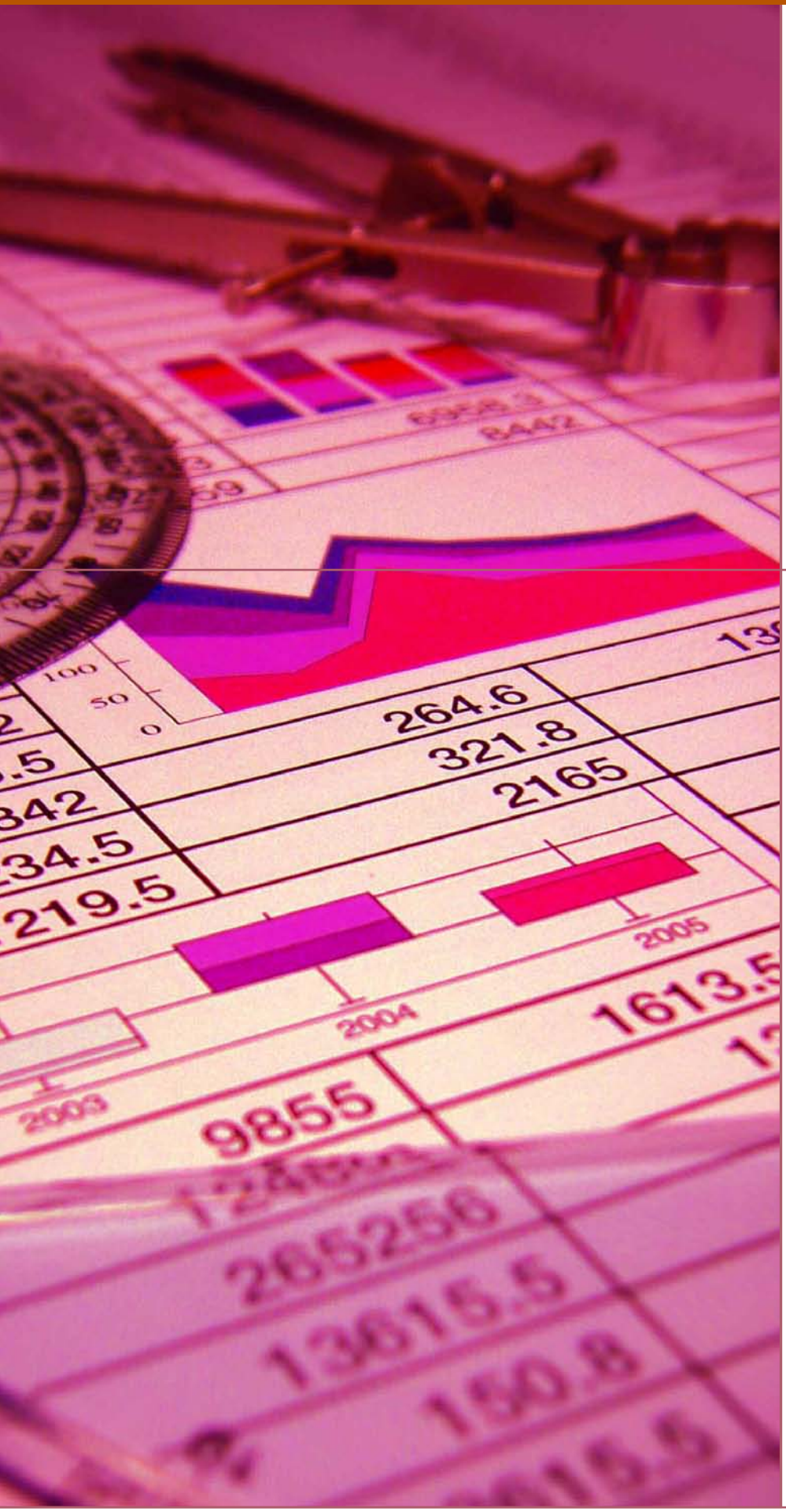

IMPROVING SERIES

IMPROVING ACHIEVEMENT

IN MATHEMATICS IN PRIMARY AND SECONDARY SCHOOLS

HMIe
improving Scottish education

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IN MATHEMATICS IN PRIMARY AND SECONDARY SCHOOLS

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FOREWORD

This is the fourth in a series of reports from HMIE, designed to promote improvement in school education in Scotland. This report focuses on mathematics education in primary and secondary schools.

Improving achievement in mathematics is a key priority for Scottish education. Improvements are evident in the teaching of mental mathematics in primary schools and in the assessment through SQA examinations of pupils' ability to do calculations without using a calculator. The overall quality of mathematics education in Scottish schools is good, with a number of key strengths. Our youngest pupils get off to a very good start, a major strength of which we should be proud. At the same time, almost all pupils achieve SCQF level 3 or better by the time they complete S4. International studies show strengths in the achievement of Scottish pupils at S2 and S3 in aspects of mathematics.

These are important strengths, but more needs to be done to ensure that all Scottish pupils reach appropriate levels of numeracy and broader mathematical abilities. Too often, pupils do not see the relevance of the mathematics they are being taught nor the connections with the skills they need in other subjects. Skills such as the ability to solve problems and deal effectively with mental calculation lie at the heart of mathematics education.

A number of important questions remain for those involved in leading and delivering mathematics education. Employers and staff in higher education institutions continue to express concern about the basic mathematical abilities of young people. How well equipped to face a rapidly changing society are the 16 year olds who leave school having achieved SCQF level 3 in mathematics? In terms of numeracy, how well placed are young people to apply their mathematical skills to new experiences and contexts? To what extent does the qualifications framework adequately assess the levels of numeracy of young people? And are all our young learners given equal opportunities to develop and use critical problem solving skills in a range of relevant contexts across the curriculum? I do have a particular concern about our current capacity to address the needs of young people for whom learning presents a major challenge. We need to do more to identify early enough those pupils who are likely to be within the lowest achieving group nationally, and plan specific, targeted approaches which will engage them more effectively in learning that is designed to promote and improve their levels of numeracy.

