Guidance

Curriculum, Examination & Assessment

Key Stage 3
National Strategy

Training for supply teachers: science

Notes for tutors

Science consultants and tutors

Status: Recommended

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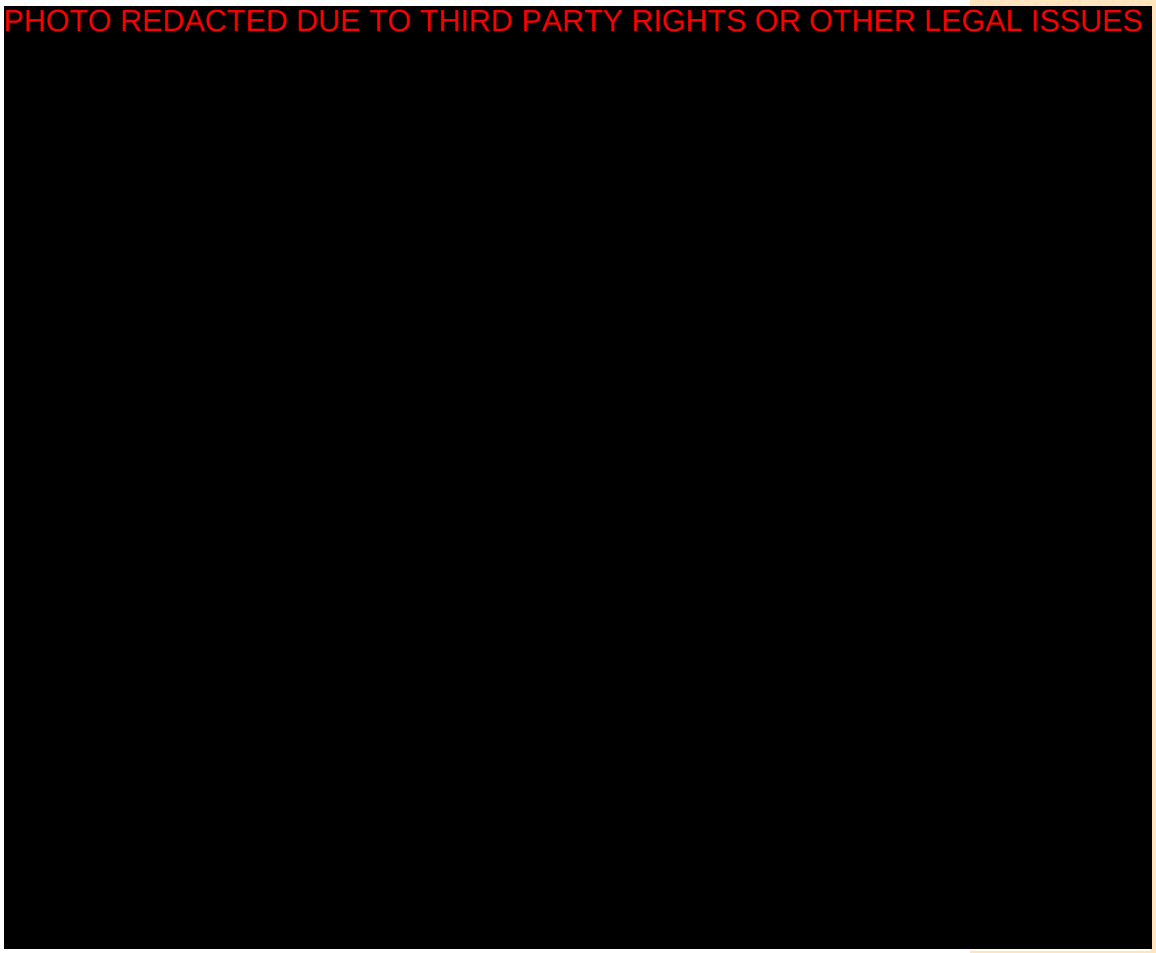


department for
education and skills
creating opportunity, releasing potential, achieving excellence

Key Stage 3
National Strategy

Science

Training for supply teachers: science

Notes for tutors

Contents

Overview of the unit

Aims and outcomes of the course

This one-day course is for supply teachers who may not have access to the Key Stage 3 National Strategy training provided in schools or by LEAs. It provides background information and the opportunity to experience some of the activities from the CPD training currently provided in the science strand of the Key Stage 3 Strategy.

