Ofsted

**OFFICE FOR STANDARDS
IN EDUCATION**

Inspecting post-16

mathematics

with guidance on
self-evaluation

The post-16 subject guidance series currently
comprises: art and design; business education;
classics; design and technology; drama and theatre
studies; engineering and manufacturing; English;
geography; government and politics; health and
social care; history; information and communication
technology; law; mathematics; media education;
modern foreign languages; music; physical
education; religious studies; science; sociology.

Contents

Introduction

This booklet aims to help inspectors and staff in schools and colleges to evaluate standards and quality in mathematics for students post-16. It complements the *Handbook for Inspecting Secondary Schools* (1999), the supplement *Inspecting School Sixth Forms* (2001) and the *Handbook for Inspecting Colleges* (2001). It replaces the earlier guidance *Inspecting Subjects and Aspects 11-18* (1999).

This guidance concentrates on issues specific to mathematics. General guidance is in the *Handbooks*. Use both to get a complete picture of the inspection or evaluation process.

This booklet is concerned with evaluating standards and achievement, teaching and learning, and other factors that affect what is achieved. It outlines how to use students' work and question them, the subject-specific points to look for in lessons, and how to draw evaluations together to form a coherent view of the subject.

Examples are provided of evidence and evaluations from college and school sixth form inspections, with commentaries to give further explanation. These examples are included without any reference to context, and will not necessarily illustrate all of the features that inspectors will need to consider. The booklets in the series show different ways of recording and reporting evidence and findings; they do not prescribe or endorse any particular method or approach.

Inspectors and senior staff in schools and colleges may need to evaluate several subjects and refer to more than one booklet. You can download any of the subject guidance booklets from OFSTED's website www.ofsted.gov.uk.

Our Inspection Helpline team, on 020 7421 6680 for schools and 020 7421 6703 for colleges, will be pleased to respond to your questions. Alternatively, you can email schoolinspection@ofsted.gov.uk or collegeinspection@ofsted.gov.uk.

OFSTED's remit for this sector is the inspection of education for students aged 16–19, other than work-based education. In schools, this is the sixth form provision. In colleges, the 16–19 age-group will not be so clearly identifiable; classes are likely to include older students and, in some cases, they will have a majority of older students. In practice, inspectors and college staff will evaluate the standards and quality in these classes regardless of the age of the students.

As an inspector of mathematics post-16, you will need to make sure that you are familiar with the particular course objectives and examination syllabuses used by the institution. In particular, you will need to know the specifications for:

- General Certificate of Education (GCE) Advanced Subsidiary (AS) and Advanced level (A level), and how the various AS and A2 modules fit together to create the subject titles offered, including 'further mathematics';
- the Advanced Extension Award (AEA) in mathematics.

You may also need to inspect General Certificate of Secondary Education (GCSE) courses in mathematics, with students preparing for assessment either in November or the following June. In colleges, there is likely to be a broader range of courses, across three levels and including courses such as City and Guilds numeracy, in addition to those already mentioned.

Currently under development are 'free-standing mathematics units' (FSMUs), a new mathematics qualification for post-16 students (not covered in this booklet; see www.qca.org.uk for more details). These are unique to mathematics and are available for students in schools and colleges. They provide a focus on a particular aspect of mathematics as well as mathematical support to programmes leading to other qualifications at levels 1–3 and across a range of subjects. There is no vocational element, but it is expected that students on vocational courses will cover work-related themes in their coursework. You may also be required to evaluate work for application of number key skills.

This booklet concentrates on the most commonly found courses in mathematics for students 16–19. However, the principles illustrated in this guidance can be applied more widely.

Common requirements

All inspectors share the responsibility for determining whether a school or college is effective for all its students, whatever their educational needs or personal circumstances. As part of this responsibility, ensure that you have a good understanding of the key characteristics of the institution and its students. Evaluate the achievement of different groups of students and judge how effectively their needs and aspirations are met and any initiatives or courses aimed specifically at these groups of students. Take account of recruitment patterns, retention rates and attendance patterns for programmes and courses for different groups of students. Consider the individual goals and targets set for students within different groups and the progress they make towards achieving them.

You should be aware of the responsibilities and duties of schools and colleges regarding equal opportunities, in particular those defined in the Sex Discrimination Act 1957, the Race Relations Act 1976 and the Race Relations (Amendment) Act 2000, and the Special Educational Needs and Disability Act 2001. These Acts and related codes of practice underpin national policies on inclusion, on raising achievement and on the important role schools and colleges have in fostering better personal, community and race relations, and in addressing and preventing racism.[1]

As well as being thoroughly familiar with subject-specific requirements, be alert to the unique contribution that each subject makes to the wider educational development of students. Assess how well the curriculum and teaching in mathematics enable all students to develop key skills, and how successfully the subject contributes to the students' personal, social, health and citizenship education, and to their spiritual, moral, social and cultural development. Judge how effectively the subject helps prepare students aged 16–19 for adult life in a culturally and ethnically diverse society.

---

[1] See Annex *Issues for Inspection arising from the Stephen Lawrence Inquiry (Macpherson Report)* in *Evaluating Educational Inclusion*, OFSTED, 2000, p13.

