OFFICE FOR STANDARDS
IN EDUCATION

INSPECTING SUBJECTS AND ASPECTS 11-18

MATHEMATICS

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INSPECTING MATHEMATICS

INTRODUCTION

As an inspector of mathematics, you need to find out how good the pupils are at the subject, to what extent they understand the essential concepts and can apply them, and whether the subject captures their interest. You are likely to be able to explain your findings largely by evaluating how stimulating and effective the teaching is.

WHAT YOU NEED TO DO

These are the main questions which your inspection should answer.

- How high are the standards in mathematics, and are they high enough?
- How well are pupils progressing?
- How well is mathematics taught?

Before you begin your inspection in the school

- Revise your knowledge of the *Handbook* and associated guidance.

- Where necessary, make sure that you are familiar with the particular course objectives and examination syllabuses used by the school.

  You should already have a good knowledge of the National Curriculum Programmes of Study for mathematics and the level descriptions.

- Analyse performance data, to form a view of the standards achieved in recent years and any trends, and to establish hypotheses about strengths and weaknesses in mathematics.

- Study any departmental documentation which has been made available, and evaluate its potential contribution to teaching and its coverage of curricular requirements.

- Check the school's policy on numeracy and agree with the registered inspector how evidence of numeracy will be collected.

When you are in the school

- Use the first-hand evidence from observation of lessons, looking at pupils' work and talking with them to assess what they are like at the subject, what they do well and where they could do better. Focus on the current pupils in the year groups in which they become 14, 16 and 18. Refer to the records of teachers' assessments of pupils' work. Establish attainment on entry and assess what progress pupils are making through the school - how fast it is, on how wide a front and in what depth.

- Observe teaching, talk to teachers about their work, look at their plans and records, and judge how effective the teaching is - how it contributes to pupils' attitudes to learning, progress and standards. See which approaches work well and which are unsuccessful.

- Take stock of the way any other factors affect how well mathematics is taught and the standards achieved. Assess, in particular, how effectively the subject is led and managed.

- Make sure that your observation forms contain enough evidence to support your judgements; telling examples are needed for your subject report.

Numeracy and information technology

- Expect to take responsibility for co-ordinating the evidence and judgements about pupils' skills in numeracy in the school, drawing evidence from other subjects as well as from mathematics.

- Evaluate the contribution mathematics teaching makes to developing pupils' capability in information technology. Sometimes, mathematics will be used to develop particular information technology skills; at other times, information and communications technology may be used to support pupils' learning in mathematics. In these cases, pupils may be working below their level of competence in information technology, but this may be entirely appropriate; assess the effectiveness of the use of information and communications technology in enhancing pupils' standards in mathematics. This includes calculators of all types and whether they are used sensibly across the work in mathematics.

- You must decide how to record evidence but, generally, if information technology is not the main focus of the lesson, record your evidence and evaluations in the 'Other significant evidence' section of the observation form.

Feeding back your inspection findings

- Feed back your findings clearly and helpfully to the head of mathematics and to the individual teachers by:

    - identifying the most important strengths and weaknesses in the teaching, and supporting your assessments with illustrations from the lessons and other work you have seen;

    - giving convincing reasons for what you judge to be successful or otherwise, making clear how the teaching affects what is achieved;

    - showing the head of department how other factors, particularly leadership and management, affect the quality of teaching and the standards achieved;

    - ensuring that there is opportunity to discuss the findings and that points for development are identified.

Writing the subject section

- Make sure that the mathematics subject section of the report tells a coherent and convincing story. It should explain why the standards achieved are as they are. In particular, report on the effectiveness of the teaching. The following questions will help you to check the quality of your reporting.

    - Are test and examination results interpreted so as to give a clear view of the standards attained and to show how they compare with other subjects in the school? Are there any trends over time?

    - Are there clear judgements about what is achieved by the current pupils in the year groups in

which they become 14, 16 and 18? Are the strong and weak features identified in the different aspects of the subject?

- Does the picture of what pupils achieve in mathematics and how they use the skills draw on evidence from across the curriculum?

- Is there a convincing explanation of any significant differences in standards between what is seen and what the results indicate?

- Are variations in the progress of different groups of pupils or in different years evaluated and explained?

- Does the evaluation of teaching spell out how it affects pupils' response and what they achieve? Is it clear which teaching methods are successful and which are not? Is there an explanation of any other factors, such as leadership and management, which are significant in affecting standards?

