Qualifications and
Curriculum Authority

Mathematics

2002/3 annual report on curriculum and assessment

This report is based on the activities to investigate curriculum, assessment and qualifications issues in mathematics.

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INTRODUCTION

QCA has a remit to keep the curriculum under review. This includes identifying aspects of the curriculum that would benefit from further development and providing information and guidance to support the curriculum. In the context of monitoring and evaluation we view the curriculum in its widest sense. This includes assessment and qualifications and their effect on the delivered curriculum. One of the main aims of this monitoring is to ensure that policy advice at the national level is based on sound evidence. We also need to ensure that any work on developing the curriculum framework and any review of content are based on accurate knowledge of current practice and curriculum innovation, the effectiveness of recent changes, an understanding of needs and a critical evaluation of current policies and initiatives.

To do this effectively, QCA has a programme of monitoring and evaluation, which includes a balance of quantitative and qualitative information and data. QCA's ongoing School Sampling Project (SSP) involves questionnaires to heads of subjects and headteachers in primary and secondary schools. In some subjects we are able to draw on early drafts of annual Ofsted reports. In most subjects, focus groups of teachers are conducted to sound out their views and to triangulate findings from SSP questionnaires. Drawing on the full range of evidence, reports are produced for each national curriculum subject and for two main phases: 3–14 and post-14. (See Annex 1 for the list of sources of evidence used to compile this mathematics report.)

The QCA mathematics team's monitoring plan is reviewed annually, and changes are made based on the previous year. This includes judgements on the effectiveness of the monitoring activities as well as the actual findings. We also have to take into account the team's capacity to organise and manage monitoring activities alongside other work, QCA's remit with respect to monitoring and evaluation, and value for money.

This report draws heavily on the mathematics SSP questionnaire to heads of department and on the teacher focus groups we have conducted for mathematics. The SSP goes to a representative sample of schools and therefore has a degree of reliability. However, the evidence is drawn from what heads of department indicate about practice and this is subject to their interpretation of the questions. Where possible we triangulate the evidence with findings from Ofsted or other sources. The focus groups are used to test out teachers' views. The sample is not necessarily representative, but we do draw on teachers from across the country. A focus group provides the opportunity to explore what the findings mean. Members of the primary focus group were also given a questionnaire to complete. This year we organised 17 student focus groups with students in year groups 9 to 13. These were commissioned by the Post-14 Mathematics Inquiry. We are grateful to the inquiry for giving us permission to use the findings from those focus groups in this report. They appear mainly in the section on pupils' attitudes (section 3.5).

1. CONTEXT

This year is the third year of implementation of the revised national curriculum, which became statutory in 2000. Changes to national curriculum tests and to GCSE that reflect the changes to the curriculum came into effect in summer 2003. In mathematics the pre-2000 'Using and applying mathematics' section of the national curriculum was integrated into each of the other sections, such as 'Number and algebra'. The intention is that problem solving, communicating and reasoning become more embedded in curriculum delivery, rather than always being taught separately. To reflect this curriculum change the role of 'Using and applying mathematics' in tests has increased. Up to 12 per cent of the marks on any 2003 mathematics test are for this section. Purpose-designed year 7 progress tests and new optional tests for year groups 3, 4, and 5 in English and mathematics were also introduced in 2003.

Web-based tasks for pupils working above and below the level of tests at the end of key stages 1, 2 and 3 were developed for the first time for use in 2003. The provision of extension tests came to an end. At key stage 3 and at GCSE there is an increased emphasis on reasoning, including abstract work in algebra and geometry. In GCSE a new coursework element in handling data came on stream to reflect the inclusion of the full data-handling cycle in the national curriculum. GCSE mathematics has not yet been restructured to match the two-tier programme of study at key stage 4 of the national curriculum.

During this, the fifth year of the national literacy strategy and the fourth year of the national numeracy strategy, a new primary national strategy was launched. This new strategy subsumes the national literacy and numeracy strategies and is concerned with the whole primary curriculum. It is linked to a new DfES initiative, 'Excellence and Enjoyment'. This is the second year of the key stage 3 national strategy. The focus this year broadened beyond English and mathematics to include all subjects and aspects of the curriculum.

A national inquiry into post-14 mathematics was launched during 2002/3 and continues into the educational year 2003/4. The inquiry began in December 2002 and is due to report in the autumn term of 2003. This inquiry follows on from a recommendation in Sir Gareth Roberts' report, *SET for success: the supply of people with science, technology, engineering and mathematics skills* (April, 2002). The report recognised a national skills shortage in mathematics at all levels. QCA consulted on a revision to the mathematics GCE criteria during 2002/3. This will not affect teaching until 2004.

There had been concerns about the grading of the new A levels in 2002. Although mathematics A levels were not implicated, all subjects developed exemplification of standards at AS and A2 following a review of 2002 A level grading, led by Mike Tomlinson. There is now a longer-term review of the entire spectrum of 14–19 provision and qualifications. This began in the summer term 2003 and is due to produce its final report in July 2004.