1   Standards and achievement

1.1   Evaluating standards and achievement

From the previous inspection report, find out what you can about standards and achievement at that time. This will give you a point of comparison with the latest position, but do not forget that there is a trail of performance data, year by year. Analyse and interpret the performance data available for students who have recently completed the course(s). Draw on the school's *Pre-Inspection Context and School Indicator* (PICSI) report or, in the case of a college, the *College Performance Report*. Also analyse the most recent results provided by the school or college and any value-added information available. When numbers are small, exercise caution in making comparisons with national data or, for example, evaluating trends. For further guidance on interpreting performance data and analysing value added, refer to *Inspecting School Sixth Forms,* the *Handbook for Inspecting Colleges* and the *National Summary Data Report for Secondary Schools.*

Where you can, form a view about the standards achieved by different groups of students. For example, there may be data which enable you to compare how male and female students or different ethnic groups are doing, or how well 16–19-year-old students achieve in relation to older students.

Make full use of other information which has a bearing on standards and achievement, including success in completing courses, targets and their achievement, and other measures of success.

You should interpret, in particular:

- trends in results;
- comparisons with other subjects and courses;
- distributions of grades, particularly the occurrence of high grades;
- value-added information;
- the relative performance of male and female students;
- the performance of minorities and different ethnic groups;
- trends in the popularity of courses;
- drop-out or retention rates;
- students' destinations, where data are available.

On the basis of the performance data and other pre-inspection evidence, form hypotheses about the standards achieved, whether they are as high as they should be, and possible explanations. Follow up your hypotheses through observation and analysis of students' work and talking with them. Direct inspection evidence tells you about the standards at which the current students are working, and whether they are being sufficiently stretched. If the current standards are at odds with what the performance data suggest, you must find out why and explain the differences carefully.

Note any significant differences between performance data for different modules or for different mathematics courses – for example, between those students following a 'pure mathematics and statistics' course and those following a course in 'pure mathematics and mechanics'. Consider also how non-completion rates influence the department's overall profile of grades and how these compare to national figures.

Consider results in the AEA for the most able (top ten per cent approximately) A-level mathematics students. In schools, be alert to any early entry to GCE AS or A-level module examinations by gifted and talented students in Key Stage 4, the results they achieve, and provision made once they have achieved the award.

Look carefully at the results from re-sit GCSE courses in mathematics. The aim must be that all students will improve on their previous GCSE performance, and the prime objective must be to achieve at least a grade C. Data from previous years' results should provide a good indication whether the department is enabling the students to be successful or not, especially if the institution works out the value added in average GCSE points.

Judge the attainment of students in relation to the assessment objectives and requirements of the courses. Highlight any significant differences in the standards and achievements of students on different modules, or between different groups of students, such as male and female students or students of different ethnic groups.

As you observe students in mathematics lessons, look at their work and talk to them, concentrate on the extent to which, in the context of their courses, students:

- recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of contexts;
- apply written routines and standard procedures accurately and with understanding;
- use technology such as calculators and computers effectively, recognise when such use may be inappropriate and are aware of their limitations;
- talk about the methods they have used to solve problems and offer explanations;
- construct and present a reasoned mathematical argument through appropriate use of logical deduction and precise statements involving the correct use of mathematical language, notation and symbols;
- apply methods of proof, including proof by contradiction and disproof by counter-example, especially at AS and A level;
- recall, select and use their knowledge of standard mathematical models to represent situations in the real world;
- consolidate their learning and make connections with familiar areas of mathematics, especially in GCSE re-sit courses;
- explain and interpret results in the context of the problem or assignment;
- use their mathematical knowledge, skills and understanding in an increasingly wide, complex and unstructured range of problems, especially for higher-attaining students, including those taking AEAs;
- (those taking AEAs) develop fluency in multi-step analysis, chains of logical reasoning and complex proofs;
- read and understand articles concerning the application of mathematics, especially at AS and A level;
- recognise which methods are more efficient and elegant and why;
- take increasing responsibility for their own learning.

By using these criteria, shape your analysis of students' strengths and weaknesses in mathematics. Bring them together to reach your 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 that exemplifies them and explains your judgement. Then judge how well students achieve in mathematics, by taking account of the progress they have made, the level of demand placed on them and other relevant factors.

1.2 Analysis of students' work

GCE AS and A level

From looking at students' written work in GCE AS and A level, form a view of their standards and, if possible, their achievement. Sample A-level work from the range of elements covered to see if progress is even across 'pure mathematics', 'statistics' etc. Take care in interpreting this evidence, as written work can give an over-positive impression. See whether the students develop their own methods. They are often successful at current work where they may be practising methods demonstrated by the teacher or given in a textbook. If the course includes a coursework module, students' projects will provide important evidence but other work should still be analysed. In work for the AEA, see whether it tests students' skills of critical thinking.

Example 1: evidence from analysis of second year A-level work in an FE college.

