processes rather than content is the underlying cause of the difficulties surrounding its implementation into the curriculum. While there is a need for UAM to permeate the entire curriculum, ensuring that pupils have the opportunity to apply their content-based knowledge in a variety of contexts, the planning and assessment of the mathematical processes need careful consideration. All too often, attention is paid to the mathematical content at the expense of using and applying skills in formal school policies and schemes of work. This is not surprising since, by definition, it is much easier to refer to capability in specific aspects of mathematics than in the wider skills in UAM. As has been noted before, if UAM is not explicitly recognised in formal school policies and schemes of work, there is a danger that it will be overlooked by teachers and taken for granted. The need for further support and training in this area for many schools is evident.

1.7 HOME–SCHOOL LINKS

This final section of Part I focuses on primary schools' development of links with parents. It presents a range of issues both in the broader context of the school and, in particular, in relation to mathematics.

1.7.1 Introduction

The importance of parental involvement in schools in supporting children's learning has been well documented (see, for example MacBeth, 1989; Docking, 1990 and Jones *et al.*, 1992). Findings from the extensive Junior School Project (Mortimore *et al.*, 1988) suggested that pupil achievement and motivation were better in schools where parents were encouraged to visit classrooms and participate with school excursions etc.

Docking (1990) has identified two main 'strands' of developments since the late 1970s. One is related to the enhancement of parental rights (in particular, as a 'consumer') and issues of schools' accountability which have been reinforced by the Education Acts of the 1980s (GB. STATUTES 1981, 1988). The second is concerned with home–school relationships and the development of a partnership between teachers and pupils. It is the development of the latter which will be briefly discussed here primarily in the context of mathematics.

1.7.2 A channel of communication

While recent legislation has promoted the rights of parents to gain access to information on schools' performance and facilitated teacher accountability, partnership between home and school is not guaranteed. As Docking (*op.cit.*) has noted, *'rights are sterile unless the right-holders have the requisite knowledge, skills and motivation to take advantage of their rights'* (p. 99). He continues by describing a variety of ways in which dialogue between parents and teachers has been facilitated in many local authorities and primary schools. In this way, dialogue promotes parental *empowerment,* enabling them to work with teachers and become more involved with the life of the school.

A wide range of material has been published for teachers offering guidance on home/school relations (see, for example, Long, 1986; Sullivan, 1988; Bastiani, 1989 and Sullivan, 1991). Bastiani (1989) offers a wealth of ideas for the development and evaluation of a whole-school approach to parental partnership. He suggests the following key areas as a starting point for such an approach:

- communication of information;
- arrangements to discuss problems of individual children;
- involving parents in their children's learning;
- help with the running of the school: routine tasks, maintenance, etc;
- developing interest in, understanding of, and support for the work of the school;
- use of parental skills, interests and experience;
- providing opportunities for parents' own education and development;
- enlisting parents' views in decision/policy making (both formal and informal);
- active involvement with, and support for, family and community life.

As Bastiani has noted, these areas cover a wide range of purposes, and often the same practice can be used to achieve different means. In considering each of the above, it seems likely that teachers and parents may have differing views about the levels of responsibility and the exact nature of their roles.

Burton (1994) offers a variety of strategies for involving parents and establishing effective channels of communication. She stresses the need for frequent contact with parents if they are to work together with teachers and pupils as part of the educational process: *'The requirement to inform parents annually of the progress of their children in school is a minimal demand. Much more important is that parents, children and teachers feel like a team in the educational process and this can only happen if there is a regular information flow'* (p. 130).

School L, a suburban primary school, had administered confidential questionnaires to parents of Year 1 and Year 6 children. These had been developed by the Deputy Headteacher and a member of the Parent/Teacher Association to gather parents' opinions on issues such as:

Reception Issues	**Year 6 Issues**
Reasons for choice of school	Atmosphere of school
New Parents' Evening	Child's learning experiences
School Brochure	School environment
Introductory visit	Approachability of staff
Child's first week/term/year	Extra-curricular activities
Home/school communications	Home/school communications
Parent/Teacher Association	Homework

The survey was administered for the first time during the summer term of 1997. The headteacher commented that information from the questionnaires will be used each year to maintain an up-to-date awareness of parents' needs and feed into future planning.

1.7.3 Involving parents in the learning of mathematics

The issue of home–school continuity in the context of the teaching and learning of mathematics has been explored by Burton (1994), who has suggested that '*mathematics frequently touches a raw nerve for parents*' (p. 123). She notes that while the majority of parents share the sense of the importance of the learning of mathematics, their own experiences of learning mathematics might have been unfortunate and very different in nature to that of the mathematics experienced in classrooms today. This can result in an in-built fear of mathematics and a feeling of confronting the unknown. Burton argues that it is therefore essential that teachers enter into dialogue with parents to enlighten them of the changes to the teaching and learning of mathematics.

In addition to offering ideas for the involvement of parents at home in their child's learning, Burton suggests a variety of strategies to involve parents in the learning of mathematics in school:

- playing mathematical games;
- supervising children undertaking some project work out of doors or on a visit;
- a contribution to a project which invites information from a mother or father in a particular job or role;
- displaying work or constructing the resources necessary to a particular activity;
- the opening of a facility such as the use of computers to an after-school club of parents and/or children.

Similar strategies which have proved successful in informing parents and promoting home/school links in mathematics have been suggested by Stow (1989), who notes that it is important to consider the involvement of staff and parents in the organisation of such activities.

Following the success of an after-school Reading Club, School G, an inner city primary, had set up a similar Maths Club. The school was involved in a local authority Numeracy Initiative throughout 1995/6 which highlighted the need for the pupils to have regular practice of number skills. The establishment of the Maths Club was seen as providing the opportunity for many pupils to spend some extra time practising number work as well as involving parents in their child's learning of the subject. This was noted in the Maths Club preliminary guidance material produced by the school mathematics coordinator:

> *We feel that by establishing a Maths Club outside of normal school hours, we will be able to provide some of the extra time to consolidate these skills. Moreover, such a club provides an excellent opportunity for parents to develop confidence in the subject and to become involved in mathematics with their children. It will provide them with many ideas for activities that can be continued at home.*

The club ran during the autumn term of 1996 for the first time and again for half a term during the subsequent spring term. The weekly 40-minute sessions consisted of a variety of mathematical games (within eight workshops) which were supervised by adults (parents and classroom assistants). The outline plan of workshops comprised four 'number' and four 'shape logic' workshops. In addition, chess and strategic games were also offered. Class teachers decided which workshops were appropriate for individual children.

Teachers discussed the Maths Club at Parents' Evening and encouraged the parents of underachieving pupils to allow their child to attend. A letter was sent out to all parents inviting their child to the club. Training was provided for staff and classroom assistant volunteers. Certificates were issued both to parents and pupils who had attended four out of five sessions.

The Maths Club was run by nine teaching staff for two five-week periods. At each session, approximately 75 children were involved. In each classroom there were two teachers with 15 children with additional helpers. Year 6 pupils also assisted with Key Stage 1 pupils. Approximately 50 of the 75 children received certificates for each period. In general, the results were positive and many of the weaker pupils attended, although the headteacher commented that this required continuous encouragement.