In considering these questions, and others, we can build on the undoubted strengths that are clearly emerging in those schools where high expectations and best practice are the norm for all pupils. Learning and teaching in mathematics should be the main focus for improvement.

Presently, the process of curriculum review flowing from *A Curriculum for Excellence* has challenged us all to consider how mathematics can better meet the needs of young people in the 21st century. As we move to a clearer understanding of the nature of high achievement, we all need to think again about the impact that our learning and teaching approaches and contexts for applying mathematical skills have on developing pupils' general learning skills, personal confidence, individual responsibility and effectiveness in contributing to group tasks and success. This is not just about modernising the content of our syllabuses so that they are fit for purpose, but an opportunity to think again about how best to increase the capacity of young Scottish citizens. To help build this capacity, I look forward to the ensuing debate and action as we all respond to the challenges ahead.

Graham Donaldson
HM Senior Chief Inspector of Education
October 2005

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INTRODUCTION

This report is based on inspections of mathematics in primary and secondary schools carried out between August 2002 and April 2005. In addition to schools inspected, HM Inspectors also visited primary and secondary schools to observe and describe aspects of best practice. This report also draws on pupils' attainment in Scottish Qualifications Authority (SQA) examinations, the Assessment of Achievement Programme (AAP)[1], the Programme for International Student Assessment (PISA)[2] and Trends in International Mathematics and Science Study (TIMSS)[3].

The focus of this report is on action for improvement. The starting point is the existing good practice which many schools are using to strengthen pupils' learning and to raise achievement. A number of previous reports have identified strengths and areas for improvement in learning and teaching mathematics. This report builds upon the earlier HMIE reports *Improving Mathematics Education 5-14* (1997), *Standards and Quality in Primary Schools: Mathematics 1998-2001* (2001) and *Standards and Quality in Secondary Schools 1995-1999: Mathematics* (1999).

Particular questions addressed through the report include the following:

- How good are attainment, courses, learning and teaching and leadership?
- What is the evidence of improvement?
- What are the strengths of existing good practice?
- Where is the scope for further improvement?

Each section of the report identifies strengths and issues common to both the primary and secondary sectors. Where appropriate, the report comments on features applicable to specific stages. The report also provides a series of prompt questions which schools should find helpful in evaluating and improving their own practice.

[1] Every three years, AAP surveys performance at three or four stages in a range of mathematical skills. The most recent AAP survey in mathematics was in 2004 and surveyed pupils' performance at P3, P5, P7 and S2. Further information on the AAP survey is available on the website of the Scottish Executive Education Department (SEED). SQA provides information on pupils' attainment on its website as well as annual reports from examiners on pupils' performance in national examinations.

[2] PISA is an international survey of 15 year old pupils' standards in literacy in reading, mathematics and science, particularly in relation to young people's capacity to use their knowledge and skills in order to meet real-life challenges. Forty-one countries participated in PISA 2003, including all 30 OECD countries. Further information on the PISA survey is available from the PISA website.

[3] TIMSS is an international survey which measures trends in mathematics and science performance at P5 and S2. Surveys in mathematics were carried out in 2000 and 2003. In 2003, 25 countries took part in the P5 study and 46 countries in the S2 study.

1

ACHIEVEMENT

The overall quality of attainment in mathematics is good, with a number of key strengths. At all stages from P1 to S2, the proportion of pupils reaching and exceeding appropriate national levels of attainment between 2002 and 2005 increased (see Chart 1). At S3 to S6, attainment in SQA examinations remained relatively static.

Significant features by 2004 were:

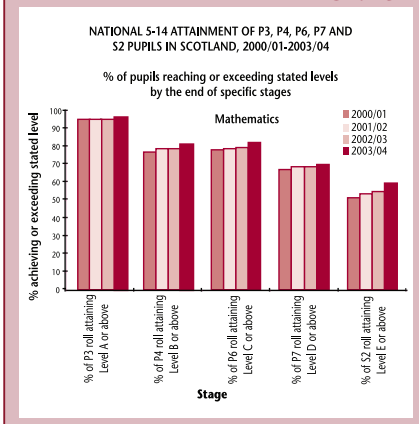
- most pupils at P2 had achieved level A in mathematics;
- almost all pupils at P5 had achieved level B and around half had achieved level C;
- most pupils at P6 had achieved level C;
- almost all pupils had achieved SCQF level 3 or better in mathematics by the end of S4; and
- around 30% of pupils had achieved SCQF level 5 or better in mathematics by the end of S4.

However, there are still several areas that require improvement.

- Only around 70% of pupils at P7 achieved level D and this improved little by the end of S1.
- Only around 60% of pupils at S2 achieved level E.
- Around 6% of pupils did not achieve an award in mathematics at SCQF level 3 or better by the end of S6.

The 2000 AAP mathematics survey showed significant improvements from previous surveys. However, it also identified weaknesses at P7 and S2, where large numbers of pupils were not attaining their expected level in mathematics. The change of format to the 2004 survey means that little comment can be made on improvements between surveys at the early and middle stages. However, the AAP 2004 survey showed strengths in pupils' performance at P3 and P5 with encouraging evidence of pupils performing well beyond the expected level.

Chart 1



SCQF levels
level 3: Standard Grade Foundation award or Access 3
level 5: Standard Grade Credit award or Intermediate 2

How do the levels attained by your pupils at the end of S1 compare with their levels when they started secondary school?

How many of your pupils do not achieve an award in mathematics at level 3 or better by the end of S6? Why is this?