- Is it clear how far standards and teaching have improved since the last inspection and are reasons given?

- Are the main judgements supported by the most telling examples?

- Is it clear what needs to be done to improve the quality of teaching and standards in mathematics?

ATTAINMENT AND PROGRESS

Your judgements on attainment in mathematics will be based on **performance data** and direct **observations** in the school. Any differences between these judgements **must be explained convincingly**.

Interpreting data

- For pupils aged 14, compare the school's National Curriculum results with:

  - the results achieved in all schools nationally;
  - the results achieved in schools with 'similar intakes' - by eligibility for free school meals - and to be so specified in the report;
  - the results achieved in English and science in the school.

- For pupils aged 16:

  - compare the proportion of pupils failing to achieve a GCSE grade in mathematics with the national proportion;

  - compare the school's GCSE results with:

    - the results achieved in all schools nationally;
    - the results for schools of 'similar type' - comprehensive, selective or modern - and to be so specified in the report;
    - the results achieved in other subjects in the school.

      Most pupils who do not achieve a GCSE grade in mathematics are unlikely to be adequately prepared to cope with the mathematical demands of adult life, nor be confident in their understanding and use of number.

      In interpreting GCSE results you need to take account of the school's entry policy - for example, how the proportions of pupils entered for each of the three tiers correspond to their previous attainment. Entry policy may be influenced by timetabling constraints and the organisation of pupils into sets, and not based on good assessment information linked to targets.

- Evaluate A-level and AS performance in mathematics, comparing the school's results with the national results, including those for schools of a similar type. Look at results over several years and take account of achievements in GCSE and any value-added measures.

  *In making judgements, you will need to **exercise caution** because of the various factors at play, such as the numbers involved and the nature of the students and courses.*

  The school may allow students to embark on an A-level course only if they achieve a particular grade in the higher tier examination. Other schools may have a more open policy and provide a short "bridging" course in preparation for A-level. You will need to judge the extent to which the school has added to the students' mathematical knowledge, skills and understanding after their GCSE performance. For example, what proportion of those students who started A-level mathematics courses transfer to AS, drop-out entirely or complete and gain a grade? How do drop-out rates influence the school's overall profile of grades when compared to national figures?

Using evidence from observations

- Judge the attainment of pupils by the age of 14 according to what is typical in relation to the National Curriculum Programme of Study. Evaluate the attainment of pupils by the age of 16 and 18 in relation to the requirements of the course which they follow.

- Ensure that you evaluate what pupils know, understand and can do **across all the aspects of mathematics** - within the statutory National Curriculum and at GCSE this includes number and algebra; shape, space and measures; handling data; and using and applying mathematics.

Significant weakness in any aspect compared with others means that standards overall cannot be high enough.

The school may provide courses that include the application of number or other courses that develop numeracy skills. Some of these numeracy skills courses may be taught by staff who are not from the mathematics department. Such courses may account for the whole of the students' mathematics study during that phase of their education; you should report on the provision, particularly with reference to standards of numeracy in the school.

- For pupils aged 14, use teachers' assessment alongside your observations as an indicator of attainment and a means of investigating the relative attainment of boys and girls.

- Judge the **progress** which pupils make in each year, referring to any significant differences between particular groups, such as able pupils, those with special educational needs, and boys and girls.

  The evidence comes from talking with pupils, looking at their written work and seeing how they get on in lessons - how much do they learn and at what rate?

  For pupils with special educational needs, including those in special schools, judgements on standards, particularly progress, should be made taking into account their best means of communicating - for example, by computer or other form of technology. There may be a need for pupils to do work pitched at levels lower than is normally associated with their age.

- Form a view of pupils' standards from looking at their **written work**, but take care in interpreting this evidence.

  Written work can give an over-positive impression. Pupils are often successful at current work where they may be practising methods demonstrated by the teacher or given in a textbook. If their understanding is not secure, pupils may be much less successful if they are asked to carry out the same techniques in different contexts, or to combine techniques to solve problems.

- Build up complementary evidence from **observing pupils at work** on their own, in groups or as a class and **tapping into their discussions and talking with them** about their current and past work.