2. SUMMARY OF KEY FINDINGS

2.1. Curriculum

- The curriculum guidance for the foundation stage has been well received and is used effectively, in conjunction with the national numeracy strategy's *Framework for teaching mathematics* for reception children. The quality of provision at the foundation stage is better than at key stages 1 and 2.
- The national numeracy strategy, now included as part of the primary national strategy, continues to have a positive impact on mathematics. Teachers appreciate the training and are more confident.
- Some teachers feel that the strategy framework has inhibited cross-curricular work and creativity.
- Primary teachers' knowledge and understanding of mathematics continues to improve and is now good or better than any other subject in more schools.
- More training is required for teachers on teaching pupils to use and apply mathematics.
- Able and gifted pupils are sometimes not sufficiently challenged in lessons.
- Research shows that in general the national numeracy strategy has been of benefit to pupils from ethnic minorities.
- Although transition from key stage 2 to key stage 3 has improved on previous years, there are continuing difficulties with obtaining transition data in time to be useful.
- The key stage 3 national strategy is having an impact on provision in secondary mathematics. Most schools use the objectives from the framework and have changed the way they teach mathematics.
- The shortage of suitable teachers continues to be perceived as a major problem in terms of delivering the secondary mathematics curriculum.
- At key stage 4, examination syllabuses are the major influence on what is taught, with the national curriculum taking a subsidiary role. There is widespread support among teachers for the concept of a two-tier GCSE, which would improve the match between the structure of the curriculum and examination syllabuses.
- The introduction of the handling-data coursework task for GCSE caused considerable concern among schools. The most significant problems were with applying the assessment criteria.
- Just over half of students aged 16 to 18 are educated in further education colleges. The quality of science and mathematics provision is unsatisfactory in 20 per cent of colleges, much higher than the average for other subjects.

2.2. Assessment

- Although procedures for assessing pupils' attainment and progress are good in primary schools, the quality and use of ongoing (formative) assessment are weaker in both primary and secondary schools.
- One national assessment scheme at the end of the foundation stage is welcomed by teachers. There are, however, workload issues associated with the profile.

- The quality of end of key stage tests is generally well received by teachers. However, there is now an increased emphasis at national level on using teacher assessment at key stage 1.

- The optional tests for years 3, 4 and 5 are widely used, with many local education authorities (LEAs) expecting schools to use the tests year on year to track children's progress and for value added purposes.

- Both teachers and pupils consider the new year 7 progress test to be much better than in previous years, when the key stage 2 tests were used.

- 2003 saw an increased emphasis across key stages on assessing pupils' ability to use and apply their mathematics (the 'UAM' expectation).

- Changes to the statutory tasks and tests at key stage 1 included the introduction of separate level 2 and level 3 tests. Although teachers see this as an increase in workload, they agree that separate tests provide a better experience for pupils working at level 2.

- Teachers generally feel that children should have the same access to resources during the tests as they do in the classroom.

- Advisers recommend the use of P scale descriptions in tracking the progress of pupils who are likely to be awarded a W at the end of more than one key stage.

2.3. Pupils' attitudes to mathematics

- Children at the foundation stage and at key stages 1 and 2 have positive attitudes to mathematics. Higher attainers at key stages 3 and 4 and in sixth forms enjoy mathematics and find it rewarding.

- Pupils are of the opinion that GCSE mathematics is 'an enormous amount of work', compared with other subjects.

- Students at AS and A levels find mathematics more demanding than other subjects. They would recommend the subject only to others who have high prior attainment and who are prepared to put in a great deal of time and effort.

- Most (secondary) pupils are aware that basic numeracy is useful in everyday life and in the workplace. They believe that most of the mathematics they learn in lessons is useful only for tests and examinations.

- Pupils in most secondary schools are unable to link the mathematics they learn at school with their intended future careers. Some schools are more successful in teaching pupils about the uses of mathematics in working life.

2.4. ICT and QCA support and guidance

- Calculator use in primary schools is limited mainly to year groups 5 and 6.

- The use of ICT in mathematics teaching is increasing. Interactive whiteboards are becoming more common in primary schools, and the use of spreadsheets and databases is now almost universal in secondary mathematics departments. The quality of ICT use for mathematics is better in primary than in secondary schools.

- There is little awareness of QCA's web-based materials, for example the National Curriculum in Action site and the assessment tasks for more able pupils. They are well regarded by those teachers who have seen them.

3. MAIN FINDINGS

3.1. Curriculum

Foundation stage

The early years community values the *Curriculum guidance for the foundation stage*, published by QCA in 2000. The guidance covers six areas of learning as well as attitudes and dispositions. It describes mathematical development in three strands: numbers as labels and for counting; calculating; and shape, space and measures. Early years practitioners are particularly positive about outdoor activities described in the guidance. Since the establishment of the foundation stage as a statutory stage of education, some schools have been using this part of the guidance as a lever to procure funding for outdoor play facilities for reception classes.

Almost all schools are able to put into practice, in reception classes, the principles of early years education as laid out in the curriculum guidance. Most schools are able to cover all aspects of each area of learning, except where children attend part time and particularly where children are placed in mixed age classes. Most schools give high priority to mathematics, ranking it third after personal, social and emotional development and communication, language and literacy.

Ofsted inspectors judge the quality of the provision at the foundation stage to be stronger than that at key stage 1 or 2. For pupils aged under 5, teaching and learning is good or better in three-quarters of schools. Teachers plan effectively from the *Curriculum guidance for the foundation stage* and national numeracy strategy documentation and teach basic skills well. Pupils, including those with special educational needs, make good progress and have a positive attitude to mathematics.