Whilst there remains significant scope to improve performance as gauged against 5-14 and SCQF levels, Scottish pupils perform well in international terms. In the 2003 TIMSS survey, Scotland's performance at P5 was around the international average. It was, however, significantly higher than the international average at S2.

In the 2003 PISA survey of mathematical literacy amongst 15 year olds, Scotland scored significantly above the OECD mean. Scottish pupils performed particularly well in relation to probability and statistics. Only one OECD country had a mean score in this area which was significantly higher than that of Scotland. The next strongest area was in relation to algebra. Scotland's performance in relation to geometry and number was good.

There are encouraging indications that schools have responded well to a number of recent national developments, including changes to syllabus content and recommendations in earlier HMIE Standards and Quality reports. It will be important to continue to build on these strengths to improve further in the key areas of mathematics. Improvements also in the way that mathematical skills are taught and assessed consistently across the curriculum should ensure continued rises in pupils' levels of competence.

Inspections in primary schools showed that attainment was good and had remained steady in recent years. In almost 80% of schools pupils were attaining very good or good standards in mathematics (see Chart 2). However, in many schools, performance by the end of P7 had not built sufficiently on the strong start made at the early stages.

Inspections in secondary schools noted that pupils' attainment in mathematics showed strengths at S5/S6, but continued to need improvement at S1 to S4 (see Chart 3). The overall quality of attainment was very good in 25% of schools at S5/S6. At S1/S2, however, it was only very good in around 5%. Attainment at S1 to S4 showed some important or major weaknesses in around 40% of secondary schools.

Chart 2

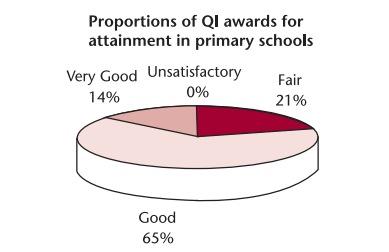
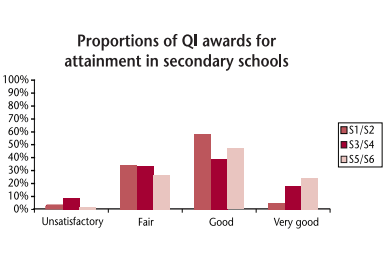


Chart 3



1

ACHIEVEMENT

General features of attainment in primary schools

At all stages in primary schools, most pupils were attaining well in number, money and measurement and their skills in written calculation were well developed. However, all too often these skills were not practised in a sufficient variety of practical contexts. In many primary schools where pupils were attaining very good standards, mental calculation skills were a notable strength at all stages. In many schools where weaknesses in this area had been identified, such weaknesses were most often in mental calculation, particularly at P4 to P7.

Most pupils were performing well in shape, position and movement and in aspects of information handling. At all stages, most were aware of a range of shapes and angles and could interpret data from graphs appropriate to their stage. The most common weakness was in pupils' skills in using information and communications technology (ICT), particularly databases and spreadsheets, to handle information and produce graphs.

In the best practice, pupils could confidently use a variety of strategies to solve a range of problems. They could apply these strategies and responded effectively to changes in the context of the problems.

Features of attainment at P1 to P3

At P2, the percentage of pupils attaining level A in mathematics increased steadily from 2001 to 2004 (see Chart 4). The percentage of pupils achieving beyond Level A at P3 improved slightly too, for example, the proportion achieving level B or better in P3 rose from 11% in 2001 to 16% in 2004.

Features of attainment at P4/P5

At P4, the percentage of pupils attaining level B or better was above the national expected figure and had increased between 2001 and 2004 (see Chart 5). The percentage of pupils attaining level C during the course of P5 had risen from 41% in 2001 to 47% in 2004.

Chart 4

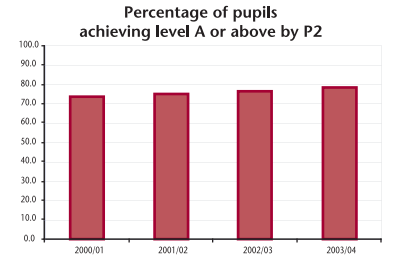
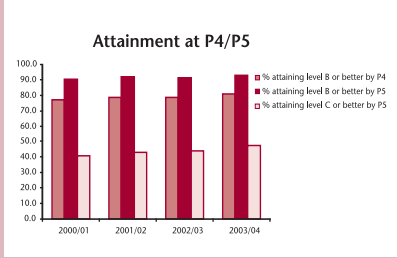


Chart 5



However, the scale of the early gains made by pupils at P2 was not being sustained consistently in P4 or P5. Chart 6 illustrates the uneven pattern of pupils' progress in attainment from P2 to P7.

Features of attainment at P6/P7

From 2001 to 2004, the proportions of pupils attaining level C or above at P6 increased from 78% to 84%. The proportion of P6 pupils attaining level D or above also increased, from 19% to 22%. At P7 the percentage of pupils attaining level D or above increased from 67% in 2001 to 70% in 2004. The percentage of pupils attaining level E or above at P7 also increased from 10% to 15%. These are encouraging trends which schools should build upon as they continue to improve approaches to learning and teaching.

Features of attainment at S1/S2

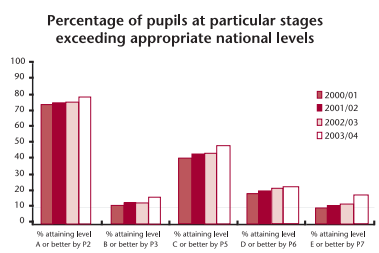
Pupils performed generally well in their coursework. They displayed good knowledge and understanding across most aspects of mathematics. Their ability to perform written and mental calculations without a calculator was improving. However, schools still did not place enough emphasis on the appropriate development of pupils' skills in mental calculation.