1.7.4 Parents in the classroom

While many primary schools invite parents to help in various ways in assisting in the organisation of school excursions, productions and fetes, etc., an increasing number are encouraging volunteer 'parent helpers' to assist the teacher in the classroom (Docking, 1990). Used in this way, parents might work with the teacher to produce resources, organise display work or work directly with groups of pupils or individuals, for example listening to reading or supervising art sessions. As Docking has pointed out, the involvement of parent helpers in the learning process is often not without difficulties. Many teachers have reservations concerning the involvement of unqualified parents with children's learning, in particular with those pupils with special educational needs. He suggests that in considering the use of parent-helpers, teachers need to give them guidance to ensure that they are clear about their role. This might include:

- *how the class is organised;*
- *classroom rules, for example about what children have permission to do;*
- *which children the parents should work with, on what task and for how long;*
- *what is the purpose of the activity;*
- *what level of achievement to expect;*
- *how much help the children should be given;*
- *what to do if children make mistakes;*
- *where children can find materials and reference books;*
- *where parents are to work.* (p. 171)

Sullivan (1991) has identified a similar range of issues to be considered in reviewing the role of parental support in the classroom. He stresses the need for schools to review systematically their strategies for parental involvement on a regular basis to minimise the risk of ensuing problems.

As well as school-based schemes of parental involvement, in recent years a number of local authority initiatives have emerged (see, for example, Barker, 1996). The recent Government White Paper, *Excellence in Schools* (GB. Parliament. House of Commons, 1997), highlighted a range of local authority initiatives to involve families in learning, in particular in the fields of literacy and numeracy: *'We will look to every primary school to have a plan for involving parents in the way their child learns to read and goes on to gain broader skills of literacy and numeracy'* (para. 3, p. 54). A number of these schemes have been

targeted at less fortunate families in an attempt to raise awareness and counteract any effects of disadvantage on the educational achievement of those children concerned.

In addition to organising a Maths Club, School G had also participated in an LEA parent accreditation scheme to encourage parent helpers in the classroom. Parents came to school each week to attend a meeting with a teacher who demonstrated techniques to help children with reading and numberwork. They were encouraged to help in classes on a regular basis (choosing literacy or numeracy) and build up a portfolio of work carried out with pupils. At the end of the year they received a certificate. The headteacher felt that this had been instrumental in *'breaking down the barrier'* between school and parents, and many had gone on to further study.

1.7.5 Homework

There has been, in recent years, increasing concern over the lack of homework in many primary schools in this country. The recent Government White Paper, *Excellence in Schools* (GB. Parliament. House of Commons, 1997), advocated the use of homework as *'an essential part of a good education'* (p. 58), highlighting the fact that *'the enormous inconsistencies between schools mean that hundreds of thousands of primary children are missing out on opportunities to build on what they learn in the classroom'* (p. 59). In an attempt to address this issue and raise the profile of homework across the country, the Government is to issue national guidelines on the practice of homework for pupils of all ages from September 1998.

Data from the recent Third International Mathematics and Science Study (TIMSS) (Keys *et al.*, 1997) revealed that almost one-fifth of teachers in England who participated in the survey said that they never set mathematics homework for their Year 5 pupils. In general, teachers in England said that they set mathematics homework for pupils in Year 5 less frequently than teachers in countries such as Singapore, Japan, Hungary and the United States. Furthermore, within England, there was a positive correlation between the frequency with which teachers set mathematics homework and pupils' mathematics scores.

The majority of schools visited during the project did not have a whole-school formal homework policy. Most commonly, mathematics homework consisted of the learning of tables or the completion/ extension of classwork at the discretion of the individual class teacher.

Despite the apparent lack of mathematics homework in many primary schools, a wide-scale mathematics homework project, Maths for Parents and Children and Teachers (IMPACT) has involved more than 15 LEAs across England and Wales since 1989 (Merttens, 1991). The project ran as a pilot in the Inner London Education Authority (ILEA) from 1985 to 1986 and was subsequently set up in three authorities the following year.

The main aim of the project was to encourage the involvement of parents in their child's learning of mathematics. Weekly activities are selected by the teacher (from a bank of published or self-produced material) for the children to take home and share with their parents or siblings. The results of the homework are brought back to school to feed back into the curriculum. One of the principal developers of the project, Ruth Merttens (1991), has cited the main advantages of a teacher working with the scheme as:

- The teacher is encouraged to develop a strong working relationship between classroom mathematics and mathematics used at home and in everyday life.
- Children are more able to relate their school work to the familiar context of the home.
- Practical tasks are incorporated into every teacher's classwork, developing children's abilities to solve problems and develop individual strategies.
- Parental involvement with mathematical activities on a weekly basis strengthens the working partnership between home and school and teacher and parent.

School F, an inner city primary, had been using the IMPACT scheme material since it was introduced by the local authority in 1993. The school made use of resource books focusing on attainment targets Ma2, Ma3 and Ma4. Each booklet consisted of a range of photocopiable worksheets, presenting a number of mathematical investigative activities with a National Curriculum reference. Each child had a copy of the relevant worksheet to take home. In addition, they were given an IMPACT diary, which was used as the principal means of communication between pupil, parent and teacher.

Activities were used by all year groups (including reception) and sent home with children once a fortnight. Children were asked to complete the assignment within a week to allow time for marking, evaluation and follow-up work. Despite the extra workload produced by the scheme, the coordinator felt that it was worthwhile as a means of reinforcing an investigative approach to mathematics and encouraging the involvement of parents.

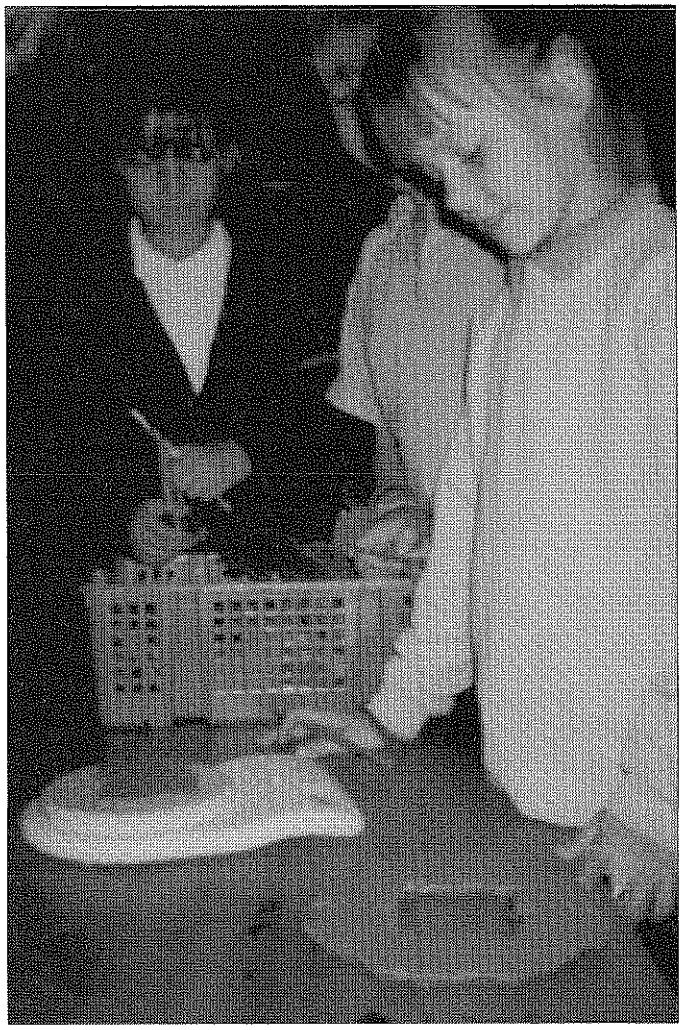
1.7.6 Summary

There is little doubt that effective home–school links can make a positive contribution to pupil achievement and motivation in schools. In developing a whole-school approach to parental partnership, schools may need to address issues surrounding levels of responsibility of staff and parents. In particular, in mathematics, parents may feel anxious about their own abilities and/or unfamiliar curriculum content and need extra encouragement and support from teachers to become involved in their child's learning.

