OFFICE FOR STANDARDS
IN EDUCATION

INSPECTING SUBJECTS AND ASPECTS 11-18

SCIENCE

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INSPECTING SCIENCE

INTRODUCTION

As an inspector of science, you need to find out how good the pupils are at science, to what extent they understand what lies at its heart, and whether it 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 science, and are they high enough?
- How well are pupils progressing?
- How well is science 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 being used in the school.

  You should already have a good knowledge of the National Curriculum Programmes of Study for science 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 science.

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

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. 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 science 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.

Literacy, numeracy and information technology

- Evaluate the contribution science teaching makes to developing pupils' skills in literacy, numeracy and information technology. Often, information and communications technology may be used to support pupils' learning in science. Here, 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 science.

- Be alert to situations where weaknesses in these skills impede progress in science.

- 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 science 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 science 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 of 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?

- 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 standards in science?

ATTAINMENT AND PROGRESS

Your judgements on attainment 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 mathematics in the school.

■ For pupils aged 16:

- compare the school's GCSE results with:

  - the results achieved in 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;

- consider the proportion of the year group which fails to achieve a GCSE grade in science.
  You should be alert to the school's curriculum and entry policies when you interpret the results at age 16. In particular, you need to take account of the proportions of pupils who follow different science courses and are entered for GCSE in single award or double award science and the three separate sciences.

Where a higher than normal proportion of pupils is entered for three separate sciences this will affect the double award results in comparison with national averages. Schools which enter an unusually high proportion of pupils for single award science may achieve double award results which compare favourably with those in other schools where the entry for double award examinations is more typical. If few pupils are gaining double award and many are only going for single award, you must explore why; unless the school is giving, say, a particularly strong emphasis to the arts, then standards in science are unlikely to be high enough if the year group is 'normal'.

- Evaluate the A-level and AS results in the range of science courses available, comparing with national results, including those for schools of a similar type. Look at results over several years and take account of performance 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.*

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, as far as you can, you evaluate what pupils know, understand and can do **in all the aspects of science** - that is, experimental and investigative science; life processes and living things; materials and their properties; and physical processes.

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

- For pupils aged 14, use teachers' assessment alongside your observations as an indicator of attainment and a means of investigating matters such as 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.

- **Observe** how pupils go about their science, and tap into their discussions.

It will give insights into how well pupils plan and carry out experiments, handle equipment, observe, use evidence and explain their findings, seek to improve their experiments, solve problems and so on. By listening in as pupils talk together in groups, or during class teaching or group work involving discussion or questioning by the teacher, you will have opportunities to evaluate what pupils know and understand. Listen to how well pupils use their knowledge and understanding of science to help them explain the results of their experiments, and whether they use correct terminology.

- **Talk with pupils** as they work in groups on practical tasks, or in a more structured discussion.

  It will help you to explore what pupils know and understand and to see whether they think scientifically, if you ask questions along the lines: "What do you know about ... ?" "What are you trying to find out now?" "What does it tell you?" "Why is it happening?" "How did you make the experiment fair?" "What would happen if ...?" "How could you find out?"

  Talk with groups of pupils to fill in gaps in evidence. With pupils near to, say, 14 or 16 years, you should find out whether they have a broad knowledge and understanding of science, not just of the topics being taught during the inspection. Questions which ask pupils to distinguish, for example, between weight and mass, acceleration and velocity, igneous and sedimentary rocks, covalent and ionic structures, photosynthesis and respiration, allow pupils approaching 16 years to show their understanding of these concepts.

  Following up written work gives you the chance to assess how well the work is understood, whether it is written in pupils' own words, whether the work has contributed to the development of key ideas and so on.

- As you **observe pupils** in lessons, **look at their work** and **talk to them**, you should consider the extent to which pupils:

  - know and understand scientific facts and concepts in all aspects of science;
  - demonstrate skills in experimental and investigative science;
  - apply their scientific knowledge and skills in unfamiliar contexts, solving problems to help them understand scientific things they encounter in everyday life;
  - understand the nature of scientific knowledge and ideas, how they evolve and how they are supported by evidence;
  - understand the practical applications of science and how these are changing the nature of society and the economy;
  - use their literacy skills to best effect to communicate scientific ideas and findings, including the use of relevant terminology;
  - use mathematical and graphical skills to manipulate, display and analyse numerical scientific data, and use information and communications technology to capture, store, retrieve, analyse and present information.