In S2, the proportion of pupils achieving appropriate national standards of attainment increased from 2001 to 2004. However, only around sixty per cent achieved level E or F (see Chart 7). Nonetheless, as illustrated in Chart 8, the proportions achieving level E by the end of S1 and level F by the end of S2 were increasing. A major weakness was that the proportion of pupils achieving level D or beyond by the end of S1 showed almost no increase from the position at the end of P7.

Features of attainment at S3/S4

- Overall, pupils' attainment at S3/S4 at SCQF level 5 remained steady between 2001 and 2004 at around 30%. At SCQF level 4, numbers of pupils achieving a General award or equivalent by the end of S4 decreased slightly (see Chart 9).

Chart 6



What steps could you take to establish a more even gradient to learning?

What further improvements can be made to learning and teaching to ensure that the proportion of pupils attaining level E by the end of P7 continues to grow at a healthy rate?

Chart 7

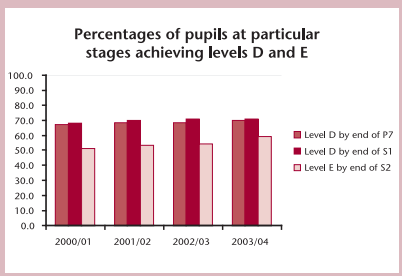
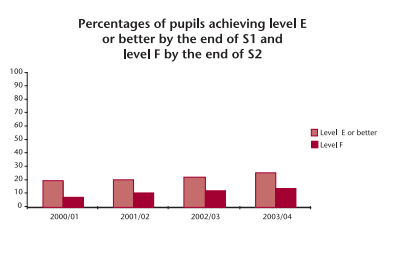


Chart 8



1

ACHIEVEMENT

The proportion of pupils achieving SCQF level 3 or better by the end of S4 remained at around 93%.

- The number of S4 pupils presented for Access 3 increased from 2002 to 2004, but the success rate dropped from 100% to 84%. A small but increasing number of schools presented pupils at Access 3 in S3 but with a drop in the success rate from 100% to 79%.

- Schools presented small numbers of pupils for Intermediate 1 in S3 with slightly more in S4. While 78% achieved A-C grades in S3, only 44% did so in S4. In S3 and S4, most of the small numbers of pupils presented for Intermediate 2 achieved A-C grades.

Features of attainment at S5/S6

- Overall, pupils' attainment at Higher and Advanced Higher remained consistently good across 2002 to 2004.

- At Intermediate 2 pupils' attainment increased. However, at Intermediate 1, pupils' attainment continued to cause concern with only around 50% of those presented at S5/S6 achieving A-C grades (see Chart 10).

- Entries for Intermediate 1 and 2 remained constant with only very small numbers being presented for Intermediate 1 at S6. The numbers of pupils being presented for the option of Mathematics 1, 2 and Applications increased. In 2004, around 25% of entries at Intermediate 2 included the Applications unit.

- At Higher, the overall proportion achieving A-C grades remained steady at around 65%. S5 pupils performed notably better than S6 pupils with around 70% of S5 entries achieving A-C grades compared to around 50% of S6 entries (see Chart 11). Only 49 pupils were entered for the statistics option with less than 50% of them achieving A-C grades.

SCQF levels
level 3: Standard Grade Foundation award or Access 3
level 4: Standard Grade General award or Intermediate 1
level 5: Standard Grade Credit award or Intermediate 2

Chart 9

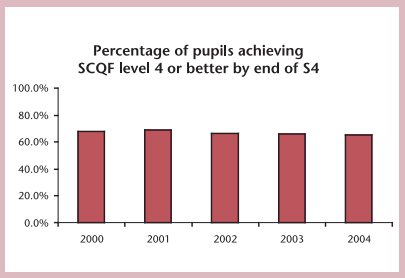


Chart 10

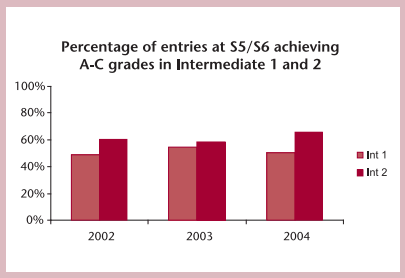
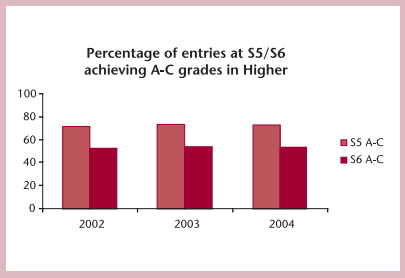


Chart 11



- For Advanced Higher Mathematics, entries dropped slightly in 2004 but the proportion of pupils achieving A-C grades increased to 66% (see Chart 12). For Advanced Higher Applied Mathematics, the number of entries dropped in 2004. The proportion achieving A-C grades remained broadly the same at around 70%. Around 35% of those presented achieved A grades compared to around 25% in the Advanced Higher Mathematics paper.

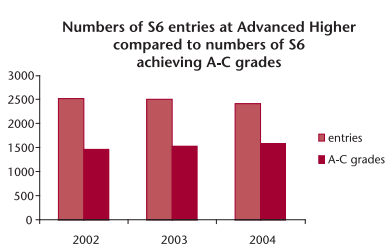
Other features of achievement in primary and secondary schools

In many primary and secondary schools pupils took part in a variety of mathematical competitions. These competitions enabled pupils to work together and individually solving problems in a range of contexts. Increasing numbers of schools were encouraging pupils at all levels of study to solve problems through running competitions such as, 'problem of the week'. Some primary schools had recognised the need for pupils to apply their learning in mathematics to other areas of the curriculum and to use mathematics confidently to solve problems. These schools were successfully promoting pupils' wider achievements in mathematics. They had, for example, ensured that pupils' learning in enterprise education or environmental studies involved them working together in applying their mathematical skills in real-life situations.