The involvement of parent helpers in the classroom requires careful consideration and planning. Additional training and support for parents in this field has been shown to have numerous benefits. While there is at present wide variation between schools in the practice of setting homework, there has been an increased acknowledgement of its benefits, and the proposed Government guidelines for September 1998 (GB. Parliament. House of Commons, 1997) will undoubtedly offer clarification on this issue.

PART II:

THE SURVEY



2.1 BACKGROUND

This section presents background information on the questionnaire survey and the schools that responded to the survey.

2.1.1 The sample

Altogether 615 questionnaires were sent out to primary schools. Of these, 170 were sent to schools which had responded to the previous year's survey and had indicated that they were willing to participate in the next survey. The remaining 445 questionnaires were sent to other primary schools which were randomly selected from across England and Wales: the sample included LEA-controlled schools and schools with grant-maintained status. The sample was stratified to include schools of different sizes and to represent different geographic locations and both metropolitan and non-metropolitan areas. The following types of school were included in the sample:

- infants only
- juniors only
- infants and juniors
- first schools (covering ages 5–8; 5–9 and 5–10 respectively)
- middle schools (those deemed primary schools)
- first and middle combined schools.

The structure of the sample, together with the relatively high response rate, ensures that the respondents to this survey are reasonably representative of primary schools in England.

2.1.2 Response rates

Of the schools that had been surveyed the previous year, 132 responded to this survey (representing a 78 per cent return). Two-hundred-and-fifty-nine of the schools randomly selected for the first time for this survey also responded (representing a 58 per cent return). Overall, the response rate for the survey when the two groups were combined was 64 per cent.

2.1.3 Background information on schools

The questionnaire asked headteachers to indicate whether their catchment area was best described as: country town and/or rural; suburban; or urban/inner city. Forty-one per cent of respondents indicated their school was located in a rural area, 27 per cent stated the school was in a suburban location and the remaining 32 per cent indicated that the school was in an urban area.

The age range of pupils within the schools varied according to the type of school. However, information held on the NFER's Register of Schools shows that 349 schools had pupils for at least part of Key Stage 1, and 331 schools had Key Stage 2 pupils; some of these (289) schools had children in both key stages. The number of pupils on the school roll varied considerably, from 23 to 602 children, although 50 per cent of schools had 206 or fewer pupils.

The mean teaching time available in the school week (after excluding all breaks for playtime, lunch, etc., together with the time allowed for registration and assemblies) was approximately 23 hours for Key Stage 1 and $23^{1}/_{2}$ hours for Key Stage 2.

2.2 QUESTIONNAIRE RESPONSES

This section presents the responses made by headteachers to the questions regarding teaching and learning in mathematics within the primary school.

2.2.1 Planning and implementing the National Curriculum

Headteachers were asked whether or not the school had prepared a post-Dearing plan for mathematics; those who had were also asked whether the plan had been translated into schemes of work for Key Stages 1 and/or 2. As shown in Table 2.1, about two-thirds of respondents indicated that a plan for mathematics within the school had been drawn up and most of the remainder had a plan 'in preparation'.

Table 2.1: Percentages of schools with Key Stage 1 and Key Stage 2 children that indicated different stages of development of a curriculum plan for mathematics

	KS1 %	KS2 %
Yes, curriculum plan for mathematics prepared	64	63
In preparation	30	32
No curriculum plan prepared	5	5
No response	1	<1

Based on responses from 349 schools with KS1 children and 331 schools with KS2 children.

Of the schools that had prepared a mathematics plan, again about two-thirds of respondents for both key stages had already taken the additional step of preparing a scheme of work (this is equivalent to approximately half of the total number of respondents), with most of the remaining headteachers indicating that such a scheme was in preparation.

2.2.2 The mathematics coordinator

Questions regarding the mathematics coordinator focused on two main areas: non-contact time and the range of activities undertaken.

2.2.2.1 Non-contact time

Three questions explored the issue of non-contact time allocated to the mathematics coordinator: the first of these asked whether or not non-

contact time was available. As shown in Table 2.2, fewer than one in five respondents indicated that the school mathematics coordinator was allowed regular non-contact time, although a substantial number were allocated time to carry out specific tasks.

Table 2.2: Provision of non-contact time for the school mathematics coordinator

	%
Regular non-contact time	18
Non-contact time for specific tasks only	42
No non-contact time	32
No mathematics coordinator	5
No response	3

Based on responses from 391 schools.

Where regular non-contact time was allocated to the mathematics coordinator, headteachers were asked to state the amount of time allowed per week; responses have been grouped into the periods of time shown in Table 2.3. There was considerable variation in the time allocated, from a minimum of ten minutes to a maximum of six hours per week, although more than half of the respondents to this question reported that the mathematics coordinator was allowed one hour or less per week as non-contact time.

Table 2.3: Numbers of mathematics coordinators allocated different periods of non-contact time

Non-contact time	No. (%)
Up to 30 mins	10 (14)
31-60 mins	29 (40)
61-120 mins	24 (33)
121-180 mins	3 (4)
More than 3 hours	4 (5)
No response	3 (4)

Based on responses from the 73 schools identified in Table 2.2 that indicated that regular non-contact time was allocated.

The third and final question in this section concerned specific tasks for which mathematics coordinators had been allocated non-contact time. Respondents were asked to list the tasks that had been undertaken; as shown in Table 2.4, these were frequently related to the schools' mathematics policy or scheme of work, although 16 per cent of respondents mentioned commitments outside the school, such as attending in-service training courses (INSET) and/or coordinators' meetings. The time allocated for these tasks was again subject to some

variation, although the majority of coordinators had been allowed one or two days for carrying out specific tasks.

Table 2.4: Specific tasks for which mathematics coordinators were allocated non-contact time

Task	%
School mathematics policy: *producing, monitoring, etc.*	55
Teacher/classroom support	30
Scheme of work: *producing, evaluating, etc.*	29
Resources	25
INSET/external meetings	16
Other	15

Based on 228 open-ended responses from 134 headteachers. Responses do not sum to 100 as respondents could name up to five tasks.

2.2.2.2 Activities undertaken by the mathematics coordinator

The questionnaire presented a list of nine different activities that might be undertaken by the mathematics coordinator and asked headteachers to indicate which ones were carried out by the coordinator in their school; headteachers were also able to indicate that there was no mathematics coordinator in the school at the time of the survey. Headteachers' responses to this question are shown in Table 2.5.