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

PUPILS' ATTITUDES TO LEARNING

- Look out for the following particular characteristics in pupils:
  - scientific curiosity, whether they ask questions and try to explain what they see;
  - willingness and capacity to draw evidence together from different sources, weigh it and reach reasonable conclusions;
  - recognising and expressing reasoned views on the moral and social issues which stem from scientific developments;
  - respect for evidence, tolerance of uncertainty, honesty and open-mindedness in their scientific enquiry;
  - respect and care for living organisms and for the environment;
  - responsibility in relation to their own safety and that of others.

TEACHING

- Judge the quality of the teaching by weighing its strengths and weaknesses in relation to the criteria in the *Framework*, and assess its **impact on educational standards**, while remaining open to other factors 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 if they do not firmly consolidate their learning.

- Inform your views of teaching by reference to the characteristics of effective science lessons, in which teachers:
  - demonstrate their enthusiasm for science and present their subject in ways which stimulate interest and scientific curiosity *(knowledge and understanding, methods)*;
  - provide effective and clear explanations to help pupils gain sound understanding of difficult scientific concepts, to avoid misconceptions and to correct mistakes *(subject knowledge, methodology)*;
  - extend and deepen pupils' scientific understanding by questioning such as *"What if ... ?"* and *"why is ...?"* which goes beyond simple one-word answers and builds on and develops ideas and challenges pupils to think scientifically *(subject knowledge, methodology, expectations, assessment)*;

- make effective use of models and analogies, emphasising their limitations as well as their advantages (*subject knowledge, methodology*);

- use the most efficient means of developing science knowledge and understanding - for example, through the effective use of demonstration rather than necessarily through class practical work *(subject knowledge, methodology*);

- provide well-managed experimental and investigative work which supports and builds on pupils' knowledge and conceptual understanding, as well as developing their skills of planning, carrying out, drawing conclusions and evaluating experimental and investigative work *(subject knowledge, management, methodology, expectations, homework*);

- capture pupils' interest by relating the science being taught to everyday applications and to environmental and social issues *(subject knowledge, methodology, homework*);

- expect pupils to use terminology correctly and to attempt well-reasoned explanations for the results of their experiments, drawing on science knowledge and understanding *(expectations)*;

- provide opportunities for pupils to apply their scientific knowledge to solving unfamiliar problems, which also helps to deepen their understanding *(expectations, methodology)*;

- encourage pupils to read about science, not just follow written instructions *(methodology, expectations)*;

- give appropriate attention to health and safety and encourage pupils to take responsibility for safe working *(subject knowledge, expectations)*.

For pupils with special educational needs, good teaching includes:

- challenging pupils on their science knowledge and not just skill development;

- providing pupils with physical, visual or hearing disabilities with suitably modified equipment to permit full participation in lessons.

■ Consider with particular care teaching which may have superficially positive features but which lacks the rigour, depth, insights and the command of good subject teaching. Examples might be teaching which:

- includes practical activity but which does not significantly advance pupils' knowledge and understanding of science - for example, trivial experiments or where pupils are told what will happen beforehand; or investigations with little science content which do not draw on or develop accessible science ideas;

- deals with the large knowledge base by requiring pupils to copy excessive notes, without checking that they have understood;

- provides trivial and time consuming tasks which do not help pupils to make progress in their understanding of science - for example, cutting out and sticking pictures on posters;

- pitches work or explanations at the wrong level for the pupils' present understanding - for example, using too demanding a model for atomic theory or use of chemical formulae and equations before pupils have clearly grasped what is happening, so that it goes over the pupils' heads;

- uses questioning to pursue ideas, but the questions are superficial or demand only one-word answers, and discussion never gets under the skin of the scientific concepts being taught;

- involves use of workbooks or worksheets which, however well-presented, limit pupils' responses and constrain the scope and depth of science ideas and awareness of applications;

- uses elaborate equipment or resources but fails to make clear the scientific purpose of the activity.

OTHER ASPECTS OF PROVISION AND MANAGEMENT

Curriculum and assessment

- Be alert to factors which contribute to the success of science teaching and what is achieved. Within the criteria in the *Framework*, assess the extent to which:

  - curriculum planning includes the development of experimental and investigative skills within the context of the development of the pupils' scientific knowledge and understanding, and takes account of links with other subjects;

  - the science curriculum contributes to cross-curricular knowledge, understanding and skills, particularly health education, environmental education and capability in information technology;

  - effective techniques are used to monitor pupils' attainment and progress in experimental and investigative skills as well as in their knowledge and understanding.