Where primary and secondary schools had developed effective links with each other, staff organised joint mathematical events for pupils from each school. These activities provided very good opportunities for pupils to work together solving problems. They often took the form of team competitions. These activities allowed pupils to use mathematics to solve 'real-life' problems.

However, staff in most primary and secondary schools had yet to consider the impact that different learning and teaching approaches and contexts for applying mathematical skills could have for developing pupils' learning skills, confidence, individual responsibility and effectiveness in contributing to group tasks and success.

Chart 12



In what ways does your school promote and develop pupils' learning skills, confidence, individual responsibility and effectiveness in contributing to group tasks and success?

What mathematical activities do you undertake jointly with your associated secondary or primary schools?

1

ACHIEVEMENT

In many schools, there remained the significant challenge of identifying early those pupils likely to be within the lowest 20% attaining group nationally, and then to promote and enhance their achievement.

Main areas for improvement

In primary schools, a key issue is to sustain the gains in early attainment in mathematics and build on these at the later stages.

In addition, overall success rates can disguise the variable progress at particular stages. For example, a school's overall target can be achieved whilst too many pupils continue to leave at P7 without the expected levels of skills in mathematics. In the best practice, schools set well-focused targets to raise attainment at all stages and in particular at the stages most in need of improvement.

Schools did not place sufficient emphasis on developing pupils' skills in written and mental calculation. Too often the approach was restricted to 'ten-a-day' which did not develop pupils' knowledge and understanding of techniques in mental calculation. In SQA examinations, examiners continue to stress the importance of preparing pupils appropriately for the non-calculator papers at all levels. Further consideration needs to be given to ensuring levels of numeracy are consistent across all SQA examinations.

At S3/S4, a very small number of schools had introduced Intermediate 1 and 2 courses in place of Standard Grade. As yet, there was no evidence to suggest that this was raising pupils' attainment. In some of these schools, the proportion of pupils not achieving an award in mathematics by the end of S4 had increased. Schools needed to ensure that they present pupils for the appropriate examination to maximise their chances of success.

At S4 to S6, around 50% of those presented for Intermediate 1 did not achieve a course award at grades A-C although they may have gained success in individual units. In schools where teachers tracked pupils' progress effectively and made good use of assessments to provide pupils and parents with accurate information on their

What steps do you take to identify those pupils likely to be in the lowest 20% attaining group nationally?

In what ways do you promote and enhance their achievement?

How do you ensure that all pupils make appropriate progress building on the gains made at the early stages?

How have you improved pupils' skills in both written and mental calculations?

Within the scope for curriculum flexibility, have you considered how well your programme content and methodology are matched to pupils' needs as citizens of the 21st century?

Will all your S4 pupils have achieved an external award in mathematics before leaving school?

progress, a greater proportion of pupils achieved success. Such approaches to tracking allowed informed choices to be made about the examination for which pupils should be presented.	Do you have assessment evidence to ensure that pupils are presented for the Intermediate course which best meets their needs?

2

COURSES

In 84% of primary schools inspected between August 2002 and June 2003, the quality of programme for mathematics was very good or good. Only 15% were very good.

Of the secondary schools inspected in the period 2002 to 2004, 64% had very good or good programmes at S1/S2. This compared with 69% at S3/S4 and 85% at S5/S6 (see Chart 13). Secondary schools had placed the highest priority on developing appropriate National Qualification courses at S5/S6. A number were now reviewing courses and programmes at S1 to S4 to improve the continuity of pupils' learning and increase the level of challenge.

Features of effective courses at P1 to P7

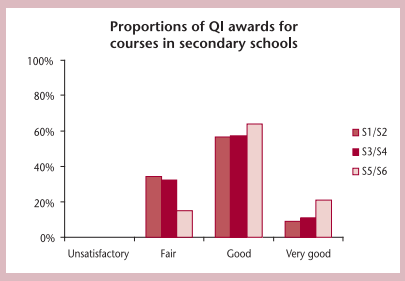
At the early stages, much of the work was oral with the focus on developing pupils' understanding of mathematical ideas.

Effective mathematics programmes ensured that pupils at all stages engaged in an appropriate range of practical tasks such as surveys, measurement tasks and open-ended problems. They avoided superficial tasks which demanded little of pupils, such as colouring-in shapes. School guidelines also included advice on pupils' expected pace of progress. In other curriculum areas, the most effective P1 to P7 courses also provided regular opportunities for pupils to use their mathematical skills in other contexts.

Good use of ICT allowed pupils to develop their mathematical skills in using databases and spreadsheets. Pupils progressed quickly from drawing graphs by hand to using computers to organise and display information in a variety of graph forms. As a result, pupils were able to spend more time interpreting the information and discussing how best to display it.

In the best practice, teachers had an agreed set of approaches for developing pupils' skills in mental and written calculation. They used a range of different approaches for mental calculation. At all stages, pupils worked independently and collaboratively in planning and undertaking tasks. These tasks required pupils to demonstrate a range of skills, including calculation, discussion of mathematical ideas and recording solutions.

Chart 13



Do programmes in your school:

- at the early stages, build effectively on pupils' pre-school learning experiences through opportunities for pupils to be active in their learning, for example, through play?
- develop pupils' mental calculation skills in multiplication and division effectively from the early stages?
- systematically develop pupils' skills in problem-solving and enquiry?
- include the use of computers to organise and display information in a range of graph forms?

How do you ensure your pupils are appropriately challenged and actively engaged in learning when carrying out mathematical tasks?

What opportunities do you give pupils to work collaboratively on tasks?

Schools in which pupils' problem-solving and enquiry skills were well developed followed clear programmes. Such schools planned effectively the systematic development of pupils' skills and the promotion of confident learning. As yet, this good practice was not widespread.