Table 2.5: Activities undertaken by the mathematics coordinator

Task	%
Coordinating the planning of the post-Dearing mathematics curriculum	79
Monitoring the implementation of the mathematics curriculum	68
Attending INSET courses	68
Translating the curriculum plan into classroom practice	63
Attending external meetings	62
Providing INSET for colleagues within the school	47
Reviewing and evaluating teacher assessment of pupils	45
Teaching classes other than own	16
No mathematics coordinator	5
No response	3

Based on responses from 391 schools; percentages do not sum to 100 as respondents could indicate that more than one activity was undertaken by the mathematics coordinator.

It is evident from Table 2.5 that the mathematics coordinators in about half or more of the schools that responded to the survey carried out most of the activities listed. This shows the range of tasks undertaken by mathematics coordinators in addition to their own teaching commitments. However, so as to get a clearer idea of which activities headteachers regarded as priorities, respondents were asked to indicate the three activities they considered to be most important. Only three of the listed activities were identified as important by at least half of the headteachers:

- coordinating the planning of the post-Dearing mathematics curriculum
- translating the curriculum plan into classroom practice
- monitoring the implementation of the mathematics curriculum.

Each of the other activities was regarded as most important by fewer than 30 per cent of the respondents.

2.2.3 Classroom arrangements for teaching mathematics

Headteachers were asked to indicate (for Key Stage 1 and/or Key Stage 2, as appropriate) the usual organisational approach for teaching mathematics. Nine different approaches were listed on the questionnaire, and respondents were also given the opportunity to specify other arrangements: fewer than five per cent of respondents at both Key Stage 1 and Key Stage 2 mentioned other approaches.

At both key stages, the most frequently cited approach to teaching mathematics was grouping children by ability (approximately 80 per cent for Key Stage 1 and Key Stage 2), although whole-class teaching, mixed-ability grouping and individual teaching were each mentioned by between half and two-thirds of respondents (see Table 2.6). Responses suggested that withdrawing less able children from classes occurred more frequently than withdrawing more able children. Organisational approaches which were more suited to larger schools with more than one form entry (setting children for mathematics across more than one class and team/cooperative teaching) were relatively infrequently used, although clearly these approaches would not be feasible in smaller schools. In summary, however, teachers were using a number of different approaches for teaching mathematics at the time of the survey. Moreover, the responses to this question indicate that, within schools, teachers were utilising several different approaches.

Table 2.6: Percentages of headteachers indicating that different approaches were used for teaching mathematics in Key Stage 1 and Key Stage 2

Organisational approach	KS1 %	KS2 %
Children taught in ability groups	81	78
Children taught as a whole class	67	65
Children taught individually	65	57
Children taught in mixed-ability groups	52	49
Less able children withdrawn	18	21
Some children in sets for maths	15	20
All children in sets for maths across more than one class	7	20
Team teaching	12	12
More able children are withdrawn	7	8
Other	4	4
No response	1	1

Based on 1,138 responses from 349 headteachers with KS1 children and 1,104 responses from 331 headteachers with KS2 children in the school. Percentages do not sum to 100 as respondents could indicate that more than one approach was used.

In School F, an inner-city primary school with a high proportion of pupils with English as a second language, children are taught in mixed-ability classes. So as to ensure that mathematics work recognises the differing abilities within the class, teachers are asked to identify three differentiated activities for each learning objective, together with references to suitable resources, assessment materials and essential mathematical vocabulary. In time, these planning materials will build into a substantial resource bank.

2.2.4 Time available for teaching mathematics

There has been considerable discussion in recent months regarding the amount of time allocated by primary schools for teaching mathematics. Recommendations for a minimum of five hours mathematics teaching per week for primary children have been made, and prior to this, Dearing (1994) provided guidelines on the number of hours per year that primary schools should spend on particular subjects, suggesting 126 hours per year for mathematics at Key Stages 1 and 2. These guidelines approximate to three-and-one-quarter hours per week for mathematics in both Key Stages 1 and 2. At the same time, however, it should be remembered that

the Dearing Review released a theoretical 20 per cent of the primary school timetable for schools to use on aspects of the curriculum at their own discretion: it is likely, therefore, that schools would have decided to use some of this time for mathematics, thereby increasing the total amount of time spent on the subject per week. A further point to bear in mind is the move made by a number of schools (such as Schools B and D in this study) to include a daily session on numeracy/mental arithmetic to supplement ongoing mathematics work.

There was considerable variation in headteachers' reports of the time allocated for teaching mathematics, both at Key Stage 1 and Key Stage 2. For the younger children, respondents stated periods of time ranging from 60–450 minutes; for the older pupils, periods of time ranged from 80–480 minutes. However, the median times allocated to mathematics (i.e. the mid-point in the range of times given by headteachers) in Key Stage 1 and Key Stage 2 were four hours per week and five hours per week respectively. It is possible that one reason for the sizeable differences in times spent on mathematics may be the difficulty in quantifying the time allocated to mathematics when some work is covered in mathematics lessons and some is covered within cross-curricular or thematic work.

Headteachers' responses concerning the periods of time allocated for mathematics each week have been grouped into five main categories as shown in Table 2.7.

Table 2.7: Percentages of headteachers who indicated different periods of time were spent on mathematics per week at Key Stage 1 and Key Stage 2

Time allocated to mathematics	KS1 %	KS2 %
180 mins per week or less	12	4
181-240 mins per week	31	22
241-300 mins per week	36	49
301-360 mins per week	5	9
more than 360 mins per week	2	4
No response	14	12

Based on responses from 349 schools with KS1 pupils and 331 schools with KS2 pupils.

The mathematics policy in School C states that a minimum of five hours per week should be spent on mathematics, although teachers are free to decide how and when to teach it.

In School F, mathematics is taught daily and teachers are advised to allocate 20 per cent of their teaching time to the subject.

After disappointing results in the mathematics (and English) SATs when the school had been using an integrated curriculum approach to teaching these subjects, staff at School M decided to de-integrate mathematics and English and ensure that they were taught as separate subjects each morning.

Clearly, at the time of this survey (autumn 1996) approximately half the schools with Key Stage 2 pupils were allocating a minimum of five hours per week for mathematics, as compared with about one-third of schools with Key Stage 1 pupils. In the light of recent Government guidelines, it remains to be seen whether schools will increase the time spent on mathematics.

2.2.5 Assessment procedures

So as to gain information about the types of materials used for carrying out assessments in mathematics, headteachers were asked to indicate which ones from a list of five had been used for Key Stages 1 and/or 2 as appropriate. As with other questions, respondents were also given the opportunity to list any other types of material that had been used, although few mentioned other materials (see Table 2.8).

The most widely used materials were those produced by teachers within the school, with tests that were included within published schemes also frequently used. It is worth noting that in both Key Stage 1 and Key Stage 2, a majority of schools indicated that they used oral tests, such as mental arithmetic sessions, to assess pupils. Although this survey did not collect information on the frequency with which each type of assessment was used, evidence collected from schools revealed that at least some primary schools are already working within the approach adopted by the National Numeracy Centres (practising mental arithmetic for ten minutes per day).