  Questions and discussion with pupils should be framed in such a way that will enable pupils to show, for instance, the extent to which they:

  - *have a repertoire of mathematical techniques that they can bring to bear on problems, and whether they use them effectively and efficiently;*

  - *have a feel for the size and scale of the numbers involved in the question or problem so that they can give an estimate and recognise for themselves whether answers are reasonable or not;*

- *understand the context of the problem, use the information provided, interpret their results, including calculator displays, and set their solution back in context using the units involved.*

■ As you **observe pupils** in lessons, **look at their work** and **talk with them**, you should concentrate on the extent to which pupils:

- recall from memory number facts and other key facts quickly and accurately;
- work out in their heads simple calculations which involve each of the four operations;
- use known facts to establish other facts and to solve computational and related problems;
- apply written routines and standard procedures accurately and with understanding;
- use scientific calculators accurately and sensibly;
- give reasonable estimates, check results and working, and give answers to the required degree of accuracy;
- represent and interpret information - numeric, spacial and algebraic;
- talk about those methods they have used to calculate and to solve problems;
- present a reasoned argument why something must be true or false;
- recognise and describe patterns, equivalences, similarities and congruences;
- use correct mathematical language, notation, symbols, tables and diagrams;
- manipulate algebraic expressions, use formulae, and solve equations;
- derive expressions and equations, sketch, draw and interpret graphs and use a graphics calculator or graphics package on a computer;
- use their mathematical knowledge, skills and understanding in an increasingly wide and complex range of applications;
- recognise which methods are more efficient and elegant and why.

These attributes will help you to shape your analysis of strengths and weaknesses in mathematics as well as the overall judgements about attainment. Remember that in your reporting you need to go further than just citing the attributes; draw on the most telling evidence which exemplifies them.

PUPILS' ATTITUDES TO LEARNING

■ Judge whether pupils are positive about mathematics.

Pupils' attitudes and self-confidence about whether they can or cannot do mathematics can strongly influence their progress and attainment.

- Look out for particular characteristics that pupils might show in mathematics. For example:

  - interest and pleasure in mathematics - pupils want to learn, are keen to share findings, and are creative, enthusiastic and curious to find out why something works;

  - growing confidence, and openness about misunderstandings - rather than becoming frustrated and disinterested through repeated failure;

  - sustained attention and concentration - listening to explanations and instructions and working at tasks without distracting others;

  - willingness to offer answers and suggestions - pupils discuss methods and accept criticism from others;

  - inclination to explore - they try different approaches to solve problems;

  - use of thinking time - pupils prepare reasoned rather than rushed responses to questions and problems;

  - recognise their achievement and weaknesses - they set their own targets, recognise when they have learned something new, refine methods, and make connections;

TEACHING

- Judge the quality of teaching by weighing its strengths and weaknesses in relation to the criteria in the *Framework*, and assess its **impact on educational standards**, but be open to other features which make lessons particularly effective or ineffective.

  Teaching cannot be satisfactory where pupils, or a significant minority of them, learn less than you would expect considering what they already knew. The same is true where they do not firmly consolidate their learning.

- Inform your views of teaching by reference to the characteristics of effective teaching, in which teachers:

  - enjoy their subject and energetically present it to pupils in ways which capture their interest *(subject knowledge and understanding, methods)*;

  - confidently and correctly explain mathematics at a level well matched to their pupils' stages of development *(subject knowledge, assessment)*;

  - build on pupils' previous learning, check their understanding of ideas, revise and refine different techniques and approaches and summarise these with pupils for future reference (*subject knowledge, methodology, assessment, homework)*;

- achieve a good balance between explaining, demonstrating, discussing and practising new mathematics, so that pupils have a thorough understanding *(methodology*);

- regularly encourage pupils to discuss and explain what they are doing, challenge them to find alternative/shorter/more elegant methods, and monitor knowledge and understanding through well-chosen questions *(expectations, subject knowledge, assessment)*;

- stimulate students to think mathematically, to look beyond routines and outcomes, to ask questions and to search for reasons why something works *(expectations)*;

- set and insist on high standards of rigour, precision and presentation in written work and when discussing mathematics *(expectations)*;

- make mathematics enjoyable as well as understandable by relating new and previous work, exploiting links between different branches of mathematics, and providing opportunities to use and apply mathematical skills in various contexts *(subject knowledge, expectations, planning)*;

- ensure that pupils have opportunities to learn mathematics in a variety of ways, involving direct-teaching, oral and mental work, practical work, homework, personal study, investigation, problem-solving, and use of information technology *(methodology)*;

- keep pupils' mental recall skills finely tuned and sharp and extend their visualisation skills and mental strategies *(subject knowledge, expectations, planning, homework*);

- ensure calculators, textbooks and other resources are used judiciously with no over-reliance on any one of them *(resources)*.