Features of effective courses at S1/S2

In the best practice, secondary schools met regularly with all their associated primary schools and agreed on the range and quantity of information on pupils' mathematical skills to be transferred. They knew the strategies taught to pupils at primary school, for example in mental calculation, and built on these at S1/S2. However, far too often, secondary teachers only had access to the date and level of pupils' attainment in their last national assessment.

A number of schools had reviewed their courses at S1/S2 to increase the level of challenge and to include more statistics and algebra. A few courses enabled pupils to work together solving problems, which required them to think for themselves and present solutions clearly.

Only in a small number of schools had the mathematics department consulted other departments, such as science, business education and geography, to discuss the mathematical skills required for their subject and at which point in the course of S1/S2 these skills would be needed. Mathematics courses were then reviewed to ensure that pupils were better prepared for the mathematical and numeracy demands they would meet in these other subjects.

Features of effective courses at S3 to S6

Effective courses at S3 to S6 were well planned to allow for all pupils to make progress and to achieve their potential. They prepared pupils thoroughly to meet the requirements of external examinations. In the best practice, courses at S3/S4 prepared pupils for smooth progress into courses at S5/S6. For example, courses at General/Credit level included sufficient emphasis on developing the

Do you have well planned approaches which allow pupils to gradually develop their skills in applying appropriate strategies when solving problems?

Do you have clear guidance for teachers and other staff?

How does your S1 course allow all pupils to make appropriate progress from their earlier learning in primary school?

Do programmes include outcomes, such as statistics and algebra, which go beyond the minimum assessment requirements?

How often are there well-planned opportunities for pupils to work together solving problems?

Do you know the mathematical skills which pupils use in other subjects and when they are needed?

How do you ensure consistency in teaching approaches and use of language to ensure that pupils can effectively use their mathematics in other subjects?

2

COURSES

algebraic skills which would be required for Higher. Courses at General/Foundation level included algebra and trigonometry which prepared pupils well for Intermediate 2 courses.

The most effective courses at S3/S4 took account of changes which had been made at S1/S2. Where schools had introduced Intermediate courses at S3/S4, the best courses went beyond the minimum assessment requirements for Intermediate 1 and 2.

Main areas for improvement

Inspectors found that the most common areas for improvement for some schools were, for primary schools to:

- build effectively on the skills in mental calculation developed at the early stages;
- avoid multiplication tables being taught as isolated sets of facts;
- use computers to develop pupils' skills in information handling; and
- place more emphasis on the discussion and selection of strategies in problem solving.

and for secondary schools to

- provide better guidance on approaches to learning and teaching and more consistency in quality;
- avoid over-dependence on a textbook for the choice of task and activity;
- provide flexibility to meet the needs of all learners;

In what way do the courses in your school extend pupils' learning beyond the demands of their current course requirements?

Do courses include outcomes which go beyond the minimum assessment requirements for SQA examinations at S3/S4?

Are pupils repeating work related to outcomes already mastered in S1/S2?

Do courses provide for the full range of previous achievement levels to meet the needs of all pupils?

- ensure that at S3 to S6 pupils work independently and collaboratively when solving problems; and

- develop pupils' numeracy and broad mathematical literacy to enable them to apply their mathematical skills to other areas of the curriculum.

3

LEARNING AND TEACHING

Features of effective learning and teaching at primary stages

In the best practice teachers had ambitious and appropriate expectations of pupils' achievements in mathematics. They related previously taught content to what they were teaching, and shared with pupils what they expected them to learn. They also made clear what skills and knowledge they expected pupils to be able to demonstrate as a result of their learning experiences. Chart 14 shows the evaluations in mathematics from inspections of primary schools.

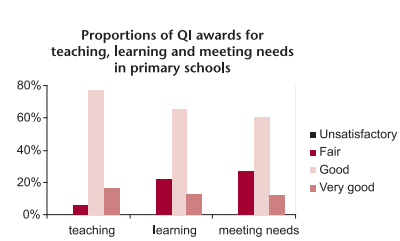
In those lessons that were predominantly oral, teachers regularly and fully involved all pupils. When such lessons involved activities, such as pupils counting by clapping or finger clicking in groups, teachers ensured that higher attaining pupils were challenged by targeting their follow-up questions. Teachers focused their questioning on checking pupils' understanding rather than simply eliciting correct answers. They asked pupils to explain their thinking, and responded skilfully when pupils made mistakes using these as a basis for further learning. In the best practice teachers sought feedback from pupils on their understanding of what had been taught.

The most effective teaching made appropriate use of ICT. Teachers used mathematical terminology correctly and set high expectations for accuracy and neatness in written work. Such teaching ensured that pupils worked at an appropriately brisk pace and pupils were clear about how long tasks would take.

In the best practice, teachers and other school staff provided well-targeted support to pupils with additional support needs in mathematics.

Teachers took appropriate account of pupils' prior attainment, particularly the improved number awareness of many pupils entering P1. Effective early-years teachers whether in single or multi-stage classes challenged pupils according to their prior attainment rather than their class stage.

Chart 14



How do you share learning outcomes with pupils?

In mental mathematics, in what ways are you challenging pupils at all levels of ability?

Do you use pupils' misconceptions to improve understanding?

Are you making effective use of assessment for learning?

Do all teachers make appropriate use of ICT to improve pupils' learning experiences – in what ways?

Is the presentation of pupils' work as good as it could be?

Are those pupils in need of extra support in mathematics using appropriate resources?

What activities do you use at each stage to extend pupils' mental skills?

Main areas for improvement

Multiplication and division activities were too often not linked effectively to what pupils had previously learned in simple addition activities. In teaching multiplication and division number facts, too many teachers taught pupils each "table" as a set of isolated facts and did not make appropriate connections.

Most teachers gave appropriate support to pupils in learning number facts. A few teachers, however, provided excessive levels of support, which hampered the development of pupils' mental calculation skills.