Work shows that students make good use of earlier techniques – eg, on differentiation and integration. Algebraic skills are generally secure, but there are instances where students try to make the model of a physical situation fit their previous formulae rather than find a general way of creating a formula from the practical situation. Standards of work on the two statistics projects match course aims and include good-quality and well-reasoned analyses using statistical techniques. Other work indicates average or higher standards on Newton's Laws of Motion, problem-solving and the Normal Distribution. Students appear to have some difficulty with iterative methods. Many students find explanations difficult if they stray from standard methods. They undertake corrections systematically and make good use of teacher's written annotations and suggestions.

Overall, average attainment and, with all students starting the course from a higher level GCSE course, an indication that achievement is no more than satisfactory.

[Attainment average (4)]

Commentary

Standards of work match those that might be expected at this stage of the course. The students' written work is well presented and well organised but, apart from a few higher-attaining students, there is little evidence of any penetrating analysis or mastery of the subject matter. On the other hand, all students display a reasonable grasp of the fundamental concepts and this enables them to go beyond the basic requirements of the course. What appears to be lacking is that individual approach that shows students thinking for themselves.

GCSE

Schools may run GCSE re-sit courses. In colleges, there may also be GCSE courses for students who have never taken GCSE mathematics. In both cases, see how good students are at interpreting questions and how this improves over time. These students are likely to be focusing strongly on examination techniques as well as consolidating their mathematics. Both should get better as the year moves on.

Example 2: evidence from analysis of Year 12 work from a GCSE re-sit group in a school sixth form.

Marking of their well-presented work leads students to a range of more challenging questions on the same topic (when they are successful) and there are helpful comments to point them in the right direction (when they are not). Numerical skills are generally secure, but many find any hint of algebra difficult. Mistakes such as $2a \times 3b = 5ab$ or $(a+2)^2 = a^2 +4$ abound. Statistical graphs are often not scaled properly, leading to weak interpretations. Some are able to handle trigonometrical ratios with ease, but many find the manipulation of simple equations difficult. This group has very low previous attainment (mean of 2.1 GCSE points) and the school's target of an average increase of two grades over the year would still put them below C. All students have shown significant progress over the last two terms, several sufficient to achieve a C, suggesting that achievement is good overall.

[Attainment below average (5)]

Commentary

The attainment of these students is below the expectations of a GCSE course. Although this means that attainment is below average, in view of the students' previous attainment and the evidence of their progress during the course, this points to good achievement. The most striking evidence from this group's work is the way the teacher's marking helps move students on.

1.3   Talking with students

Build up complementary evidence from observing students at work on their own, in groups or as a class. Tap into their discussions and talk with them about their current and past work.

Questions to A-level students should be framed in such a way that will enable them to show the extent of their knowledge and understanding. The following are examples.

- *Under what conditions would you use the binomial distribution?*
- *So, when does the sum of a geometric progression converge?*
- *How do you show the forces acting on an object on an inclined plane?*
- *What methods of integration have you used?*
- *What is the period of sin 3x, and of sin 2x?*
- *What methods are there for determining the roots of a polynomial?*
- *How could you prove that by induction?*

Questions and discussions with students doing GCSE courses will need to focus on a different level of mathematics, as in these examples.

- *Explain how you selected the information you needed and chose the approach you used on this project.*
- *How would you compare these two sets of data?*
- *What formula would you use to calculate the volume of this cylinder?*
- *What would be a good way of presenting these data?*
- *What opportunities are there for you to use numerical methods in your other subjects?*

Above all, it is helpful to ask students to communicate the mathematics that is going on in their head. There is no more powerful question to do this than the following.

- *Please talk me through this question/piece of work/investigation, so that I can see how you've done it?*

If there is time, arrange to have a meeting with a representative group of students from the course(s) you are evaluating. This can throw light on many aspects of the way they learn mathematics and give a longer-term view about students' achievement. Try lead-in and follow-up questions like these.

- *How good a model of the real world is the mechanics you are doing at the moment? How could it be improved?*
- *What use do you make of graphic calculators in this course? How do you use computer software in your statistics project work?*
- *Which recent piece of mathematics have you enjoyed most/least? What was it about this work that made you feel successful/unsuccessful?*

The following evaluation is an extract of evidence from a discussion.

Example 3: evidence from discussion with 6 Year 12 AS-level students in a sixth-form college.

Students adamant that the increased focus on algebraic skills at the end of Y11 has made a lot of difference to their progress in the first term of AS level. Several able to talk through the remainder theorem confidently and explain how the special case of the factor theorem allows factorisation. Those doing mechanics have benefited from an early practical approach and have a good conceptual grasp of the way Newton's laws model the real world. The first independent study unit, using the college intranet, is seen as a positive feature of the course. It generates a lot of debate between students and this discussion helps learning. All students can recall the sequence of the animated PowerPoint presentation the unit involves. They show a good grasp of co-ordinate geometry, and particularly the relationship between the number of roots of an equation and the number and types of intersections of the graphs. In spite of their generally good GCSE grades, the speed with which students have acquired the depth and range of knowledge and understanding they have for this stage of the course points to very good achievement. It is likely to contribute to a judgement of above average attainment at the end of the course.