■ Take particular care when evaluating teaching which may have superficially positive features but does not result in pupils' learning being as fast, broad or deep as it should be - for example, where:

- the teacher simply manages a mathematics scheme and only talks to pupils when they are stuck or to give instructions;

  the repeated use of worksheets or excessive individualised work is unlikely to ensure that the pupils' range and knowledge, skills and understanding will be adequately developed;

- every lesson involves a brief input from the teacher followed by individual practice but no discussion of methods or ideas;

- pupils are engaged in sustained activity or an investigative task that is well presented but is thin on mathematical substance and undemanding;

- pupils are employing information and communications technology but unproductively repeating work they have already mastered or using software applications which they do not understand;

- homework is set but rarely marked by the teacher; pupils' books include much work which they have marked themselves and there are no comments on how to improve; often the homework is a 'finish-off' activity;

- work is regularly marked, but simply 'right' or 'wrong' with little attempt to find out where and why a mistake has been made or to distinguish between a simple error and a misunderstanding which needs to be followed up;

- the teacher shows unwillingness to explore with pupils different ways of solving problems or the pupils are reluctant and anxious about using mental strategies.

Teaching mathematics well at any level requires a detailed knowledge of the subject content within the curriculum/syllabus taught and how operations, methods and topics relate. A-level teachers, in particular, often need to draw upon a depth and breadth of subject knowledge beyond that which they are teaching to be able to identify connections across and within topics.

■ Try to establish the extent to which A-level teachers:

- draw connections between mathematics topics to provide students with an understanding of the central and unifying ideas and themes in mathematics;

- develop students' study skills, encouraging them to read around a topic in preparation for lessons and to undertake their own study to practise and maintain techniques they have learnt in the past;

- capitalise on available resources, other than standard texts, such as graphic calculators and software packages.

OTHER ASPECTS OF PROVISION OR MANAGEMENT

Curriculum and assessment

■ Be alert to evidence of a curriculum which is over-narrow in content or approach.

Warning signs in exercise books include excessive repetition of similar topics or problems set in a similar form. Wall display and display of artefacts often give clues about the breadth of mathematics - for example, whether it extends beyond the textbook into other contexts, whether shape is considered in three dimensions as well as two, and so on.

You should look for evidence that pupils have engaged in some sustained enquiry and assessment tasks which prepare them for coursework or related activities that form part of the GCSE assessment. At A level, you need evidence of the extent to which students are encouraged to take initiative and develop good skills in studying for themselves.

Numeracy

- When you report on standards in mathematics, give due attention to **numeracy** and pupils' competence in using their knowledge, skills and understanding of number not only in mathematics but in other subjects.

- In relation to numeracy, establish:

  - whether there is clear understanding and consistent practice among staff in the development of pupils' mental skills, written methods of calculation and use of calculators;

  - if pupils can identify and use the most efficient strategy for the calculation involved;

  - if pupils cope well with the mathematical demands made in different subjects, or are held back through lack of mathematical knowledge or poor basic skills in numeracy;

  - how well numeracy and, where appropriate, other mathematical skills are taught or developed in other subjects.

- More specifically, secure evidence ***from other subjects*** of the extent to which pupils can:

  - recall number facts and manipulate whole numbers - positive and negative - and fractions, decimals and percentages;

  - use the methods of calculation they have been taught in mathematics lessons in different curricular contexts;

  - use calculators and information and communications technology, recognising when they are inappropriate tools;

  - estimate and judge the reasonableness of their solutions and check their methods;

  - give results to a required degree of accuracy and set them in the context appropriate to the subject;

  - solve problems that involve one or more calculations, particularly where pupils need to identify the operations needed; interpret and check their results, setting them in the context of the original problem;

  - substitute numbers into formulae;

  - use and make sense of information presented in tables, charts and diagrams, and graphically;

  - collect data, discrete and continuous, represent data pictorially and graphically and analyse the results and make predictions;

  - explain their strategies and methods and use correct mathematical vocabulary.

These are characteristics of a numerate pupil. They should help you to alert inspectors of other subjects to the features of numeracy, but it would not be reasonable to expect them to give you evidence on each characteristic.