Transition from nursery to reception and from reception to key stage 1

Teachers report a gradual transition in the style of classroom activity during the reception year. In some schools the curriculum in reception classes is more like nursery than year 1. For example, foundation stage planning sheets might be used until the beginning of year 1. In some schools, teachers use different styles of working for different groups where they find that some children are ready for sustained mathematical activity early in the reception year. In most schools, transition to a key stage 1 style of working is left until later in the reception year, and in some it is left until the first term of key stage 1.

Primary mathematics curriculum

The taught curriculum at key stages 1 and 2 continues to be dominated by the national numeracy strategy's framework for teaching mathematics. Generally teachers are confident that the strategy framework broadly covers the programme of study for mathematics. Almost all schools are able to cover the mathematics programme of study, even though just under one-fifth report some difficulty in doing this in both key stages 1 and 2. This is confirmed by some responses to our primary focus group questionnaire, which indicate that teachers feel that the curriculum, including the mathematics curriculum, is very full at key stage 1 and that more time is needed to consolidate children's learning.

The strategy's unit plans for year groups 4 to 6 are used widely. Teachers feel that these plans are better used as a resource for planning rather than a substitute for teachers' planning and that many teachers need practice in developing the plans for their own classes. If a school has a drive on a particular aspect of mathematics, the unit plans may not match. Teachers in years 1–3 are looking forward to the development of unit plans for younger age groups.

Teachers' knowledge and understanding of mathematics continues to improve. It is now good or better than any other subject in more schools. Basic skills, mainly in number, are taught well at all levels. However, training is needed in pupils' recording of calculations. A number of terms are used to describe pupils' recordings, including 'jottings' and 'informal written methods'. Such terms are developing new meanings as numeracy consultants and teachers work with the ideas. Care should be taken in publications at both local and national level to ensure that where terms are used they are exemplified.

LEA mathematics advisers feel that more training is needed on teaching pupils to use and apply mathematics, in view of the greater emphasis on this in the national tests. Furthermore, some teachers do not find enough time to plan and teach the more challenging parts of the curriculum. There is evidence that teachers would find it useful to have a variety of tasks to support work with more able children.

Teachers feel that essential skills can be covered through cross-curricular themes but that there is also a need to retain the dedicated time for mathematics. Some teachers feel that there is a need to link to other curriculum areas and to become more creative. They suggest that mathematics lends itself to a cross-curricular approach. However, they feel that the framework inhibits this where it specifies the number of days for each topic to be taught and for assessment. Teachers feel that there is little or no time for breadth in mathematics. They feel that they used to do a lot more cross-curricular work than they do now.

Transition from key stage 2 to key stage 3

Evidence about transfer from primary to secondary school in 2001/2 was available from an Ofsted report that was linked to the introduction of the key stage 3 national strategy. This evidence indicated that transition was much improved on previous years but that there was still a long way to go. What little evidence we have for 2002/3 indicates that the position is much the same. Visits to primary schools by secondary teachers are seen as useful. However, partner schools still need to improve continuity by focusing on what pupils are expected to achieve. Strategy transition units are used in some areas of the country to support progression at transfer.

There are logistical problems for schools where the cohort transfers to or arrives from a large number of schools. Secondary teachers report a wide variety of strategies used to smooth transition, but they also indicate that there are continuing difficulties with obtaining transition data – even key stage 2 test results – in good time for all their year 7 pupils. Some LEAs help in this process, but many do not. There is a feeling that data transfer should be coordinated at LEA level rather than at school level.

There are differences in perception between primary teachers of year 6 pupils and secondary teachers of year 7 pupils. Primary teachers judge that not only are there fewer low-attaining children than a few years ago but that those below level 4 are less far behind. This contrasts with the view expressed by secondary teachers, who note an improvement with the more able and middle-ability pupils but feel that there is little change in the performance of less able pupils, thus making the spread at age 11 wider.

Primary teachers speculate that less able children might find the transition process harder than other children and suffer more of a drop in performance on transfer as a result. It is felt that a lot of information is lost between primary and secondary, and this too might have more impact on lower-attaining children than on the rest of the cohort. The four-month gap between key stage 2 tests and the beginning of year 7 could also be a factor.

Secondary mathematics curriculum

The shortage of suitable teachers continues to be seen as a major problem in terms of delivering the secondary mathematics curriculum. Data on unfilled vacancies and unqualified staff, although highlighting serious issues, still underestimate the problem, as they do not report the number of underqualified or inexperienced teachers. QCA's monitoring tends to support this view. The mean number of vacancies in mathematics

departments is 0.2, which is slightly lower than the figure for English. However, the mean number of staff members per department who have a recognised pre-service qualification in mathematics is 6.1, whereas the corresponding figure for English is 6.98. Secondary mathematics teachers feel that the staffing problem is getting worse rather than better.

Key stages 3 and 4

The delivery of the key stage 3 mathematics curriculum continues to change as a result of the national strategy. In 2001/2, most schools had already used framework objectives to plan their scheme of work. Secondary mathematics teachers tell us that the strategy framework is now the main influence on curriculum planning. In 2002/3, 31 per cent used the framework to modify their school's scheme of work extensively and 38 per cent used it to replace their scheme of work entirely. However, the national curriculum for mathematics continues to have a strong influence on planning at key stage 3. Of 200 respondents, 62 per cent said they use the programme of study 'a great deal' and a further 30 per cent 'quite a lot'.