[Attainment above average (3)]

Commentary

Here the students' ability to recall and explain what they have learnt gives plenty of opportunity to assess the level at which they are operating. Pointers such as the use of the word 'tangent' linked with repeated roots and how non-intersection is linked to quadratic equations with no roots can be tested out by searching questions. In this case, students' confidence in their work helps them in their explanations.

1.4 Lesson observation

Example 4: evidence from Year 12 A-level mathematics lesson in a school sixth form; 10 students present.

The lesson deals with two aspects: graphs of trigonometric functions and the effect of geometrical transformations on the equations of functions.

Students show a very good understanding of the relationship between graphs of the sine, cosine and tangent functions. Their grasp of the impact of translating a graph in the direction of the x-axis enables them to establish for themselves identities of the type: sin(x + 90) = cos x. Use of technical language very good and always accurate. Student with English as an additional language uses written medium when finding going hard orally, and displays same high standards as others. The strong emphasis in the lesson on a visual, dynamic approach also helps the students to relate, for example, sin 3x to sin x, and they are quickly graphing more complex trigonometric functions with ease. Nearly all students tackle necessary algebraic manipulation in a very competent way. Given the above average GCSE results of the intake to the sixth form, this might suggest satisfactory or good achievement.

[Attainment well above average (2)]

Commentary

At this stage of their A-level course, the students are showing very good understanding of trigonometric functions. They are able to build quickly on their firm grasp of the basics and to make links between the range of ideas covered so far. The students are able to relate the trigonometric functions with the shape of the associated graphs and their location on the axes, and vice versa, correctly and with ease.

Example 5: evidence from a second year A-level mathematics lesson for a mechanics module in an FE college; 13 students present.

Lesson involves the setting up of an experiment to determine the coefficient of restitution between a soft ball and a hard surface – part of the A-level coursework.

Students show good understanding of the design of the experiment. The questions asked by the students about a strategy for carrying out the experiment demonstrate a very clear grasp of the underlying principles. Students work at the experiment in pairs (slight minority of female students all working with males). Show enthusiasm, think first to avoid the pitfalls, and get a consistent set of results. Students are able to set up the experiment quickly and are effective in discovering and overcoming the difficulties. Discussions show that they have a good grasp of the errors involved. Most students are able to find the coefficient of restitution by substitution into the previously generated formulae, without help. All are able to interpret and manipulate formulae such as $v^2 = u^2 + 2as$ with ease. No difference in attainment between male and female students. They show good understanding of the mechanics and how the theory impinges on the experiment. They are also good at relating this work to other elements of mechanics and at dealing with error calculations in experimental results.

[Attainment above average (3)]

Commentary

These students demonstrate very secure and confident knowledge and understanding of the theory behind collisions. They are also able to step back and reflect on the interrelationship between the theory and the experiment. They have above average skills in their ability to draw upon and use accurately a range of other mathematical topics.

Example 6: Year 13 (October) A-level mathematics lesson in a school sixth form; 12 students present.

Lesson on stratified sampling, for a second statistics module.

Teacher's initial introduction explains the limitations of random sampling and shows how a stratified sample can be obtained. Students then work on a series of simple examples. They tend to rely heavily on learnt techniques; only three show a sound understanding. Others are unable to say what chance each item has of being chosen. Two students, working together, fail to notice that the method they have chosen gives three items twice the chance of being selected. Several students, in the guise of co-operative working, are following what another student is doing, without really understanding.

Students understand the need for a stratified sample. Although on first appearances they are competent with basic probability calculations, their understanding of probability is not secure enough for them to be able to apply it to this new situation. This is below the standard which would be expected for this stage in the course. Since students started on the A-level course with grade B and A passes at GCSE, this seems to represent unsatisfactory achievement.

[Attainment below average (5)]

Commentary

This is a new topic, but it is their inadequate understanding of work done previously which is letting the students down. They are probably competent at answering the probability questions which they encountered in their first statistics module, but their weak understanding prevents them from applying the ideas in an unfamiliar situation.

Example 7: evidence from a GCSE mathematics lesson in an FE college; 18 students present, all sitting GCSE in a few weeks' time; most obtained grade D or E in GCSE mathematics last year; 3 are older students. They are working individually on past papers.

Students have relatively good numerical skills, sharpened by regular short session at beginning of lesson. Books show very committed students, most of whom have narrowly missed a grade C, working mainly from past papers and annotating solutions to act as revision aids. Students make good reference to these throughout lesson and are able to select and apply suitable techniques from past to similar problems. Routine single-stage problems are tackled confidently, but some students are unable to make a start on more complicated questions. Marking highlights strengths and weaknesses and gives references where further work is needed. The students have followed these up. Books indicate steady progress through the term and students find targets set with teacher very helpful in moving them on. Given students' past attainment at GCSE, this lesson points to satisfactory achievement.

[Attainment average (4)]

Commentary

Students are attaining what is expected at this stage of the course, and most are likely to achieve a grade C. There are few gaps in their knowledge or understanding, but lack of confidence leaves them insecure. The use of well-defined targets, frequently checked, is a key feature in the way this group have managed to put themselves in a position to reach the course aim.