OBSERVATION FORMS

There follow two sample observation forms for mathematics. These are intended to show how evidence and judgements contribute to a coherent picture of attainment in these lessons. In one lesson, the teaching is judged to be 'very good' (grade 2) and in the other it is considered 'satisfactory' (grade 4).

MATHEMATICS YEAR 11 LOW SET - **Very good teaching**

CONTEXT:
Set 6/7. One in a series of revision lessons for trial GCSE exams. Work on simple formulae covering L4 - L5. CT explains a technique, leads class discussion, sets practice examples, summarises, checks understanding, moves on to next technique. Homework set covering techniques revised.

TEACHING:
- V good methodology and assessment - tightly-controlled, staged learning with small manageable and well-timed steps, based on thorough prior and ongoing assessment of progress.
- High expectations - challenging questioning (Is £500 reasonable? Could you do that in your head?); ps expected to contribute fully to discussion; worksheets covering techniques of increasing difficulty.
- V secure subject knowledge - good explanations, common pitfalls pinpointed.
- Firm control - off-task behaviour nipped in the bud; handling potentially difficult pupils well, but with humour. Grade 2

RESPONSE:
- Good behaviour - respond well to CT's insistence on full concentration
- Highly motivated by the teaching - active participation in discussion; relate well to the contexts chosen by CT; persevere, but do ask when really stuck
- pool knowledge well - unusual for this type of group. Grade 2

ATTAINMENT
Lowest GCSE grades:
- all can substitute and manipulate numbers in simple formulae expressed in words (L4)
- most cope with more complex symbolic notation and can set up own formulae from given information (L5)
- some use calculators for simple arithmetic involved, but most can do mentally or on paper. Grade 6

PROGRESS
Achieving good consolidation of relevant techniques because:
- ps work at unusually fast speed given general attainment level
- good engagement - on task and concentrating throughout
- have to think v hard to cope with L5 symbolism - but succeeding well.

Have moved from non-exam to GCSE syllabus during the year. Grade 3

MATHEMATICS YEAR 8 HIGH SET - **Satisfactory teaching**

CONTEXT:
Solving simple equations with whole number coefficients (Level 6). CT introduces topic at the blackboard, then sets exercise from text book. As pupils work, T circulates marking and helping individuals. Set 1 of 4.

TEACHING:
Lesson appropriately prepared eg CT made reference to earlier work in algebra and number during introduction and identified where work would lead. Explanation of method for solving equations was clear but no obvious enthusiasm. Qs asked to check if ps could apply the technique before being set the exercise. CT alert to the likely pitfalls ps make such as not changing signs correctly when taking terms across the equals sign. Brief summary at end of lesson, highlighted one arithmetic error made by number of pupils, subsequently rectified. Overall, teacher's knowledge secure; sound but limited teaching methods; satisfactory planning; relaxed but purposeful relationship with class. Grade 4

RESPONSE:
Pupils attentive to CT's exposition. Respond to questions and note down the examples the teacher covers. Work steadily on tasks set for whole of lesson and hands-up when stuck But no real sparkle shown - no questions to teacher during intro, no discussion between ps of underlying concepts or difficulties. Grade 4

ATTAINMENT:
Ps able to manipulate symbols and numbers, recognising the need to 'do same to both sides' of the equation. Write answers in fractional or decimal form and can convert from one to the other. All successful at L6. Presentation good - careful and accurate. Methodological approach to the work. Grade 2

PROGRESS:
All pupils working at a fast pace but finding the work relatively straightforward, as exercise offers little variation in technical or conceptual difficulty. Most complete the exercise by the end of the lesson successfully applying the basic techniques they have been taught. Grade 4

ABOUT THIS BOOKLET

This is one of a set of booklets which make up *Inspecting subjects and aspects 11-18*. The set consists of:

- an introductory booklet, *General guidance*, which is for all inspectors who evaluate the work of secondary age pupils - it is mainly about inspecting subjects;
- separate booklets on inspecting specific subjects and aspects; the contents page of *General guidance* shows the subjects and aspects which have booklets.

The main points in the *General guidance* are summarised in each subject, but if you are inspecting the work of secondary age pupils you should read the introductory booklet so that you are fully in the picture of what you have to do.

The contents of all the booklets are on the Internet and can be accessed from OFSTED's website [http://www.ofsted.gov.uk]. This will allow you to obtain guidance for individual subjects or aspects.

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