At key stage 4, examination syllabuses are the major influence on what is taught, with the national curriculum taking a subsidiary role. Many schools are now following modular GCSE courses, and the content of the modules defines the structure of the delivered curriculum. There is widespread support among teachers for the concept of a two-tier GCSE, which would improve the match between the structure of the curriculum and examination syllabuses. Teachers are clear that a structure that allowed a grade C on the lowest tier is highly desirable. However, there are some concerns that the pilot structure paper 3 (covering grades A*, A and B) is likely to prove demotivating for all but the highest-attaining students.

The introduction of the handling-data coursework task for GCSE has caused considerable concern among schools. Evidence from a variety of correspondents and from meetings with heads of mathematics points to some difficulties for pupils with data collection, which can be very time consuming. The most significant problems are with applying the assessment criteria. Some schools complained that it is difficult to achieve high marks and that there has been a general lack of exemplification and guidance. Evidence from awarding bodies confirms that marks for the handling-data coursework were generally low. Informal feedback suggests that this was largely a consequence of a focus on statistical techniques at the expense of skills of planning and interpretation. The emphasis on the handling data-cycle in the national curriculum has yet to be fully assimilated into the taught curriculum.

Post-16

Just over half of students aged 16 to 18 are educated in further education colleges. The quality of science and mathematics provision is unsatisfactory in one in five colleges, much higher than the average for other subjects. Basic skills provision is unsatisfactory in 18 per cent of colleges, and despite some improvements the proportion of students gaining grades A*–C in GCSE mathematics at college remains low. Pass rates for key skills qualifications are also low, and students' motivation has been eroded by the lack of recognition given to the key skills. This is also the case in secondary schools. Teachers comment that the assessment for application of number discourages schools from participating. In contrast to this there is strong support, at least in principle, for wider use of free-standing mathematics qualifications.

3.2. Assessment

Procedures for assessing pupils' attainment and progress are good or better in almost two-thirds of primary schools – along with English, the highest among all subjects. Use of assessment to guide curricular planning is less strong (good or better in just over half of primary schools). In keeping with most subjects, the quality and use of ongoing (formative) assessment remains the weakest feature (good or better in only half of primary schools), although it is noticeably stronger for pupils under 5 than at key stages 1 or 2.

There is a wide variety of assessment structures in secondary schools. Test styles tend to be heavily influenced by the style of national curriculum tests, and information from both statutory and non-statutory tests is viewed as useful. About 70 per cent of respondents to the SSP questionnaires use the key stage 3 test results for each of four purposes: tracking progress, measuring the value added, predicting GCSE performance, and setting by prior attainment in year 10. Analysis of test outcomes on a question-by-question basis is much less common.

Apart from tests, other forms of assessment are more varied and generally of less good quality. As with primary schools the quality and use of ongoing assessment in secondary mathematics is a weakness. It is unsatisfactory in one school in eight and overall is lower than most other subjects, especially in key stage 4. This echoes comments made in the key stage 3 strategy evaluation.

Foundation stage

The foundation stage profile was piloted in 2003. Teachers support having one national assessment scheme at the end of the foundation stage. There are, however, workload issues associated with the profile. Although completing the profile booklet is non-statutory, some LEAs requested completed booklets as part of their moderation procedures. The completed booklet can be used as the end of year report to parents. However, schools wish to retain it as part of the pupil's ongoing school record. Schools find photocopying the profile booklet costly, and consequently the reception teacher duplicates record keeping by completing a separate report for parents. Other reception teachers have found that completing the profile booklet duplicates the summative records they already keep.

Teacher assessment

The use of level descriptions in primary schools is declining. Level descriptions appear to be more widely used in secondary schools. In the SSP questionnaire, about nine-tenths of heads of department found level descriptions useful. They use level descriptions for: end of key stage 3 statutory teacher assessment; planning targets for year groups; and assessment at the end of each year. Their usefulness in providing information about a pupil's key stage 2 performance when they enter secondary school was rated much less highly, with 44 per cent of respondents indicating that they are either 'not very useful' or 'not useful at all'. SSP responses show that schools (approximately 90 per cent) feel that the expectations in the level descriptions are about right across key stages 1 to 3.

There is now an increased emphasis at national level on teacher assessment at key stage 1. A pilot for 2004, involving about a quarter of LEAs, is being developed. Schools in the pilot will report teacher assessment results – although children will have taken a test – to contribute to the teacher assessment at some point during year 2. LEAs will also work to moderate teacher assessment within and across schools. Teachers welcome the increased emphasis on teacher assessment, which is more ongoing than a test score. In questionnaire responses teachers make further points: teacher assessment should be the way forward, with tasks to complete along the way for any child reaching a milestone; tests would not be needed; teacher assessment gives a much better overall picture of children's progress; one-off 'snapshot' tests do not give children the chance to show what they can do. Primary teachers feel that teacher assessment is very accurate at both key stages 1 and 2.

Optional tests and tasks

Years 3, 4 and 5 optional tests

The optional tests are widely used. Teachers tell us that LEAs expect schools to use the tests year on year to track children's progress and for value added purposes. Teachers also feel that schools need a means to see whether children are progressing, and the tests are helpful in this respect. These teachers feel that the standard of work at the end of year 6 is higher than before and that the optional tests have helped to bring about this improvement. Using the tests helps to spread the responsibility for year 6 results across

the key stage. This means that teachers in years 3 to 5 now feel the pressure in a similar way to year 6 teachers. Analysis of tests helps schools to plan more accurately, as it shows clearly the mathematics that has yet to be taught.