2 Teaching and learning

2.1 Evaluating teaching and learning

Interpret the *Handbook* criteria with specific reference to mathematics. Teaching mathematics to post-16 students requires a secure knowledge of the subject and an expectation that students will take on increasing responsibility for their own learning. A vital element in good teaching is getting the right balance between giving information and setting challenging work which engages students and promotes the acquisition of new knowledge, skills and understanding. Judge the extent to which students rely on their teacher and how much they use their own thinking and study skills.

In GCE AS and A-level mathematics lessons, try to establish, in particular, the extent to which teachers draw connections between mathematical topics to provide students with an understanding of the central and unifying ideas and themes in mathematics. Keep in mind the following characteristics of effective teaching and learning, in which teachers:

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

- build on students' previous learning, check their understanding of mathematical ideas, revise and refine different techniques and approaches, and summarise these with students for future reference *(subject knowledge, methods, assessment, private study);*

- regularly encourage students to discuss mathematics 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 *(methods, expectations);*

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

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

- make effective use of available resources, other than standard texts, such as graphic calculators, software packages and practical resources *(planning, methods, resources).*

Be alert to teaching which may have superficially positive features but lacks rigour, depth or insight and, as a consequence, results in students' learning not being as fast, broad or deep as it should be. Examples of this might be teaching in which:

- each lesson involves input from the teacher followed by individual practice but no discussion of methods or ideas, the teacher only talking to students when they are stuck or to give instructions *(methods, expectations, challenge and inspire);*

- individual practice consolidates the same points over and over again with no development which requires students to select how they will tackle the task *(methods, expectations);*

- the teacher does not explore with students different ways of solving problems or the students are reluctant and anxious about using mental strategies *(methods, expectations, interest).*

In GCSE lessons, establish the extent to which teachers encourage students to take responsibility for their own learning and maintain good study habits outside the lessons themselves. Keep in mind, in particular, the following characteristics of effective teaching and learning, in which teachers:

- pitch the work at the right level for the student, taking account of the different needs of individuals in the group, so that each can experience success and move on confidently *(assessment, planning, methods);*

- provide suitable input that consolidates existing knowledge, understanding and skills, takes students forward in areas where there are gaps and corrects misconceptions *(subject knowledge, planning, assessment, expectations);*

- provide well-structured work outside designated classes, backed by suitable resources, so that students do not become quickly stuck and lose time and motivation *(planning, methods, expectations, private study).*

2.2 Lesson observation

Example 8: second year A-level mathematics lesson for a statistics module in an FE college.

Introducing the idea of significance testing.

Lively introduction which immediately captures students' interest. A doctor is trying out a new treatment for a serious condition, and three of his five patients die. Should he be stopped immediately? Lively debate, with students themselves quickly identifying two important points. 'It could just be bad luck.' 'It depends how likely they would have been to die using the established treatment.' Teacher skilfully develops from this the basic ideas of a null hypothesis, the fact that the test cannot prove conclusively that the alternative approach is better or worse, and the need to decide on a level of 'unlikelihood' – the significance level.

Students are quick to grasp the concepts and have a good understanding of what a significance test is even before the teacher completes the calculation for the initial example. They then work on a series of examples. In each case, the calculation of the probabilities is simple, using only binomial distribution (eg, England cricket captain has lost 10 of the last 11 tosses; 4 children in a family are all born on the same day of the week).

By the end of the lesson, students have a very good understanding of what a significance test is and how to go about doing the calculations. In a good, brief summary at end of lesson, teacher introduces example where Normal approximation to binomial distribution would be needed. Students leave the lesson recognising that they could apply the same procedure using any probability distribution with which they are already familiar.

[Teaching and learning excellent (1)]

Commentary

The keys to the excellence of this lesson are the teacher's very good subject knowledge and the very good methodology. Her subject knowledge is not simply knowing how to do a significance test but a clear understanding of the underlying concept and of the most important ideas for students to grasp. The approach she uses is well chosen to capture the students' interest and is successful in rapidly developing their understanding. Even in her choice of first examples for students to work, she is using very good methodology by separating the concepts of a significance test from the complications of having to handle more complex probability distributions.

Example 9: evidence from a Year 12 further mathematics A-level lesson in a school sixth form; 6 students present.

Lesson from the mechanics module: 'Forces and work'.

The teaching is very good, with the students being set a challenging puzzle about which to think and debate: 'Does someone at the gym do more work when walking on a treadmill if it slopes upwards than when it is level?'

After making sure that the students have a clear understanding of the question, the teacher remains silent for some time while they argue round the problem – 'It's obvious, because it's harder to walk uphill.' 'Work done equals increase in potential energy, so the slope is irrelevant.' These high-ability students are intrigued by the problem and most discuss it thoroughly and well. One is attentive, but makes no contribution to the discussion. Students put forward various proposals and counterproposals and argue them thoughtfully. The discussion moves at a very fast pace. Students show a readiness to listen to others and to consider different points of view. The teacher asks an occasional well-chosen question which helps to focus the students' thinking – for example, 'Does work done equal increase in potential energy when you pull up a weight using a pulley which is not perfectly smooth?' The students identify the need to draw a diagram showing the forces acting between the person and the treadmill and eventually explain the situation to the satisfaction of all.