Table 2.8: Percentages of headteachers indicating different types of assessment materials were used with pupils in Key Stage 1 and Key Stage 2

Assessment	KS1 %	KS2 %
Teacher/school produced oral tests (e.g. mental arithmetic)	56	74
Teacher/school produced written tests	51	65
Tests as part of published schemes	48	63
Externally produced standardised tests (including LEA tests)	21	44
Free-standing commercial tests to establish National Curriculum levels	11	24
Other	7	8
No response	12	3

Based on 715 responses from 349 schools with KS1 pupils and 928 responses from 331 schools with KS2 pupils. Percentages do not sum to 100 as respondents could indicate that more than one type of test was used.

In School B (a suburban first school), a whole-school numeracy initiative has been implemented over the last two years following an OFSTED inspection in which the standards of numeracy were criticised. One of the key aspects of the initiative is the implementation of a daily numeracy session in all classes: all teachers are expected to teach and reinforce number skills with pupils for 15 minutes daily, in addition to the main mathematics work (which is taught for three-and-a-half hours per week). There is considerable emphasis on learning multiplication tables and mental arithmetic, as well as regular tests. The daily sessions involve a range of whole-class mental arithmetic activities, including number games and teacher–pupil questioning. In the sessions pupils are encouraged to listen to and question each other and explain their own methods of working.

2.2.6 Priorities for the mathematics curriculum

In recent years, there has been an increasing emphasis on problem-solving and investigative work in mathematics. At the same time, teachers are encouraged to include activities involving calculators and computers to enhance the range of pupils' activities, and urged to spend time improving pupils' computational skills. There are, therefore, several different aspects of mathematical work to be covered within the

primary curriculum; but which are seen as having the highest priority? In order to gauge views regarding the respective importance of different types of mathematical work, the questionnaire listed eight different aspects and asked headteachers to rate each one on a three-point scale as follows: *very important, important, not important.* The eight aspects of mathematics specified were:

- emphasis on investigative/problem-solving work
- emphasis on practical work
- emphasis on mental arithmetic skills
- emphasis on written computational skills
- development of computer use
- development of calculator use
- development of mathematics in cross-curricular work
- development of classroom discussion.

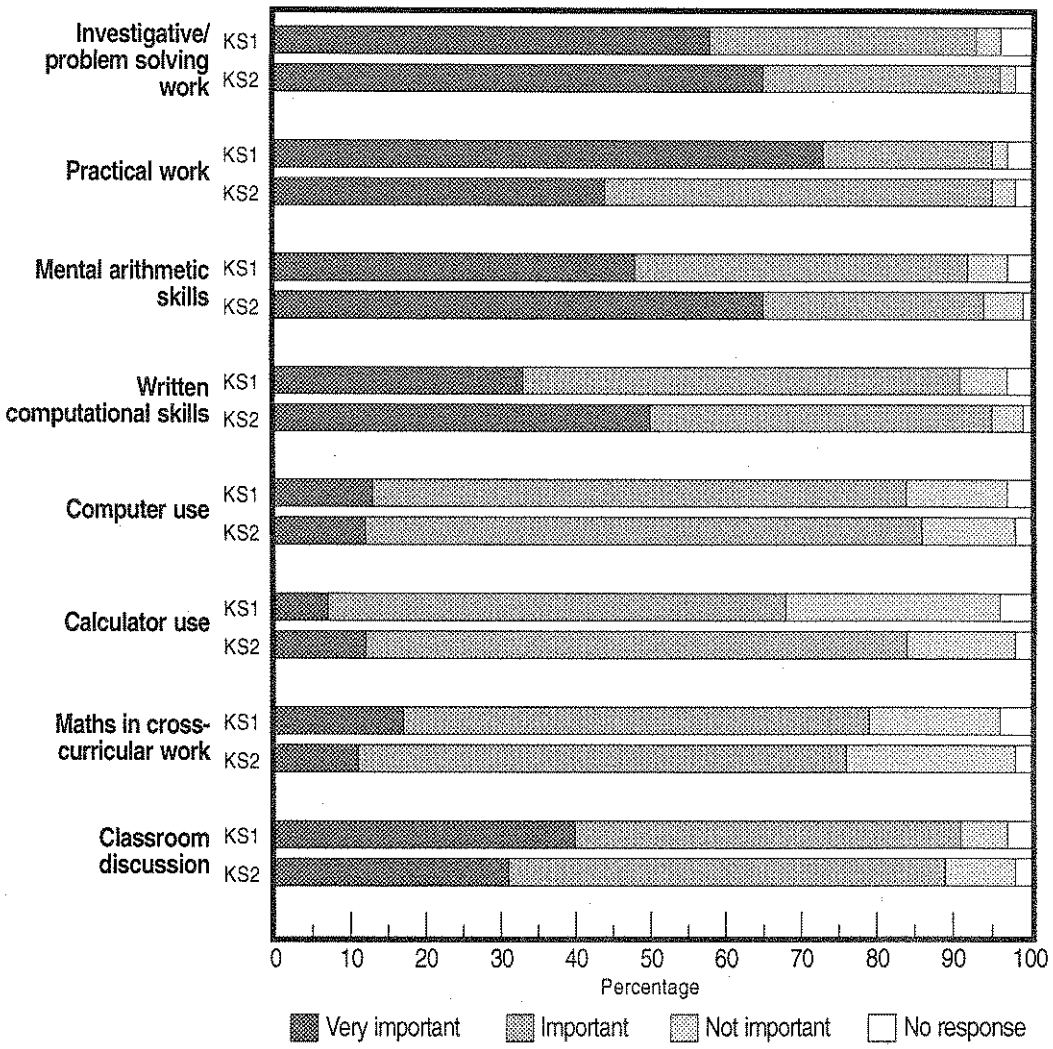
It is evident from headteachers' responses shown in Figure 2.1 that four of these aspects of mathematics were regarded as more important than the others, although there were slight differences in the priorities identified by respondents with regard to pupils in the two key stages.

Investigative/problem-solving work was deemed *very important* by 58 per cent of headteachers with Key Stage 1 children in their school and by 65 per cent of respondents with Key Stage 2 children in their school; this is not surprising given that this type of work represents Ma1: Using and Applying Mathematics.

Following an OFSTED inspection which noted that, in mathematics, there was considerable emphasis on number work but little on data handling, investigation and algebraic work in School C, the school mathematics coordinator and the headteacher decided to improve the level of investigative work. A first step was a training session on investigative mathematics run by the coordinator. Subsequently, the staff agreed that there should be one investigation per year group each week, and a range of suitable resources have been built up.

A sizeable majority of headteachers (73 per cent) indicated that emphasis on **practical work** was *very important* during Key Stage 1, whereas far fewer respondents (44 per cent) considered this to be as important at Key Stage 2. Indeed, this aspect of mathematics stands out as the one area widely regarded as a priority for Key Stage 1 pupils.

Figure 2.1: Percentages of headteachers indicating different levels of importance for specified aspects of mathematics



Based on responses from 349 schools with KS1 pupils and 331 schools with KS2 pupils.

At Key Stage 2, however, emphasis on **mental arithmetic skills** and **written computational skills** was deemed *very important* by 65 per cent and 50 per cent of headteachers respectively. In contrast, at Key Stage 1, fewer respondents indicated the same two aspects were *very important*: 48 per cent and 33 per cent respectively.