There was consensus in the primary focus group that the optional test results generally tally with teachers' own assessments of the pupils. Other comments on the new optional tests include:

- The new tests are a better bridge between the statutory tests in years 2 and 6 than were the old tests. The new year 5 tests in particular reflect the standard of the statutory year 6 tests much better than the previous year 5 test.
- In the year 3 and 4 tests, the higher-tier test looks hard, but teachers are pleased by good results this year.

Year 7 progress test

Teachers tell us that the new year 7 progress test is much better than in previous years, when the key stage 2 tests were used. As there are no level 5 questions pupils are able to access a greater proportion of the test questions. The 45-minute timing of Papers 1 and 2 is seen as a positive feature. The questions fit the timing of the papers well. The larger spacing in the papers allows adequate space for pupils with large writing. There is also a positive reaction from pupils. The test provides a good incentive for pupils and teachers in a year that sometimes shows little improvement. There is no stigma attached to taking the test, as it is different from the key stage 2 tests.

The second paper contains a low number of questions requiring a calculator. Teachers would prefer to see more multiplication and division questions that require a calculator as a support. Teachers say that 20 questions is a good length for the mental mathematics test, though 20 minutes might be too long for some pupils to concentrate. The lack of questions on angles and coordinates is surprising, as other topics are repeated. Teachers would like more classroom items for using and applying mathematics.

Web-based tasks

There is little awareness of the website assessment tasks. None of the primary teachers at the mathematics focus group meeting had used the key stage 1 tasks for pupils working above level 3, although the key stage 2 tasks had been used. Many teachers are unaware that these tasks are available. There were comments that the key stage 2 tasks for more able children are difficult but useful in challenging those children.

Statutory tests

Changes to tests in 2003

Across key stages there is increased emphasis on assessing pupils' ability to use and apply their mathematics (UAM). Up to 12 per cent of marks are attributed to UAM. This enables schools to consider pupils' performance on the test in this aspect of mathematics. This change has caused little comment in school and LEA evaluations of the test experience in 2003. Primary teachers feel that changes to the tests at key stage 2 were not as great as they had expected.

In 2003, changes to the statutory tasks and tests at key stage 1 included the introduction of separate level 2 and level 3 tests. Most primary teachers who attended our focus group meeting prefer the separate tests, although some do not. They report that many schools entered pupils working at level 3 for the level 2 test first. This increased the workload for teachers. Teachers felt that some pupils working at level 3 were exhausted by the time they took the level 3 tests towards the end of the assessment period. The teachers agree that having separate tests provides a better experience for pupils working at level 2.

Resources in tests

QCA has undertaken research into the effects of allowing 100 squares and number lines in the level 2 test at key stage 1. The results were interesting, and although some groups did better than others on particular questions, over the whole set of questions performance was similar. Observers felt that children with apparatus tended to finish more quickly, even though the test results for each group were similar. Teachers feel that it is appropriate for children working at level 2 to have access to the additional apparatus. It would reflect the way children are taught, as they are encouraged to use apparatus in lessons.

Teachers at our focus group were asked if it was helpful for children to have access to a mirror for reflection questions in the level 2 test at key stage 1. There was a mixed response. Some teachers think that children often feel they have to use a mirror when they do not need to and then often use it wrongly. Others say that children do not use them even when they are provided. Some teachers feel that children find the mirror useful, especially for checking. Teachers agree that children working at level 3 should have the confidence to work without apparatus. Changes to the availability of resources for level 2 tests in the longer term are being considered.

Teachers were asked whether tracing paper and mirrors should be allowed for reflection and rotation questions in the key stage 2 tests. Teachers use mirrors and tracing paper in teaching the topics, and some feel it important to allow children the option of using them in the test. They feel that using these resources to help children visualise reflections and rotations is a stepping-stone in their learning. This teaching approach is felt to be most helpful for children with English as an additional language because the movements can be demonstrated visually with few words.

Concerns

There is concern about the way the attainment of the lowest-achieving pupils is reported at the end of the key stage. National curriculum assessments below level 1 are reported as W. Advisers recommend that use of P scale descriptions would be more useful in tracking the progress of pupils who are likely to be awarded W at the end of more than one key stage.

The quality of end of key stage tests is generally well received by teachers. However, there is considerable concern about the 'high stakes' nature of the tests. Their use for accountability purposes is questioned. Teachers report that target setting and the publication of test results lead to greater emphasis on teaching mathematics and English and narrow the curriculum in other subjects at key stages 1 and 2. They report concerns about the amount of curriculum time used for revision and about pressure to complete the teaching programme for years 2 and 6 by May. There is widespread feeling that testing at the end of key stage 1 should cease to be statutory. At other key stages a review is called for. There continues to be concern over the burden of national curriculum testing at KS3 and that concentration on test results as a measure of standards has a detrimental effect on the curriculum. There is strong support for formative assessment.