[Teaching and learning very good (2)]

Commentary

Learning is very good. Through their discussion, the students show very good communication skills. The lesson does not involve working on any conventional problems from textbooks or examination papers, but it does result in a significant increase in their understanding of some important aspects of mechanics. The students are confident and they work quickly and with real interest; they ask challenging questions and respond very well to the intellectual demands made of them. Very good learning is taking place, with the students thinking hard about mathematical principles and developing their understanding very well.

The very good learning takes place because the teacher has matched both the question and the amount of help needed very well to the students. The teacher shows very good command of the subject and challenges and inspires the students to tackle open-ended questions with confidence. Because of its impact on learning the teaching is also very good.

Example 10: evidence from a Year 12 A-level mathematics lesson in a school sixth form; group contains 24 students with a wide range of attainments at GCSE. The lesson is on compound angle formulae in trigonometry.

The teacher's exposition is clear and blackboard presentation is carefully set out. The pace of work is suitable for about 80 per cent (20 students) of the class, but the teacher goes too quickly for the other 4 (weaker) students, who would benefit from more individual attention and more time to master the basic principles and techniques. The questions are of an appropriate level of difficulty for students of average and above average attainment at this stage of an A-level course. However, the questions are too challenging for the weaker students in the class: the demands of the algebra prevent these students from handling the trigonometrical techniques with sufficient confidence and accuracy. Two of them respond in a satisfactory way to the teacher's questions, but the other two keep a low profile and fail to make much contribution, preferring to allow the higher-attaining students to engage in the dialogue. The teacher demonstrates a very secure knowledge of the topic and a very good understanding of where the more demanding aspects of the topic lie. He is able to guide the majority of the class carefully and step by step through the theory and technique, so that they are able to solve the questions in the exercise successfully and with a good understanding of the principles. These students are making good progress. This is a large group and the range of attainment is wide. The teaching is not equally successful with the whole class, as more could have been done to support the weakest students.

[Teaching and learning satisfactory (4)]

Commentary

The large majority of students are making good progress and they respond well to the questions from the teacher. They show that they have a good understanding of the earlier work on trigonometrical formulae and are able to apply their understanding with confidence and competence on this topic. For these students, learning is good. However, the four weaker students are falling behind. They are clearly lacking in confidence. Two are reluctant to respond to questions, and their progress is unsatisfactory. This results in the judgement that, overall, learning is only satisfactory.

Had the teacher catered more adequately for the weaker students, the teaching might have been good, because the teacher shows very good subject knowledge and understanding of the finer details of the topic. The pace and questioning are never less than good for the large majority of the class. In general, the work is appropriately challenging for these students, but not for all students. Overall, therefore, teaching is satisfactory.

Example 11: evidence from an AS-level mathematics lesson in an FE college; 10 students present.

The lesson is on the modulus function as part of coursework on calculus – differentiation. This is the first time that these students have met the modulus function.

The teacher has planned the initial input only just satisfactorily to cover the required content. Asks too few questions to check and ensure that the students are following the principles outlined. The pace of the introduction is much too fast and this becomes clear when a question from one student leads to others admitting that they do not understand. The group has not understood the concepts and is confused about the use of two different formulae for different parts of the domain – they appear to regard 'function' as meaning 'formula'. The teacher then quickly goes over the explanation again, in exactly the same way, this time attempting to check students' understanding with the use of some direct questions. However, even here the questions are too closed to allow students to show understanding through explanations. A missed opportunity here for a graphical approach. The teacher moves students on too quickly to tackle the questions in the exercise, before being sure that they have understood the topic well enough to complete them successfully.

Throughout the exposition, the students concentrate well and persevere, trying to understand what is going on. When they begin the problems, they work slowly and are unsure how to set about the early examples. When one of the students correctly sketches the graph of the function (and teacher confirms that it is correct, in a tone of voice which implies that this is obvious), the students rapidly share it round amongst themselves and the light begins to dawn. At last, they start to make real progress with their work and there has been some development of their understanding by the end of the lesson.

[Teaching poor (6); learning unsatisfactory (5)]

Commentary

The teaching is poor overall and has a number of very weak features. The pace of the introduction is much too fast for the students and the teacher has not ensured throughout that the group is following the explanations. The teacher has concentrated too much on what has to be taught rather than on what students need to learn. Consequently, the repeat presentation does not cater for the problems already identified. The quality of the questioning is weak and fails to allow the students to explore their ideas and misunderstandings. The failures to use a graph and to anticipate that students may confuse 'function' with 'formula' are both significant weaknesses which impact on the learning. One of the key features which makes teaching poor rather than unsatisfactory is the teacher's failure to respond adequately to the clear messages coming from students as they grapple with this new piece of work.

The learning is unsatisfactory because there is not enough progress in the lesson and a significant part of the time is wasted. However, in the end, by their own efforts, the students have started to make some progress. So, learning is not judged to be as weak as the teaching.