By the end of the day, participants should:

- be familiar with the structure and purpose of the science strand of the Key Stage 3 Strategy;
- be aware of the content and structure of the *Framework for teaching science: Years 7, 8 and 9*;
- be familiar with features of good science teaching.

Outline programme for the course

Session 1 The science strand of the Key Stage 3 Strategy (30 minutes)

Session 2 The *Framework for teaching science: Years 7, 8 and 9* (85 minutes)

Session 3 Effective science lessons (85 minutes)

Session 4 Using models and analogies (60 minutes)

Session 5 Scientific enquiry (70 minutes)

Session 6 Plenary (15 minutes)

Synopsis

Session 1 The science strand of the Key Stage 3 Strategy

This session provides the background to the Key Stage 3 National Strategy. The principles of the Strategy are explained and details of the science strand and the successes of the pilot are given. The video from the launch unit is used as a summary.

Session 2 The *Framework for teaching science: Years 7, 8 and 9*

This session provides the opportunity for participants to become familiar with the structure and content of the *Framework for teaching science: Years 7, 8 and 9*. The importance of key scientific ideas and yearly teaching objectives is stressed.

Session 3 Effective science lessons

In this session, participants are introduced to the idea of the three-part lesson as an effective model for teaching science and the characteristics of effective lessons

are outlined. The session focuses in particular on starter activities, sharing lesson objectives, and plenaries.

Session 4 Using models and analogies

This session provides some background to the importance of the use of models and analogies in science teaching. It gives an example of how models can be used to teach the key scientific idea of energy. This not only enables participants to develop their knowledge of the use of models and analogies as a teaching strategy, but gives them the opportunity to explore their own understanding of the different models used to teach energy.

Session 5 Scientific enquiry

In this session, participants are given the opportunity to reflect on the nature of scientific enquiry and its place in the Key Stage 3 National Curriculum. The importance of teaching individual skills is emphasised and participants are given an example of how to explicitly teach the planning of an investigation.

Session 6 Plenary

In this final session, participants use the summaries they have produced in the other sessions to reflect on the changes that they will make to their own teaching and to identify future training needs.

Preparing for this unit

You will need to check practical matters such as:

- venue, parking, suitability of accommodation, domestic arrangements, access for anyone with a disability;
- number of participants;
- availability of general resources including LCD projector or OHP, video, flipchart, facilities for using the Powerpoint slide presentation, paper, sticky notes and materials specific to each session;
- furniture arrangements – whether all the participants will be able to see the screens and whether they can work comfortably in groups;
- arrangements and times for refreshments.

Ensure you have enough participants' packs and photocopies of any materials they will need.

You will need to prepare and send to participants in good time before the event: a programme, details of how to find the venue, and a contact telephone number for the venue that they can use. You may also want to include a list of participants for all those attending. Name badges will be useful as it is unlikely that participants will know many others who will be attending.

Make sure you are familiar with:

- *Framework for teaching science: Years 7, 8 and 9*;
- these notes, the Powerpoint slides, the video and the handouts.

Resources needed for each session

Session 1 The science strand of the Key Stage 3 Strategy

For tutor

Slides 1.1–1.6

Video

For participants

Copies of all slides

Participants should bring:

Completed pre-unit task handout

Notes of ideas for lessons they would be willing to demonstrate

Session 2 The *Framework for teaching science: Years 7, 8 and 9*

For tutor

Slides 2.1, 2.3, 2.4

For participants

Copies of all slides

Handout 2.2 What do you know about the Framework?

Handout 2.5 Summary and action points

Framework for teaching science: Years 7, 8 and 9

Session 3 Effective science lessons

For tutor

Slides 3.1–3.8, 3.10

For participants

Copies of all slides

Handout 3.9 Writing objectives and outcomes

Handout 3.11 Why have a plenary?