A further question invited headteachers to list any other aspects of the mathematics curriculum within their school which were rated as *very important* at the time of the survey. Relatively few respondents completed this question (57 headteachers with Key Stage 1 children in their school, and 56 headteachers with Key Stage 2 children in their school); it would therefore be misleading to say that any of the additional aspects of mathematics were widely mentioned. However, the single extra aspect mentioned most frequently by respondents for both Key Stage 1 and Key Stage 2 pupils was *number work/basic skills*. Typical comments from headteachers referred to:

- learning multiplication tables
- number bonds
- place value
- understanding the four rules of number.

Other aspects which were also often cited were *communication skills* (including developing the correct mathematical terminology and children being able to explain their methods) for Key Stage 1 children, and *presentation* (i.e. layout of written mathematics) for Key Stage 2 children.

2.2.7 Successes and challenges

The final question in the section of the questionnaire regarding mathematics in the primary school asked headteachers to list the successes and challenges/difficulties their schools had encountered to date in implementing the post-Dearing National Curriculum in mathematics. Up to five separate codes were allocated to respondents' comments regarding **successes** and **challenges** respectively so as to represent the range of points made.

2.2.7.1 Successes

The areas which headteachers identified as having been particular successes in their schools' implementation of the mathematics curriculum are shown in Table 2.9.

Table 2.9: Percentages of headteachers identifying particular successes in implementing the post-Dearing National Curriculum in mathematics

Success	%
Mathematics scheme of work	34
Mathematics policy	20
Planning for consistency and progression	18
Assessment	15
Standards	15
Investigative/practical activities	13
Teaching practices	11
Staff issues	10
Other	15

Based on 416 open-ended responses from 275 headteachers. Percentages do not sum to 100 as respondents could name more than one success.

The one area which was regarded as a success by the highest number of respondents (one-third) was that of a mathematics ***SCHEME OF WORK***. This category included two main aspects: firstly, comments relating to the school's own scheme of work (or curriculum map) showing how and when different aspects of mathematics should be taught within the school—*'The implementation of our new schemes of work'*; *'Separating the mathematics teaching into continuous and block work'*; and *'Pulling the strands into units of work'*; secondly, comments which clearly referred to published schemes—*'Implementation of new published scheme (Maths 2000) currently used in Key Stage 1 and on order for Key Stage 2'*; *'Finding a published scheme that delivers quality mathematics teaching based on practical experiences and sound methods'*; and *'Moving away from dependency on a single scheme'*.

The ***MATHEMATICS POLICY*** category accounted for the responses made by 20 per cent of the headteachers and was concerned with comments which referred to whole-school approaches to the teaching of mathematics: *'Production of mathematics policy endorsed by all staff and governors'*; *'Whole-school recognition of mental mathematics skills'*; and *'We have looked at mathematics within the whole curriculum rather than in isolation'*.

A further 18 per cent of headteachers made comments about ***PLANNING FOR CONSISTENCY AND PROGRESSION*** throughout the school: *'Consistency across school'*; *'Development of a team approach to long-/medium-/short-term planning'*; and *'Getting whole-staff agreement on mathematics progression'*. Clearly, this category has links with both of the categories referred to above, whilst at the same time representing a substantial number of responses about a particular aspect of school planning.

Comments about successes relating to ***ASSESSMENT*** were made by 15 per cent of headteachers. These focused on both the process of assessment *('Our records and assessment techniques have improved')* and the results of National Curriculum assessments *('Improvement in SATs results'*; *'Two children achieved level 5 at Key Stage 2—an improvement on our past records')*.

Another 15 per cent of headteachers referred to ***STANDARDS***: *'High standards of mathematics achieved throughout the school'*; *'Good level of written computational skills'*; and *'Very high achievement levels for the most able'*. This category also included a number of comments relating to positive outcomes following inspection, such as *'Obtaining "Good" overall for mathematics in our recent OHMCI inspection'*.

Headteachers' comments under other specific categories were each mentioned by fewer than 15 per cent of respondents.

Particular successes mentioned by respondents which were grouped together under the ***OTHER*** category included: pupils' enthusiasm for mathematics; use of a wide range of resources; introducing home/school mathematics project; and interactive displays.

2.2.7.2 Challenges/difficulties

Table 2.10 shows those areas identified by headteachers as challenges/ difficulties they had experienced in implementing the mathematics curriculum. Not surprisingly, some of the areas identified as successes within some schools proved to be problematic in others.

Table 2.10: Percentages of headteachers identifying particular challenges/ difficulties in implementing the post-Dearing National Curriculum in mathematics

Challenges/difficulties	%
Lack of time	26
Scheme of work	18
Staff issues	17
Meeting pupils' needs	15
Resources	14
Investigative/practical activities	14
Assessment and recording	12
Standards	8
Planning for consistency and progression	7
Other	23

Based on 454 open-ended responses from 295 headteachers. Percentages do not sum to 100 as respondents could name more than one challenge/difficulty.

The most frequently cited challenge/difficulty (mentioned by more than a quarter of respondents) was ***LACK OF TIME***. Specific comments made by headteachers referred to: *'Lack of release time for coordinator'*; *'[Not enough] non-contact time for staff discussions to determine continuity of curriculum between classes'*; *'Covering the work required in the time allowed'*; and *'Finding time to develop investigative mathematics'*.

The mathematics coordinator in School D had no formal non-contact time allocated and felt this limited what she was able to achieve: *'I would love to be able to go into another year group and do some teaching and observations. There's so much I could do but I don't have the time.'*

Whilst a ***SCHEME OF WORK*** for mathematics had been cited as a success by more than one–third of headteachers, this was mentioned as a challenge/difficulty by 18 per cent of respondents. As with those comments relating to successes, some of the responses were related to a scheme of work produced within the school, and some to published mathematics schemes. Typical comments included: *'Getting together an agreed scheme of work'*; *'To replace present scheme with a new scheme and implement in long-/medium-/short-term planning'*; *'Finding a scheme of work to suit Key Stage 1'*; *'Need in Key Stage 2 to change from Steps Mathematics Scheme to Heinemann Scheme'*; and *'Getting rid of published schemes—too constraining'*.

A number of different comments relating to teaching staff were grouped under the ***STAFF ISSUES*** category, which accounted for the responses of 17 per cent of headteachers. These issues and typical comments relating to them included: **lack of cooperation/consensus**: *'Lack of cooperation from member of staff'; 'KS1 staff not keen on practical work'*; **lack of confidence**: *'Need to raise teacher confidence'*; *'Lack of coordinator then appointment given to a not very confident coordinator who has tried hard but has much to learn themselves before leading others'*; **pressure of workload**: *'Workload still extensive'*; *'Pressure of work on some staff changing existing schemes of work whilst planning new ones in other areas'*; **lack of mathematics specialist**: *'No highly qualified mathematics specialist'*.

A further 15 per cent of headteachers made comments which were concerned with ***MEETING PUPILS' NEEDS***. Issues mentioned in this category, and typical comments, included: **differentiation/wide ability range**: *'Wide ability range within each class'*; *'Differentiating in a subtle way to reinforce for the less able and challenge the more able'*; **special educational needs**: *'High numbers of special needs children with language deficiency relating to mathematics'*; **able pupils**: *'Need to challenge more able child within key stage programme of study'*.