Example 12: evidence from a GCSE re-sit mathematics lesson in a sixth-form college; 22 students present; each member of the group has GCSE grade D and seeks to gain a grade C in the re-sit examination in about 6 weeks' time.

The lesson is on probability.

The group is working well from a past examination paper, with questions on front and solutions on reverse. Students have good self-discipline in working out answers before checking. They make good use of teacher for advice and engage usefully in paired discussion. Teacher stops group for clear, well-prepared input on important points (mainly exclusive, exhaustive and independent events, use of probability trees), based on secure knowledge. Not all need this, however, and it stops the flow of work for some and lessens the pace. Students not particularly enthusiastic but recognise the importance of a GCSE grade C and work hard. Generally, they keep the pace high themselves. Teacher then gives entirely individual support and enhances students' ability to answer GCSE questions as well as supporting understanding. Most students (17+) achieve some consolidation of existing skills but a few (3) make less progress, as their skills in probability are more advanced already.

[Teaching and learning satisfactory (4)]

Commentary

The learning is satisfactory overall, despite the slow progress of a small minority, because they put in the effort the work needs and consolidate their existing knowledge, skills and understanding in unfamiliar contexts. They also gain in confidence in their ability to tackle forthcoming GCSE questions on probability. The teacher is well prepared, is clearly on top of GCSE question styles and gives good support throughout. The teaching is satisfactory, too, particularly as it results in satisfactory learning.

2.3   Other evidence on teaching and learning

Lesson observation is usually the most important source of evidence on the quality of teaching and learning, but the analysis of work and discussions with students can also yield valuable information. This is particularly important when the work includes a coursework component undertaken over time. Under these circumstances, the observation of individual lessons may give a very partial picture of the students' learning experience and of the support provided by teachers.

The work analysis will give you a good feel for the overall rate of progress, and, therefore, the pace of the teaching and learning. It will show the range and depth of the work which the students are required to do. It will indicate whether marking identifies well enough what students have to do to improve their work, and whether the various modules they do are equally represented. For the highest attaining students, it will show whether they are receiving enough challenging work to develop a high enough level of rigour.

Discussions with students will give you a sense of their motivation and the range of their experiences. You can ask questions to show whether they understand clearly how well they are doing and what they must do to improve.

3 Other factors affecting quality

Other factors are only significant if they have a noticeable impact on standards, teaching and learning. Note and evaluate any significant features of the curriculum, leadership, management, staffing, accommodation or resources. The following are examples of useful considerations in mathematics.

Curriculum and management

AS and A level
The subject criteria for GCE AS and A-level mathematics identify what is required in the post-16 mathematics curriculum. Study of the subject aims to encourage students to:

- read and comprehend mathematical arguments and articles concerning applications of mathematics;
- acquire the skills needed to use technology, such as calculators and computers, effectively, recognise when such use may be inappropriate and be aware of limitations;
- develop an awareness of the relevance of mathematics to other fields of study, to the world of work and to society in general;
- take increasing responsibility for their own learning and the evaluation of their own mathematical development.

Make judgements about the provision of the GCE AS and A-level curriculum on the extent to which students are given opportunities to meet these aims. In the modular system, consideration also needs to be given to whether the order in which topics are covered is appropriate and how it provides coherence, continuity and progression.

GCSE courses
In relation to curriculum planning and organisation for GCSE courses, judge to what extent sufficient taught time is available during the year and whether it is used to best effect. Decide whether enough attention is concentrated on those topics or areas of the syllabus in which students need to improve, rather than spending time practising what they can already do. Consider how well teachers use initial assessments to identify students' strengths and weaknesses and the impact this has on the planning of the course. Does it lead to the writing of individual students' action plans which then affect the quality of their learning?

4   Writing the report

What follows is an example of a post-16 subject section from a school inspection report. (It does not necessarily reflect the judgements in any or all of the examples given elsewhere in this booklet.) The summative judgements in these reports use, for schools, the seven-point scale: *excellent; very good; good; satisfactory; unsatisfactory; poor; very poor.* For colleges there is the five-point scale: *outstanding; good; satisfactory; unsatisfactory; very weak*. The summative judgements *excellent/very good* used in school reports correspond to *outstanding* in colleges; *poor/very poor* used in schools correspond to *very weak* in colleges.

Mathematics

Overall, the quality of provision in mathematics is **good.**

Strengths
- A-level results in recent years have been above national averages.
- The standard of work which students produce is above average, particularly in their coursework modules on statistics and mechanics; they are achieving well.
- Teaching is good overall and consequently students are highly motivated and work hard.
- The department is well managed; the monitoring of teachers is effective in enhancing their skills.

Areas for improvement
- A-level students would benefit from more opportunities to make extended contributions in class discussions.
- Some GCSE students need more help on number skills and on developing their understanding of the subject.

The inspection covered the two A-level courses offered by the school – mathematics with mechanics, and mathematics with statistics. In addition, the re-sit GCSE course for those who did not gain grade C in Year 11 was also inspected. The teaching of application of number leading to the key skills qualification has not yet begun; work is currently being undertaken to support its introduction next September.