Handout 3.12 Possible plenary activities

Handout 3.13 Summary and action points

Framework for teaching science: Years 7, 8 and 9

DfES/QCA scheme of work for science

Session 4 Using models and analogies

For tutor

Slides 4.1–4.5, 4.8, 4.10

Paper cups (one per participant)

Packet of small sweets

For participants

Copies of all slides

Handout 4.6	Teaching science at Key Stage 3 using models and analogies: a summary
Handout 4.7	Alternative models for teaching energy at Key Stage 3
Handout 4.9	Dennis the Menace
Handout 4.11	Summary and action points

Session 5 Scientific enquiry

For tutor

Slides 5.1, 5.2, 5.5

For participants

Copies of all slides

Handout 5.3	Scientific enquiry
Handout 5.4	Enquiry skills
Handouts 5.6a–c	Planning posters
Handout 5.7	Using the scientific enquiry posters
Handout 5.8	Summary and action points

A3 laminated copies of the planning posters (one for every two participants)

Small sticky notes – two colours

DfES/QCA scheme of work for science

Framework for teaching science: Years 7, 8 and 9

Session 6 Plenary

For participants

Handout 6.1	Summary and action points

Evaluation form

Unit evaluation

Collect the completed evaluation forms at the end of the course.

You will need to read them and summarise the data.

Evaluation: Training for supply teachers: science

For completion by participants

What were the most successful aspects of today's sessions?

What changes would you suggest if today's sessions were repeated?

Please grade each session on the basis of how well structured and organised it is to meet the learning objectives identified.

Session	Grade: please ring 1 = Very good, 4 = Poor	Comment
1 The science strand of the Key Stage 3 Strategy	1 2 3 4	
2 The *Framework for teaching science: Years 7, 8 and 9*	1 2 3 4	
3 Effective science lessons	1 2 3 4	
4 Using models and analogies	1 2 3 4	
5 Scientific enquiry	1 2 3 4	
6 Plenary	1 2 3 4	
Overall grade for the unit	1 2 3 4	

Please return this form to your tutor before leaving.

Summary evaluation:
Training for supply teachers: science

For completion by consultants or tutors after the unit has taken place

LEA _____

Date of training _____

What were the most successful aspects of today's sessions?

What changes do you suggest might be made to improve this unit?

a. From the tutor's point of view.

b. From participants' point of view.

What additional training did the supply teachers request?

Please grade the tutor's material for clarity, pitch, ease of use, appropriateness for teachers and so on. Use additional sheets of paper if you wish to provide more detailed comments.

Session	Grade: please ring 1 = Very good, 4 = Poor	Comment
1 The science strand of the Key Stage 3 Strategy	1 2 3 4	
2 The *Framework for teaching science: Years 7, 8 and 9*	1 2 3 4	
3 Effective science lessons	1 2 3 4	
4 Using models and analogies	1 2 3 4	
5 Scientific enquiry	1 2 3 4	
6 Plenary	1 2 3 4	
Overall grade for the unit	1 2 3 4	

Please collate the grades given to each session by the participants attending. Please provide numbers, not percentages.

Total number of participants _____

Session	Number of participants giving grade				
	1	2	3	4	No grade given
1 The science strand of the Key Stage 3 Strategy					
2 The *Framework for teaching science: Years 7, 8 and 9*					
3 Effective science lessons					
4 Using models and analogies					
5 Scientific enquiry					
6 Plenary					
Overall grade for the unit					

Please return this form to:

Science Team Senior Regional Coordinator
Centre for School Standards, 60 Queens Road, Reading RG1 4BS

Session 1

The science strand of the Key Stage 3 Strategy

Objectives

- To familiarise participants with the principles and features of the science strand of the Key Stage 3 Strategy
- To increase participants' awareness of the background to the science strand

Resources

For tutor

Slides 1.1–1.6

Video

For participants

Copies of all slides

Participants should bring:

Completed pre-unit task handout

Notes of ideas for lessons they would be willing to demonstrate

Session outline

30 minutes

Introduction		10 minutes
An overview of the objectives for the day and an outline of the structure of the day	Talk	
The Key Stage 3 Strategy		20 minutes
The principles of the Strategy and more details of the science strand	Talk Video	

Introduction

10 minutes

Welcome participants and deal with any domestic issues.

Slide 1.1

Show **slide 1.1**, which shows the objectives for the day, and explain these to the participants.

Objectives for the day — Slide 1.1

- To familiarise participants with the structure and purpose of the science strand of the Key Stage 3 Strategy
- To familiarise participants with features of effective science teaching
- To increase participants' awareness of the content and structure of the *Framework for teaching science: Years 7, 8 and 9*

Slide 1.2

Objectives for the session — Slide 1.2

- To familiarise participants with the principles and features of the science strand of the Key Stage 3 Strategy
- To increase participants' awareness of the background to the science strand

Slide 1.3

Show **slide 1.2** and explain the objectives for this session.