3.3. National strategies

The national numeracy strategy / primary strategy

Almost all schools follow the strategy in reception year. Fewer teachers than in 2001/2 perceive a tension between the numeracy strategy and foundation stage approaches in reception and nursery. A perceived pressure for more adult-initiated work was a concern in 2002 when national numeracy strategy activities for nursery and reception were published. Almost all schools now feel they offer an appropriate balance of adult-initiated and child-initiated activities. Schools use the flexibility to introduce a 45-minute continuous mathematics lesson at different times of the reception year. Over a 10th of schools delay the introduction until year 1, and this was confirmed by our primary teachers' focus group. Two of the nine schools represented delayed the 45-minute continuous mathematics

lesson until the autumn term in year 1. This had received positive comment in a recent Ofsted inspection report.

The strategy continues to have a positive impact. Teachers tell us that they and their pupils are more enthusiastic about mathematics than before. Teachers feel that low achievers are more positive about their mathematics learning than before. The Leverhulme project reported in 2002 that strategy training and the support of numeracy consultants were valued highly by teachers. The report confirms that teachers feel more confident about their mathematics teaching and describe increased confidence and enthusiasm among their pupils. A review of Ofsted inspections shows a positive impact of the strategy. There has been an improvement in mathematics teaching since the introduction of the strategy. In the SSP survey 73 per cent of respondents had 'noted improvements in the preparedness of pupils at the start of year 7'.

Research from the Leverhulme project shows improvement in the progress that children make in many aspects of mathematics during key stages 1 and 2. The strategy has had greatest effect on the progress of middle-attaining pupils, and then on high attainers. The report, however, does indicate some unease about the suitability of strategy approaches for low-attaining pupils. There is also some evidence that pupils' problem-solving abilities declined between 1997 and 2001.

Other qualitative research (*Cambridge Journal of Education*, vol. 32, no. 1, 2002) suggests that the vocabulary used in teaching sometimes hampers the ability of pupils to gain conceptual understanding, even when the vocabulary is correct. This conclusion raises doubt about the emphasis in the strategy on the use of correct mathematical vocabulary.

Asked about cross-curricular work and creativity through our primary teachers' focus group questionnaire, several teachers suggest that the framework has inhibited these approaches to mathematics. It is felt that objective-led planning can stifle creative thinking (for teachers) and narrow children's responses if the lesson is kept to the plan. Some teachers would find it helpful if (more) resources were provided alongside the framework. Schools and teachers, however, do not feel that at that point 'the job is done'. Improvements in learning have been rated less highly in inspection.

Key stage 3 national strategy

This is the second year of the national strategy for key stage 3. It has already had a far-reaching effect on the taught curriculum. The SSP survey showed widespread changes in the way lessons are taught as well. Of 199 respondents, 84 per cent indicated that there had been changes to the way mathematics is taught in their departments as a consequence of the introduction of the strategy. From a low base, pupils' achievement in mathematics had seen the greatest improvement last year. However, the quality of teaching in mathematics remains lower on average than in many other subjects. Some teachers from our focus group reported better attainment in their year 7 pupils, but there was a feeling that the gap between the most and least able had widened. Feedback from our autumn conferences indicates a perception that the effect of the strategy may have been to encourage gains in some areas (such as year 7) at the expense of others (for example, year 9 and GCSE).

A similar point has emerged in relation to professional development. Our secondary focus group (which comprised mainly heads of mathematics) was positive about the amount and quality of training offered by the key stage 3 strategy. However, the response of the National Association of Mathematics Advisers to the Advisory Committee for Mathematic Education's consultation on continuing professional development (CPD) notes that most training at secondary level is focused on the key stage 3 strategy, using a cascade model. The report is of the view that this model has a significant lack of impact on teaching and learning at the classroom level and that there is a need for more breadth in CPD, both in terms of the teachers targeted and the areas covered, so as to avoid a narrowing effect on the delivered curriculum.

3.4. Diversity and inclusion

Our primary focus group questionnaires show that some teachers feel that the national strategy's unit plans for mathematics do not give a clear steer on adapting material and that it is left to the individual teacher. Two of the nine responses suggested that materials providing multicultural contexts for mathematics are needed. About half of the schools represented at the meeting have had INSET and/or used QCA guidance to develop mathematics provision for gifted pupils. The secondary SSP questionnaire asked, 'Do you modify any aspect of your provision to cater for differences in gender/pupil need/pupil preference?' Nearly all (97.5 per cent) the respondents indicated that they made modifications to cater for differences in need, but only 26 per cent did so for gender (and 35 per cent for pupil preference).

Teachers at our primary focus group meeting felt that many questions in the key stage 2 statutory tests in 2003 were very wordy, which is especially difficult for children with English as an additional language (EAL). Teachers found that other children also asked more frequently for questions to be read than in previous years. The test may have been less accessible to pupils with EAL and those who are less confident readers. However pupils with EAL appear to have benefited more than other groups from the numeracy strategy. Pupils categorised as 'new learners / becoming familiar with English' and 'becoming confident / fluent learners of English' made larger gains in their mathematics over 1998 to 2002 than those categorised as 'English as a first / only language'.

The Leverhulme project reports that the strategy appears to have benefited boys more than girls. On project tests the difference in the mean scores of the two groups was greater in 2002 than in 1998. The research also shows that the strategy has impacted differently on different ability groups, with the greatest positive impact on middle ability pupils and then those of high ability. The research questions the value of whole-class teaching for low-attaining pupils.