Spiritual, moral, social and cultural development

- Evaluate the extent to which opportunities for pupils' spiritual, moral, social and cultural development are provided through examples such as these:

  - encouragement to reflect on the beauty and wonder of the natural world and to appreciate underlying order - for example, in the periodic table;

  - awareness of the ways that science and technology can affect our society and the environment;

  - consideration of the moral dilemmas that can result from scientific and technological developments;

  - co-operation in practical activity, where all pupils participate and assist each other;

- raising awareness that scientific developments are the product of many cultures.

Staffing, accommodation and learning resources

- Judge the contribution to the quality of teaching and what is achieved. Particular attention should be paid to the extent to which:
  - there are sufficient laboratory technicians to support practical work;
  - funding permits the replacement of equipment on a rolling programme;
  - effective use is made of school grounds, the local area and other off-site resources for fieldwork.

Health and safety

- Judge whether health and safety matters are dealt with effectively and there is provision for risk assessments[1].

  You are not required to carry out a safety 'audit', but this is part of your inspection of leadership and management.

- Be alert to any significant threats to pupils' or teachers' safety and well-being.

OBSERVATION FORMS

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

[1] For guidance on health and safety issues, a useful reference is: 'Safety in Science Education' DFE (1995)

SCIENCE YEAR 9 MIXED ABILITY - Very good teaching

CONTEXT:
Sc1 investigating the effects of pH on enzyme breakdown of starch. SC2 life processes and living things: the human digestive system. Quick teacher-led recap session. Pupils predict what will happen in their investigations. Then carry out investigations in groups. Record results and draw conclusions.

TEACHING:
Good preparation - eg practical resources very well organised in advance to get the lesson off to a prompt start. High expectations - eg ps made to recall earlier work accurately and use precise scientific language to explain their findings. Secure knowledge of enzymes and digestion. V good pace and effective methodology - good balance between whole class and group activity to maintain interest and momentum; effective recap at end where groups present their conclusions and CT sums up. Manages the group well with humour. Assessment good - eg monitors understanding whilst pupils are engaged in groupwork; circulates, asks probing questions to check progress; and books marked well using the dept scheme. Previous hw was to research information - well linked to present activity. Grade 2

RESPONSE:
V positive attitudes. Keen to answer qs. Try to solve own problems but seek help when they need it. Stay on task during the lesson - do not need prompting to do their work. Very good behaviour. Responsible approach to safety. Understand the need for safe behaviour when handling chemicals. Grade 2

ATTAINMENT:
Ps suggest the results table for the experiment. Almost all can predict and justify their predictions, and carry out an experiment with due care and accuracy. They are able to control other variables while varying the pH, and draw conclusions which match their results. SC1 attainment in the range L4-5. SC2 attainment significantly higher - most at L6 - eg good understanding of enzymes and their role in digestion. Grade 3

PROGRESS:
Good over time as seen in exercise books eg in the nutrition strand. Good development of investigation skills during lesson with eg the less able thinking hard about their responses and quite articulate in explaining their predictions. Most clearly have better understanding of effect of pH on enzymes, and how this affects digestion, at the end of the experiment than at the beginning. Grade 3

SCIENCE YEAR 11 HIGH SET - Satisfactory teaching

CONTEXT:
Changes in adolescence and effect of hormones. CT reads extract to give ideas. Ps then record main ideas, referring to textbook. Open/closed qs to recap. Set 2 out of 6. Generally more able pupils, but still a range of attainment.

TEACHING:
Good planning: objective for lesson relevant, well defined and made clear. Sound methodology: clear exposition; handles the biological aspects of sexual change with sympathetic approach. Reasonable expectations: work matched to the middle range of the group with appropriate challenge from questions, but additional materials not provided for the most able to refer to. Assessment OK: books are marked with effort grade - ps have a broad understanding of this - with critical comments provided which help pupils. Appropriate homework set. Grade 4

RESPONSE:
Ps listen well and concentrate without embarrassment. Work well as individuals. Can organise their ideas and select the relevant information. Show mature respect for each other, talk in a mature way about sexual changes. Able to take responsibility to determine the best style of recording for them. Grade 3

ATTAINMENT:
Almost all ps have a sound knowledge of changes in the body with sexual maturation and that chemicals produced by the body cause them. They appreciate there is a control function to a hormone. But often unsure of the difference between different hormones. Most on line to attain GCSE grades C & B. Grade 3

PROGRESS:
Discussion shows ps making sound progress in knowledge of secondary sexual changes and in role of hormones. This lesson a worthwhile experience with ps reasonably challenged and productive - though the best in the set not fully extended eg to appreciate differences better than they do. Past work shows similar picture.
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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