Headteachers' comments under other main categories were each mentioned by fewer than 15 per cent of respondents. For comparative purposes with the areas identified above as successes, it is worth noting, however, that seven per cent of headteachers referred to their school's ***PLANNING FOR CONSISTENCY AND PROGRESSION*** as an area of difficulty, whereas 18 per cent had deemed this area a success. As before, this category clearly has links with schools' schemes of work, which were mentioned by higher numbers of respondents, irrespective of whether schools felt that they had encountered either successes or difficulties in this area.

Particular challenges mentioned by respondents which were grouped together under the ***OTHER*** category included: adequately covering data handling; post-OFSTED inspection issues; incorporating computers; and the dilemma of group work versus teaching individually.

2.2.8 Summary

Two-thirds of the respondents to the survey had drawn up a post-Dearing curriculum plan for mathematics. Of those that had drawn up a plan, again about two-thirds had taken the additional step of translating the plan into schemes of work for Key Stage 1 and/or Key Stage 2: this is equivalent to approximately half of the schools that responded to the survey.

Fewer than one in five mathematics coordinators (18 per cent) were allowed regular non-contact time: where it was allocated, more than half the respondents reported that it amounted to one hour or less per week. The most usual practice (accounting for 42 per cent of the responses) was for mathematics coordinators to be allocated non-contact time for carrying out specific tasks: these were frequently related to giving classroom support, or concerned with the school mathematics policy and/or scheme of work. Nearly one-third of respondents reported that the mathematics coordinator was not allocated any non-contact time.

The teaching approach most frequently used in both Key Stage 1 and Key Stage 2 was grouping children by ability (within the class), but many schools also made some use of whole-class and individualised teaching as well as mixed-ability groups.

Approximately half of the schools with Key Stage 2 pupils allocated a minimum of five hours per week for mathematics, as compared with about one-third of schools with Key Stage 1 pupils.

From a list of eight priorities for the mathematics curriculum which headteachers were asked to rate on a three-point scale, the four which were identified as *very important* by at least half of the respondents for Key Stage 1 and/or Key Stage 2 were:

- investigative/problem-solving work
- practical work
- mental arithmetic skills
- written computational skills.

When asked to identify particular successes and challenges their schools had experienced since implementing the post-Dearing mathematics curriculum, the areas most frequently cited as **successes** were related to the school mathematics policy or scheme of work, but the single **difficulty** named by the highest number of respondents was lack of time.

2.3 SCHOOLS' MATHEMATICS POLICIES/SCHEMES OF WORK

One of the aims of this study was to obtain and analyse primary school mathematics policies/schemes of work which had been prepared in line with the 1995 statutory Order for mathematics in the National Curriculum. The questionnaire sent to headteachers therefore included a statement that we should be grateful to receive copies of any completed plans or schemes of work. Unfortunately, very few schools responded to this request, and only 16 documents were sent in. During visits to schools, six further documents were collected, resulting in a total of 22 mathematics policies/schemes of work for analysis. Due to the small numbers involved, the contents of these documents should not be assumed necessarily to be representative of primary school mathematics policies/schemes of work in general, and observations concerning these documents should be treated with caution.

The policies/schemes of work submitted by schools were examined to determine the content. Three main aspects were covered in most documents:

1. **Aims for mathematics education within the school**: in some cases these were expressed in general terms (for example referring to covering the appropriate programmes of study set out in the 1995 Order, helping children to develop a positive attitude towards and interest in mathematics). In other instances specific objectives were listed, such as: *'To be able to recall terms, notations, conventions and results'; 'To be able to interpret results sensibly';* and *'To be able to estimate and approximate'.*

2. **A mathematics curriculum 'map'**, showing aspects of mathematics to be covered in different year groups, and often indicating in which half-term the work should be covered. Some of the material within this category could be best regarded as a summary to indicate coverage of different topics throughout the school, in some cases differentiating between those aspects of mathematics which were *ongoing* (such as number work) and those which were *'blocked'* or *'mini-topics'* (such as capacity, time, and area). However, in other instances, the information was elaborated so as to produce a *scheme of work* containing more detailed information that would be appropriate when planning one or more lessons on a particular subject: typically, learning objectives/skills to be developed; how/what to assess (and the associated levels of attainment); relevant published material; relevant equipment.

3. **Assessment guidelines**: these included references to materials that could be used in making assessments (e.g. elements of a commercial mathematics scheme in use within the school; independent materials, such as NFER mathematics tests; teacher-produced materials; SATs). Documents also often referred to assessments made at different times for different purposes, for example *initial* assessments to determine pupils' knowledge and understanding of a particular topic before embarking on a programme of teaching; *ongoing* assessment to monitor children's progress and assessment at the end of the teaching programme for *summative* purposes. Not surprisingly, approaches to record-keeping were also frequently mentioned, with some documents including examples of the sheets to be completed.

A wide range of other information was included within the documents, which varied considerably in length from one to 80 pages. The length of the documents, the types of information and the level of detail they contained seemed to reflect their purpose: whole-school policy documents frequently included paragraphs referring in general terms to such things as differentiation within classes and providing appropriate work for pupils with special educational needs (SEN); maintaining equal opportunities for all pupils; planning work so as to ensure continuity; and making use of technological resources such as computers, calculators and floor turtles (e.g. Roamer). Schemes of work were necessarily more detailed, and in one case extended to 15 pages for each of the four years in Key Stage 2: clearly these documents were intended to be the main source of guidance for teachers when preparing their lessons.

About half of the documents included information about:

- the use of a commercial mathematics scheme within the school: whether this was to be the main source for work, or was to be used to supplement materials prepared by teachers
- the types of mathematics work that pupils might engage in, such as practical work, problem-solving and investigative activities, mental arithmetic (including times tables)
- organisational matters, such as setting for mathematics within Years 5 and 6, together with approaches to learning, such as work in pairs/groups/whole classes.

Since the documents prepared by any school are drawn up with their own needs in mind, and reflecting their own priorities, it is not surprising that some types of information were included in only a few instances (fewer than five). The following were mentioned by only a few schools:

- the school policy on pupils' presentation of written work and teachers' marking of work

- procedures for the shared planning of mathematics work in schools with more than one form entry
- liaison with other local schools and participation in 'cluster' meetings
- the policy with regard to homework in mathematics
- the role/responsibilities of the mathematics coordinator
- the provision of in-service training courses (INSET) for teachers.

Documents submitted by two schools referred to a specific scheme (IMPACT) in which pupils take home activities linked to their class mathematics work (see Section 2.2.7.1).

Very few documents addressed the issue of future developments in mathematics within the school. Only one referred explicitly to a planned review of the (newly produced) mathematics policy at a specified time during the next school year, although it is possible that other schools' plans to review their policies were documented in other places. In another case, it was apparent that the school development plan (SDP) would contain more detailed information about intended developments: '*It* [the SDP] *is designed to allow evaluation of the previous year as well as to target objectives for the current year and to project for a three- or five-year period. Each subject area is on a rolling programme — one year priority, one year audit, one year consolidation or follow-up.*' Three schools' documents mentioned that part of their planned development for mathematics involved increasing the bank of resources available for lessons (i.e. worksheets etc.).