The Leverhulme project also reports findings in terms of ethnicity for primary schools. These suggest that in the strategy black Caribbean and black British groups made greater gains than white, mixed-race and Pakistani pupils, whose gains were similar to the whole sample. The Indian group benefited most and the black African group did not appear to have benefited.

Mathematics advisers at our autumn 2002 conferences expressed concern about the way in which the attainment of the lowest-achieving pupils is reported at the end of the key stage. National curriculum assessments below level 1 are all reported as W. The use of P scale descriptions would be more useful in tracking the progress of those pupils who are likely to have W at the end of more than one key stage.

3.5. Pupils' attitudes to mathematics

This year the mathematics team organised 17 student focus groups in year groups 9 to 13. For younger pupils we have views from teachers and Ofsted inspections about pupils' attitudes. Children at the foundation stage have a good attitude to mathematics. There is evidence that the children's attitudes largely depend on the approach and activities offered. Positive factors include practical mathematical activity in which children do not feel they will 'fail', and learning well through adult-focused and child-initiated activities.

Pupils in nine out of 10 primary schools have a good attitude to their learning in mathematics. Teachers feel that the primary national strategy's more interactive style of teaching and greater pupil participation at key stages 1 and 2 are reasons for the popularity of mathematics. Other positive factors include practical mathematics at key stage 1 and clearer objectives at key stage 2. Teachers believe that interactive whiteboards are also a positive factor where they are used.

For year groups 9 and 10 the most frequent words used by pupils to describe mathematics include 'hard' and 'dull' or 'boring', alongside 'interesting', 'challenging' and 'enjoyable'. Overall, attitudes expressed in the year 9 focus groups were slightly more positive than

negative. Those in year 10 who enjoy mathematics talk about its differences from other subjects and about the need for concentrated, rigorous thought.

'It's thinking about hard things. But it makes you use your brain more than other subjects.'
Year 9 student

Almost all the students in years 11, 12 and 13 experience mathematics as more demanding than the other subjects they are studying. In year 11 the majority of students view mathematics as hard but enjoyed it to GCSE, despite its demands.

'An enormous amount of work at GCSE compared with other subjects.'
Year 11 consensus

Most students in year 12 describe mathematics as difficult – often very difficult – and year 13 students find it demands a great deal of work and commitment. However, many in year 12 and most in year 13 describe it as enjoyable and rewarding. When asked if they would advise year 11 and year 12 students to continue with mathematics, the students from the year 13 focus groups said that they would only advise them to continue if they had gained the higher grades at GCSE and if they were prepared to put in a great deal of time and effort.

'Mathematics is rewarding. You know how you are doing.'
Year 13 student

Pupils in years 9, 10 and 11 were asked about the importance and usefulness of mathematics. Most pupils think that basic mathematics is useful in everyday life but that they would need little or no mathematics in their future careers. Pupils are aware of the high status of the subject. They know that grade C at GCSE is a hurdle used by employers and by those who control entrance to further and education. Few pupils are aware of the importance of the role of mathematics in developing rigorous thinking.

Most pupils have an opinion on the usefulness of mathematics in daily life, and they feel that basic mathematics is useful. However, many pupils think that much of the mathematics they are taught in lessons is useful only for examinations. Pupils in the focus groups gave examples of the use of mathematics in daily life, for example money and percentages, averages and estimation, and using measurements to plan the use of two-dimensional space. Some pupils are aware that mathematics is used when calculating VAT and interest on mortgages and credit cards. They feel that if they understood these applications more thoroughly then they could use them better. Some pupils complained that they are not often advised on how the mathematics they are taught is useful or important. A strong opinion to emerge from pupils is that they would like to know more about the applications of mathematics.

Most pupils cannot link the mathematics they learn at school with anything in their intended future careers. There were some worrying answers. For example, pupils hoping to become nurses thought that they would not need mathematics in their jobs, although they thought that it might form part of their qualifications. However, in one of the focus groups all the pupils thought that their future jobs would involve some mathematics.

As with the acknowledged use of basic number in everyday life, pupils are aware that basic numeracy is needed in a wide range of occupations. In the main, those students aspiring to engineering, technological or financial work also know that geometry and number are useful. A small minority of students also know that the analytical skills, logic and problem-solving skills developed in mathematics lessons are useful in professional work.

In general, the extent to which pupils think that mathematics will be useful in their future careers depends not on their career aspirations but on which school they attend. This important finding would suggest that this aspect of their attitude to mathematics is based on guidance from their teachers.

3.6. Using ICT to support mathematics teaching

The quantity of the use of ICT in primary mathematics teaching has increased. It is now also used better to promote progress, with one school in three using it well. This compares well with other subjects. Whiteboards are becoming more common in primary schools, and teachers tell us that these encourage participation in whole-class and group work. Short, interactive computer programs are used, and these have a positive impact on pupils' learning. Teachers feel that the power to demonstrate mathematical ideas in a dynamic way enhances the teaching of topics such as angles.

Calculator use is generally limited to years 5 and 6. Teachers report reduced use of calculators since the introduction of the numeracy strategy. Teachers feel there is scope for greater use of ICT but that its use depends on individual teachers' knowledge and skills. Almost all report a continuing need for training, further resources and/or time to research resources. The use of ICT remains a weakness in about 20 per cent of schools.