Structure of the day — Slide 1.3

Session 1: The science strand of the Key Stage 3 Strategy

Session 2: The *Framework for teaching science: Years 7, 8 and 9*

Session 3: Effective science lessons

Session 4: Using models and analogies

Session 5: Scientific enquiry

Session 6: Plenary

Show **slide 1.3** and explain the structure of the day.

The Key Stage 3 Strategy

20 minutes

Make the following points.

- The Strategy is intended to improve achievement at Key Stage 3. Attainment at the end of Key Stage 2 has continued to improve – in 2002, 86% of pupils achieved level 4 or above, but at the end of Key Stage 3 the figure for pupils achieving the expected level of 5 or above in the same year was 66%.

T

Slide 1.4

Principles Slide 1.4

- Expectations
- Progression
- Engagement
- Transformation

Slide 1.5

Features of the science strand Slide 1.5

- Framework
- Audit
- CPD
- Consultancy
- Booster

- The Ofsted report *Progress in Key Stage 3 Science (March 2000)* identified strengths, but also areas for development and recommendations for teaching and learning. The pilot was designed to improve these weaknesses.

Additional guidance

It would be useful to have a copy of this report to show participants and perhaps select some points to use as illustrations.

Show **slide 1.4**, which outlines the principles of the Strategy.
Explain each of the principles in turn.

Make the following points.

- In many schools, the **expectations** of teachers for their pupils are too low. In some schools, for example, even though they are following the DfES/QCA scheme of work, which states that the expected level for most pupils at the end of Year 9 is level 6, many teachers still believe that it is level 5.
- The Strategy is targeting **progression** as a major issue. This is particularly emphasised in the training that focuses on transition from Key Stage 2 to Key Stage 3 and in the training on progression for subject leaders within Key Stage 3.
- The Strategy provides many examples of methods that teachers can use to **engage** pupils in their learning and therefore improve motivation and enjoyment.
- The training programme, with support from consultants, is intended to help teachers **transform** and improve teaching and learning.

Show **slide 1.5**, which outlines the features of the science strand of the Strategy.

Video

Slide 1.6

Successes of the pilot Slide 1.6

- Training was well received
- Teachers are more confident and motivated
- Observing primary lessons had a positive effect
- The work of the consultants was highly valued
- Key scientific ideas helped focus planning and teaching

Make the following points.

- The Strategy is funded by central government with contributions from LEAs. Schools receive standards funding to pay for supply cover for training and for 'in school' development. Some schools in LEAs will receive extra funding as they have been chosen as additional support schools. There is also money available for other projects such as leading teachers or departments.
- The *Framework for teaching science: Years 7, 8 and 9* gathers together the main ideas in the science strand in order to support science teachers, departments and schools. It was written during the pilot period (January 2001 to April 2002) and was based on experiences gained during this time. Session 2 will deal with the Framework in more detail.
- The audit is in two parts – a generic audit, which all departments in a secondary school complete, and a science-specific audit, which enables teachers to identify their CPD needs. The audit results in action points, which are built into a department's planning cycle.
- The CPD programme has been developed to address areas identified in the Ofsted report and others identified in the pilot. The materials were trialled during the pilot and have been modified to take account of the evaluations.
  - In the first year, the focus is on pedagogy and management.
  - Special schools have their own training programme.
  - In subsequent years the focus will shift to include subject knowledge.
  - One session of the training is the transition unit and this includes a visit to a primary school to see science being taught.
- LEAs are provided with money to fund consultancy for schools. In most instances this consists of a dedicated Key Stage 3 science consultant who delivers training and works alongside teachers helping them implement the ideas from their training.
- Schools have been provided with money to fund booster programmes. In addition, a file of materials containing advice and sample lessons has been provided free of charge.

Show the **video** that accompanies Session 1: *The launch of the science strand.*

Show **slide 1.6,** which describes the success of the pilot.