To summarise, schools submitted documents which had been prepared with different purposes in mind. In some cases, it is likely that the documents were supplemented by other information available within the school (such as a published mathematics scheme), whereas in other instances, the level of detail suggested that the documents were to be teachers' main sources of reference when drawing up schemes of work for the year/term, and, in some cases, when preparing lesson plans.

2.4 LOOKING AHEAD

There is no doubt that the extensive changes to the curriculum over the last ten years have had a significant impact on the teaching and learning of mathematics in primary schools in this country. This report has highlighted a number of successes and challenges faced by primary school teachers in their implementation of the mathematics curriculum in recent years.

We conclude this report against an unsettled backdrop of ongoing concern about approaches to the teaching of mathematics in primary schools. While the Dearing Review promised an abstention from any further changes to the curriculum until the year 2000, there is at present, a huge amount of anxiety over standards, in particular, in literacy and numeracy. This in turn has led to a barrage of new ideas, an overwhelming emergence of arguments for and against particular methods of the organisation of mathematics in primary schools.

Within this context, and in reviewing the findings of the previous chapters, it remains clear that there are many questions yet still to be answered, some of which are posed here.

2.4.1 Curriculum content

The mathematics curriculum of the last decade has focused increasingly on problem solving and thought processes, often at the expense of numerical operations. Back in 1982, well before the introduction of the National Curriculum, the Cockcroft Report (1982) clearly advocated an investigational approach to the learning of primary mathematics.

However, in recent years, the growing concern for standards in numeracy has resulted in the Government advocating a focus on the teaching and learning of numeracy skills. Is there a danger that these skills will be removed further from the context of the whole curriculum, prompting the isolation of mechanical skills as condemned by the Cockcroft Report (1982) in the following comment 15 years ago?

> *An excessive concentration on the purely mechanical skills of arithmetic for their own sake will not assist the development of understanding in these areas. It follows that the results of a "back to basics" approach (as we understand the words) are most unlikely to be those which its proponents wish to see, and we can in no way support or recommend an approach of this kind.*
>
> (para. 278, p. 80)

Furthermore, assuming that the 'basic skills' are necessary because they underpin the entire structure of the curriculum, what aspects of numeracy and literacy are desirable for the educational development of our children if it is to prepare them for adult life in the twenty-first century? As Robin Alexander (1995) has noted:

> *.. it seems reasonable to ask whether as a judgement of what is "basic" to a modern education, the 3Rs definition can be regarded, after over a century of continuous and unquestioned use, as adequate. In any event, it rests on unexamined but suspect assumptions about the separation of cognition from affectivity and skills from their application.* (p. 307)

The emergent tension between the *consolidation and practice* of basic numeracy skills and their *application* remains as a key issue. Teachers may be concerned with the balance between numeracy work and other areas of the mathematics curriculum. In dealing with an already overloaded primary curriculum, they may feel under pressure to prioritise distinct areas of mathematics at the expense of others. As an increasing amount of attention is being paid to the daily teaching of numeracy skills, further guidance on the coverage of the whole mathematics curriculum might help to clarify some of these issues.

2.4.2 Published schemes

The debate concerning the use of published schemes continues. Is the use of a published scheme, written by experienced authors, ensuring adequate coverage of the curriculum and guiding the entire practice of the teaching and learning of mathematics in a school preferable to a poorly produced school scheme? On the other hand, produced by experienced, competent staff and meeting the needs of all pupils within a school, is a school-produced scheme the most flexible and cost-effective option? Who decides whether or not a school-produced scheme is meeting the needs of all pupils and offering effective coverage of the whole curriculum? What are the implications for resourcing, both in introducing and maintaining a new scheme? Further research into these issues would be welcome.

2.4.3 Classroom organisation

The Cockcroft Report (1982) recommended that mathematics teaching at all levels should include opportunities for:

1. *exposition by the teacher;*
2. *discussion between teacher and pupils and between pupils themselves;*

3. *appropriate practical work;*
4. *consolidation and practice of fundamental skills and routines;*
5. *problem solving, including the application of mathematics to everyday situations; investigational work.* (para 243)

It has been suggested by commentators that effective whole-class teaching, (i.e. 'interactive' whole-class teaching) should employ both 1 and 2 above. As has been noted by Straker (1997), the greater the difference in attainment of individual pupils in a class, the more difficult it becomes to employ teaching a class as a whole. While whole-class teaching methods of other countries have been identified (by international comparisons such as TIMSS and other ongoing research projects such as that within Barking and Dagenham) as making a positive contribution towards pupil attainment, Straker has noted that a differing school system often results in a narrower ability range: '*Pupils sometimes repeat a year, or entry to school may be delayed; special needs pupils may be withdrawn from mainstream classes rather than integrated.*'

Care must therefore be taken in assuming that these techniques might be effectively transferable to the (often large) classes of mixed-ability pupils in primary schools in this country. Moreover, the welcome inclusion of many pupils with special educational needs in mainstream settings further widens the ability range of classes in this country, which may create additional challenges for teachers working with a whole class.

2.4.4 Future targets

Finally, to the National Targets for the next millennium. Are they achievable? If so, what are the implications for professionals both at LEA level and teachers at the chalk face? Where will the extra resources needed to fund new initiatives and promote further development come from? What do primary teachers think about these targets? Do they believe that they are achievable? While primary teachers continue to endeavour to develop effective practice in their teaching of mathematics, this can only be done with the continuous support of colleagues and external professionals and the necessary resources.

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MATHEMATICS IN PRIMARY SCHOOLS

There have been considerable changes in mathematics teaching in recent years, not least as a result of the implementation of the National Curriculum. In the post-Dearing era, what are the issues facing teachers in primary schools, and how *is* the subject being taught to primary-age pupils? Drawing on information collected as part of the NFER's *Annual Survey of Trends in Education*, this report highlights current issues regarding the implementation of the National Curriculum for mathematics in primary schools.

In Part 1, literature relating to mathematics in primary schools is reviewed, including evidence from research projects, OFSTED reports, guidance documents and the work of contemporary experts in this field. The range of topics discussed includes:

- the use of published mathematics schemes
- assessment
- raising achievement
- using and applying mathematics (UAM)
- home-school links.

Part 2 focuses on headteachers' responses to questions within the *Annual Survey* concerning the teaching of mathematics since the Dearing Review of the National Curriculum. Specific aspects covered include:

- planning and implementing the National Curriculum
- the role of the mathematics coordinator
- classroom arrangements for teaching mathematics
- time available for teaching science in Key Stages 1 and 2
- priorities for the mathematics curriculum
- successes and challenges in implementing the post-Dearing curriculum for mathematics.

Illustrative examples of individual schools' approaches to such matters as setting, homework and investigations in mathematics are included throughout the report.

An analysis of mathematics policies and schemes of work submitted by schools identifies common approaches utilised in teaching mathematics in Key Stages 1 and 2, and also reveals the consideration given to issues such as differentiation, ensuring continuity and the use of appropriate resources.

This report is essential reading for all those concerned with the teaching of mathematics in primary schools: teachers, governors, LEA advisory teams, teacher trainers and policy makers.

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