The use of ICT in secondary mathematics lessons is also on the increase. However, it is used often in only one-sixth of mathematics departments, with four-fifths using it sometimes. Accessibility of computers and lack of time are the main inhibiting factors. The patterns of pupils' use of different ICT applications as part of their work in mathematics are similar across key stage 3 and 4. Spreadsheets or databases are used in almost all schools. The following applications are the next most often used, given in decreasing order of frequency: commercial packages, the internet, word processing. The following applications were not used by pupils in the SSP sample as part of their mathematics work: e-mail, preparation of presentations, video, still cameras, data logging. The pattern of use for independent learning (CD-ROMs) and dynamic geometry is more mixed. The use of ICT to promote progress in mathematics remains a relatively weak aspect of provision, with its use being unsatisfactory in a third of schools and good or better in only a quarter.

4. EVALUATION OF QCA SUPPORT AND GUIDANCE

QCA periodically monitors the number of hits on parts of the website. A typical outcome from such monitoring is the result for the National Curriculum in Action site (www.ncaction.org.uk/) in April 2003. There were over 2000 hits on the English, mathematics, ICT and science parts of the site. Of these four subjects mathematics was the least frequently visited. About half of secondary heads of mathematics have seen the National Curriculum Online site (www.nc.uk.net/), but almost a quarter have never used it. The National Curriculum in Action site has not been seen by almost two-thirds of heads of mathematics and not used by about a fifth. In general, awareness of sites other than these two is poor. Almost all support and guidance from QCA now appears online, so more needs to be done to communicate this to those for whom the guidance is intended.

Teachers' awareness of QCA publications, such as *Working with gifted and talented children: KS1 and 2 English and mathematics*, is patchy. Where materials do reach teachers they are felt to be helpful. LEA mathematics leaders tell us that references to mathematics in the QCA schemes of work for science, ICT and art and design are not entirely consistent with mathematics in the national curriculum and in the strategies' frameworks. QCA is in the process of deciding whether producing updated guidance on this is a sufficiently high priority.

ANNEX 1: SOURCES OF EVIDENCE

Advisory Committee for Mathematic Education (ACME)
ACME's first self-initiated report: *Continuing Professional Development for teachers of mathematics*, December 2002

Awarding bodies
OCR feedback meeting on GCSE two-tier pilot, 22 September 2003

Centre for Formative Assessment Studies
Evaluation of statutory assessment at key stage 1, 2 and 3 (2003)

Comments from individuals
Tony Burtenshaw, Bexhill College
Dr Tony Gardiner, Birmingham University
Steve Garrett, Bruton School
Professor Peter Saunders, King's College London
Sue Waring, Queen Elizabeth's High School, Gainsborough

Conferences
Ireland, one-day conference, 'A day with Constance Kamii', March 2003

De Havilland Information Services
The national president of NASUWT, speaking on BBC Radio 4, April 2003

EURYDICE at NFER (the information network on education in Europe)
Education in the news, issue 24, June 2003

Focus groups
QCA primary teacher focus group for mathematics, July 2003
QCA secondary teacher focus group for mathematics, July 2003
QCA student focus groups for mathematics, July 2003
QCA mathematics teachers re year 7 progress test

HM Inspectorate
Mathematics briefing paper, June 2003

Local education authorities
Letter from Nigel Rigby, director of education, Stoke-on-Trent, February 2003
Meeting with LEA line managers, June 2003

Office for Standards in Education (Ofsted)
Section 10 inspection evidence, primary
Section 10 inspection evidence, secondary
College and area-wide inspections, April 2003
College and area-wide inspections, June 2003
Ofsted report, *Good assessment practice in mathematics*, March 2003
Ofsted web publication, *The key stage 3 strategy: evaluation of the second year*, March 2003

Press summaries
QCA daily press summaries, September 2002 to August 2003

Research
Adult numeracy: review of research and related literature

British Educational Research Journal, Vol. 29, Number 2

British Journal of Special Education, January 2003

Cambridge Journal of Education, vol. 32, no. 1, 2002

Educational Research and Evaluation, 2002

Publications of the Learning and Skills Development Agency, November 2002 and March 2003

Case-study data from the Leverhulme Numeracy Research Programme, October 2002

Nuffield Year 4 Project: Impact of the National Numeracy Strategy, August 2003

The Roberts Review, *SET for success: the supply of people with science, technology, engineering and mathematics skills*, Sir Gareth Roberts, April 2002

Support for Learning, vol. 17, no. 2, 2002

Publication of the Science, Technology and Mathematics Council, June 2002 (published 2003)

School Sampling Project
Report from primary questionnaire

Report from heads of mathematics departments questionnaire

School visit
Informal discussion with staff during key stage 1 pre-test 2 observation visit to primary school, Harlow, Essex, 17 June 2003

Subject associations
Joint Mathematical Council meeting, November 2002

National Association of Mathematics Advisers (NAMA) autumn newsletter, 2002

NAMA winter newsletter, 2002

Minutes of meetings between subject associations and QCA mathematics team, November 2002, June and July 2003

Websites
QCA National Curriculum in Action website: number of hits on the website, April 2003

Summary reports of websites of subject associations: Association of Mathematics Education Teachers; Association of Teachers of Mathematics; the Institute of Mathematics and its Applications; London Mathematical Society; the Mathematical Association; National Association of Mathematics Advisers: National Association for Numeracy and Mathematics in Colleges.