Features of effective learning and teaching at secondary stages

Almost all teachers provided clear explanations and made effective use of questioning to develop pupils' understanding. Almost all secondary departments had consistent approaches to homework. Most pupils regularly completed homework which was clearly linked to their coursework. Chart 15 shows the evaluations in mathematics from inspections of secondary schools.

Some teachers were beginning to make very effective use of ICT to enhance pupils' learning and increase the pace of learning. Graphic calculators linked to viewscreens were being used to develop pupils' graphicacy skills at S4 to S6.

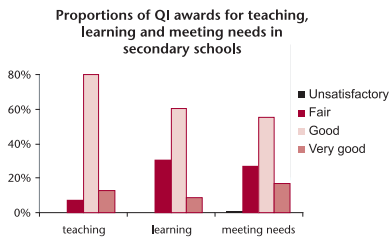
Interactive, electronic displays were beginning to be used effectively and helped to increase the pace of learning. Their use enabled pupils to discuss mathematical concepts and to be more actively engaged. In the best practice, teachers maintained a brisk pace throughout lessons, varied the activities and kept pupils on task.

Lessons were most successful when they were well structured. Teachers shared the lesson objectives and reinforced the main points of the lesson with pupils at the end. In the best practice, teachers, both in mathematics and across other departments, had worked together closely to develop consistent approaches to the teaching of certain topics. When this was successful, the continuity of pupils' learning improved and attainment increased.

At what stage are pupils beginning to learn the skills of multiplication and division?

How effectively do you link pupils' learning so that they can change a multiplication fact into a division statement and vice versa?

Chart 15



How often do you ask pupils to fully explain their answers and explore the thinking behind their answers, right or wrong?

How many of your lessons contain a review of earlier learning?

How consistent are your approaches to teaching percentages or factorising quadratics?

3

LEARNING AND TEACHING

Pupils responded very well when the pace of learning was brisk and they were actively engaged in thinking for themselves, for example, when solving problems. In particular, they progressed well when working together to discuss approaches to solving problems.

Many departments grouped pupils by prior attainment at S1 to S4 with the aim of better meeting their needs. Where this was most successful teachers engaged in increased direct teaching and gave pupils tasks at an appropriate level of challenge. Effective departments monitored groups closely and enabled pupils to move between groups as appropriate.

Many mathematics departments had clear procedures in place to monitor pupils' progress effectively. Formative assessment approaches were being used to involve pupils more in monitoring their own progress. In the best practice, teachers provided helpful information to pupils on the quality of their work and on what they needed to do to improve. The feedback allowed pupils to be actively involved in identifying their own strengths and development needs.

Some secondary schools were not making effective use of national assessments at S1/S2. Too many restricted the use of national assessments to the end of S2 and some restricted the level at which pupils were assessed. In contrast, at S3 to S6, many departments had rigorous procedures in place to ensure pupils were regularly assessed and assessments were closely linked to SQA national examinations. Effective procedures allowed internal assessments to be carried out for National Qualifications. Increasingly, pupils were able to demonstrate their competence beyond the minimum required for National Qualification internal assessments. In so doing, they built up very good evidence on which to plan next steps in learning.

Main areas for improvement

While most teachers regularly set homework a significant minority did not.

Graphic calculators were being used effectively from S4 to S6, but too little use was made of them from S1 to S3. In some cases,

How do you monitor the effectiveness of your attainment groups? Do pupils have the opportunity to move between groups?

In what ways are you meeting the needs of all pupils through effective use of differentiated courses and activities such as Access 3 at S4, and Intermediate at S5/S6 including the Applications unit?

How are pupils involved in assessing their own progress and identifying their learning needs? For example, using simple forms which both the teacher and the pupil commented on performance?

In what ways do you assess pupils' progress from S1 to S4? How effective are your assessment approaches?

Are all pupils given appropriate and regular homework?

teachers were not effectively exploiting the potential of interactive, electronic displays.

In too many mathematics classes, teachers missed opportunities for pupils to learn collaboratively and further develop their understanding of mathematical ideas.

Courses in some schools were planned on the basis of the choice of textbook and not on the skills pupils required to make effective progress.

If you have an interactive, electronic display, are you using a wide range of pre-prepared lessons, selected websites and graphics packages?

4

LEADERSHIP

In primary schools, leadership for mathematics was usually provided by the headteacher or another member of promoted staff, who had responsibility for mathematics. This responsibility typically included approaches to learning and teaching, developing the programme and monitoring pupils' progress in mathematics from P1 to P7.

In secondary schools, leadership was provided by principal teachers or heads of faculty. Some heads of faculty had responsibility for another subject area in addition to mathematics.

Features of effective leadership

Effective education authorities placed a high priority on supporting developments in mathematics. They provided staff with good opportunities for continuous professional development which commendably was focused on improving learning and teaching.

High quality leaders in schools ensured that strong teamwork secured improvements in learning and teaching.

Schools which had a strong focus on improvement used teachers' development time productively. Effective leaders ensured that staff were kept well informed and that all made a strong contribution to identifying and achieving improvement priorities. These priorities focused on ways to improve the quality of learning and teaching. In the best practice, teachers worked in a climate of trust, felt valued and were willing to share best practice to learn from each other.

Main areas for improvement in leadership

Those with responsibility for mathematics did not consistently lead teachers to examine how improved approaches to learning and teaching could raise pupils' attainment. Too often, development priorities were mainly concerned with providing new resources.

In some primary schools, arrangements for assessment and recording were limited to recording pupils' performance in national assessments and routine tests. In secondary schools, while teachers used a range of approaches to assess pupils, feedback tended to be

How do you monitor the progress of individual pupils, groups, for example the lowest attaining 20%, and classes in mathematics across all stages?