The mathematics department does well for its sixth-form students. Over recent years, they have gained results consistently higher than the national average, with a gradually rising trend. Notable features have been the 100 per cent pass rate in most years and the high proportion of A and B grades. This represents good achievement, given the average standards of students when they start the course. The take-up of mathematics is lower by female than male students, but their results overall are similar. Minority ethnic students do well overall.

The standard of work seen in lessons and in students' folders confirms this. The overall quality of students' oral and written work is above average, and standards are higher than they were at the time of the last inspection. Male and female students do equally well. They have a good understanding of mathematics and make effective use of past work when they are introduced to a new topic – for example, when using calculus to find the minimum surface area of a cylindrical package of a given volume. Students are confident in using algebra – for example, when finding the intersections of curves and lines. A particular strength is the quality of students' coursework for the modules on statistics and mechanics.

Not surprisingly, students re-sitting their GCSE mathematics course in the sixth form often find the work difficult and achieve below average grades. Despite this, they work hard and try their best to succeed. Many of the students taking the one-year course find number work difficult and this reduces their confidence in dealing with mathematics in unfamiliar contexts.
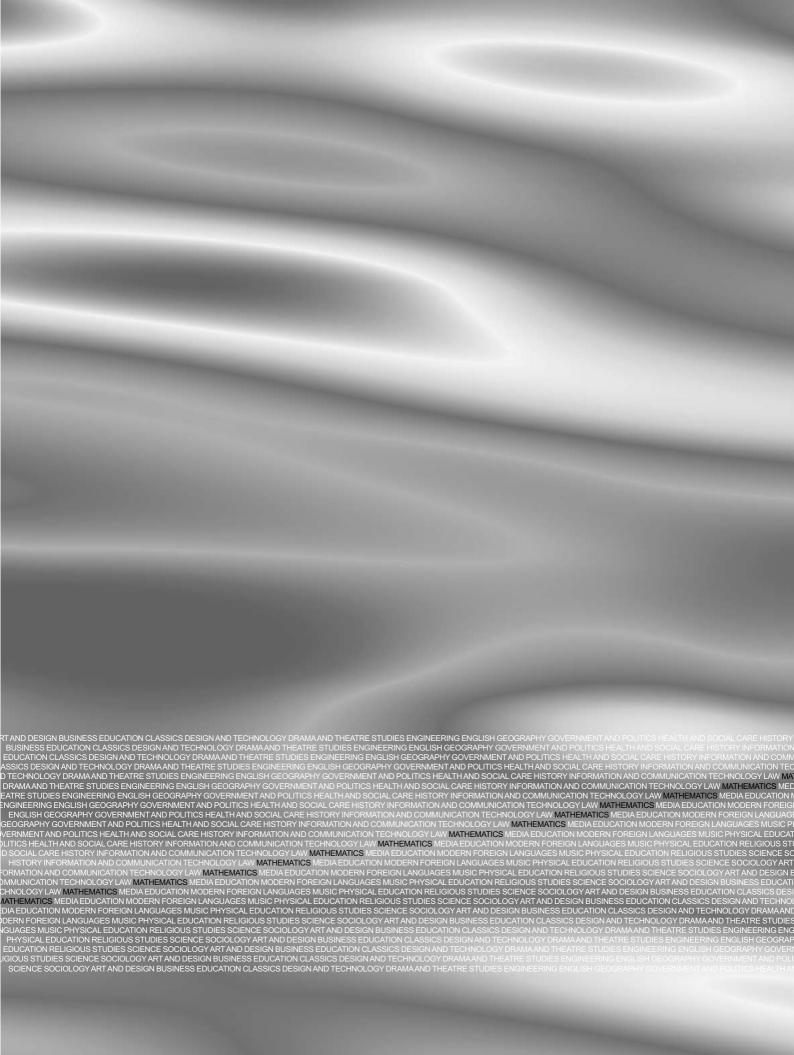
Teaching is good overall. Students learn well on the AS and A-level courses because the teaching is good. It is carefully planned and lessons always have clear objectives. Teachers structure lessons well, keep up a very fast pace and provide high levels of challenge. All this is based on a very good knowledge of mathematics and how it can be taught. As a result, students are highly motivated, work hard and are prepared to think for themselves. They showed this in devising an experiment to test the coefficient of restitution when a ball is dropped on to the floor. Students make considerable efforts to understand the work they are doing. They work well co-operatively in pairs and small groups,

but need more opportunities to make extended contributions in discussions involving the whole class. The marking of students' work does not always contain sufficient detail to help students see how they can improve.

The teaching of the GCSE groups is satisfactory, and provides good guidance on tackling examination questions. Some students, though, need more input from their teacher on number skills and on developing their understanding of the mathematics.

The mathematics department is well managed. The teachers are enthusiastic, committed to improvement and work well together to bring this about. Much of the consistency of approach to mathematics teaching comes about because of the positive way in which teachers work with each other, but also because the monitoring of teaching by the head of department is effective in enhancing teachers' skills. The department makes very good use of target-setting and review with its students. The process of setting challenging performance targets for mathematics students at A level could usefully be extended to the GCSE re-sit course.

Notes