Particular characteristics of effective leadership included:

- setting ambitious but attainable expectations for pupils' attainment and involving them in monitoring their own progress;
- giving clear guidance to staff on aspects of learning and teaching such as effective questioning, learning objectives, choice of resources, pace of progress and suitable challenge;
- observing and evaluating learning and teaching in classes to ensure that staff delivered high quality learning and teaching that met all pupils' needs; and
- agreeing targets for individual pupils' progress with staff and monitoring the pace of this progress, taking appropriate action when necessary.

How clearly do your development priorities focus on improving learning and teaching?

limited to raw marks. When these approaches were taken pupils were not able to identify clearly what action to take to improve.

Some education authorities did not take a clear enough lead in promoting improvements in mathematics. Staff development was limited and did not link with areas identified for development through the staff review process. In some authorities, schools were left to identify and provide their own staff development. Such weakness in leadership proved particularly challenging for schools in rural authorities. As a result, teachers were not always kept up to date with recent developments in mathematics or given sufficient opportunity to upgrade their skills.

In what ways do you engage pupils in a discussion about their learning and how it can be improved?

What constructive feedback do you provide pupils about their progress?

5

CONCLUSIONS, MAIN STRENGTHS AND AREAS FOR IMPROVEMENT

Mathematics education in Scotland has strengths in a number of key areas. Schools have improved the teaching of mathematics. Teachers use more direct and interactive approaches in both primary and secondary schools. Attainment at the early stages of primary school is high with notable numbers of pupils making very good progress. The AAP survey of attainment in mathematics 2004 confirms the considerable strengths in pupils' attainment at the early stages. At the upper stages of secondary school, pupils are benefiting from a wider range of courses which are meeting the needs of all pupils. International studies show strengths in pupils' attainment at particular stages.

However, the pattern of attainment is uneven. Gains made at the early stages are not always sustained. Pupils' attainment at P7 and S2 continues to cause concern. Too many pupils are making little progress at these stages. The arrangements for transition from primary to secondary provide effective pastoral support for pupils. However, the continuity of pupils' learning is not as strong, which is resulting in pupils' experiences early in secondary not always being at an appropriate level of challenge.

A growing number of schools have started to review their courses at S1/S2 to increase the level of challenge. Some have introduced Intermediate courses at S3/S4. A very small number have introduced Standard Grade courses ranging from S2 to S3 as a means of raising expectations. The idea is to allow two years for National Qualification courses by the end of S5. Such approaches are not, as yet, raising attainment. The focus for schools should be on meeting the needs of all pupils through ensuring continuity and progression in pupils' learning.

At the primary stages, schools have improved the quality of learning and teaching, particularly the range of teaching approaches being used. In schools where pupils' skills in problem-solving and enquiry were well developed, pupils could use a range of strategies to solve problems in a variety of contexts. In some of these schools, teachers had developed a discrete programme for problem solving. In others they had effectively integrated the teaching of problem solving into their mathematics programme and wider curriculum. What made the difference was the school's commitment to developing pupils' skills systematically, in an appropriate blend with skills in other key areas such as numeracy across the curriculum.

Secondary schools had placed a high priority on developing appropriate National Qualification courses at S5/S6. Almost all now offer a range of courses designed to meet the needs of all pupils. However, success in these courses is varied. High failure rates at Intermediate 1 are of particular concern.

Leadership for mathematics had strengths in both primary and secondary schools. However, teachers at all levels needed to place more emphasis on improving the quality of learning and teaching. Teachers needed to be more actively involved in discussing their approaches to teaching to promote greater continuity in pupils' learning. Education authorities also had a role to play in improving the quality of learning and teaching by providing appropriate opportunities for teachers to improve their skills.

Main strengths

The main strengths in mathematics education are as follows.

- very good attainment at P1 to P3 with high proportions of pupils achieving level A;
- good attainment in SQA examinations at S3 to S6;

- at primary school, pupils' knowledge of properties of shapes and angles and their ability to interpret data from a variety of graphs;
- well-planned courses at the early stages which took account of pupils' pre-school learning experiences;
- improved courses and programmes at S5/S6 which provided for all levels of attainment;
- improved approaches to learning and teaching in primary schools including interactive and direct teaching;
- effective use of interactive, electronic displays in both primary and secondary schools which widened the range of teaching approaches; and
- good arrangements in most secondary schools for monitoring and tracking pupils' progress.

Main areas for improvement

Schools and education authorities need to take steps to:

- improve the quality of attainment from P7 to S2, and at all stages for the lowest attaining groups;
- develop pupils' skills in written and mental calculation more effectively, in particular at secondary school;
- increase the proportion of pupils achieving at least SCQF level 3 or level 4 in mathematics;
- increase the percentage of pupils achieving A-C grades in Intermediate level courses;
- provide more opportunities for pupils to work collaboratively and ensure an appropriate level of challenge for all pupils;
- ensure that mathematics teachers in secondary schools work more closely with teachers of other subjects which use mathematics;
- continue to develop opportunities for pupils to be active in their learning through real-life applications and practical activities;
- ensure that schools address the need to improve the impact of mathematics learning on developing pupils' learning skills, personal confidence, individual responsibility and effectiveness; and
- improve leadership for mathematics in schools and education authorities to ensure a stronger focus on improving the quality of learning and teaching.

Appropriate bodies at national level (including SEED, SQA and LT Scotland), working as necessary with higher education and education authorities, should:

- ensure that the review of mathematics being undertaken in response to *A Curriculum for Excellence* addresses the key issues raised in this report;
- ensure that learning, teaching and programme content in mathematical skills have an impact on developing pupils' learning skills, personal confidence, individual responsibility and effectiveness in contributing to group tasks and success;
- review the content of the mathematics curriculum and advice on learning and teaching to improve progression and to equip pupils with the mathematical and broader numeracy skills across the curriculum to enable them to participate fully as Scottish citizens; and
- ensure that the review of the curriculum addresses the need to engage the lowest attaining 20% of pupils nationally in appropriate learning.

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