Slide 1.1

Objectives for the day

- To familiarise participants with the structure and purpose of the science strand of the Key Stage 3 Strategy
- To familiarise participants with features of effective science teaching
- To increase participants' awareness of the content and structure of the *Framework for teaching science: Years 7, 8 and 9*

Slide 1.2

Objectives for the session

- To familiarise participants with the principles and features of the science strand of the Key Stage 3 Strategy
- To increase participants' awareness of the background to the science strand

Slide 1.3

Structure of the day

Session 1: The science strand of the Key Stage 3 Strategy

Session 2: The *Framework for teaching science: Years 7, 8 and 9*

Session 3: Effective science lessons

Session 4: Using models and analogies

Session 5: Scientific enquiry

Session 6: Plenary

Slide 1.4

Principles

- Expectations
- Progression
- Engagement
- Transformation

Slide 1.5

Features of the science strand

- Framework
- Audit
- CPD
- Consultancy

Slide 1.6

Successes of the pilot

- Training was well received
- Teachers are more confident and motivated
- Observing primary lessons had a positive effect
- The work of the consultants was highly valued
- Key scientific ideas helped focus planning and teaching

Session 2

The *Framework for teaching science: Years 7, 8 and 9*

Objectives

- To improve participants' knowledge of the Framework and its structure
- To understand some of the main messages of the Framework
- To increase understanding of the key scientific ideas and the yearly objectives

Resources

For tutor

Slides 2.1, 2.3, 2.4

For participants

Copies of all slides
Handout 2.2 What do you know about the Framework?
Handout 2.5 Summary and action points
Framework for teaching science: Years 7, 8 and 9

Session outline

85 minutes

Introduction		10 minutes
The objectives for the session and a brief introduction to the purpose and history of the Framework	Talk	
Finding your way around the Framework		40 minutes
Two tasks intended to familiarise participants with the content and structure of the Framework	Talk	
Task A	Group work (pairs)	
Task B	Group work (fours)	
Scientific enquiry, key scientific ideas and yearly objectives		25 minutes
Task C Participants familiarise themselves with the guidance and yearly teaching objectives for Sc1and consider the impact of the key scientific ideas and the associated yearly teaching objectives on their teaching	Talk Group work	
Plenary		10 minutes
Participants reflect on what they have learned in this session and their future training needs	Individual reflection and recording	

Introduction

10 minutes

Slide 2.1

Show **slide 2.1** and explain the objectives for this session.

Objectives for session 2 — Slide 2.1

- To improve participants' knowledge of the Framework and its structure
- To understand some of the main messages of the Framework
- To increase understanding of the key scientific ideas and the yearly objectives

Give out copies of the Framework to all participants.

Briefly outline the purpose and history of the Framework.

Make the following points.

- The science Framework was written during 2001 and 2002 by members of the Strategy team, in close collaboration with other interested organisations such as HMI, QCA, subject associations, institutes and societies. An intensive consultation with LEAs and other interested groups took place in spring 2002.
- The science Framework has been developed to parallel the Frameworks for English and mathematics and to create coherence among the strands of the Strategy.
- The purpose is to raise standards at Key Stage 3 by providing guidance on planning, teaching and assessing science for this age range.
- The Framework brings together experiences from the pilot with accepted best practice into one practical guide. It does not replace the National Curriculum programme of study nor the DfES/QCA Exemplar Scheme of Work. It is guidance, not a rigid prescription of how to teach Key Stage 3 science.

Finding your way around the Framework

40 minutes

Handout 2.2

Give out **handout 2.2**. Participants will use this for **task A**.

What do you know about the Framework? — Handout 2.2

1 Where would I find guidance about teaching Sc1?

2 Where would I find information about what science pupils have experienced before Key Stage 3?

3 Where are the roles of the head of science and Key Stage 3 science coordinator described?

4 Where would I find specific guidance about planning lessons?

5 Where would I find specific guidance about marking?

6 Where would I find guidance about teaching pupils with special educational needs?

7 Where would I find out why there are five key ideas in Key Stage 3 science?

8 Where would I find guidance on target setting?

9 Where would I find out about the yearly teaching objectives?

10 In which year are most pupils expected to attain level 5?

Task A

10 minutes

Slide 2.3

Ask participants in pairs to use handout 2.2 to become familiar with sections of the Framework. Allow them 5 minutes to answer the questions on the handout and then go through the answers provided on **slide 2.3**.

Answers for handout 2.2 — Slide 2.3

1. Chapter 2
2. Appendix 1 (and in each key idea)
3. Chapter 3
4. Chapter 4
5. Chapter 6
6. Chapter 7
7. Under each key idea subheading in chapter 2
8. Chapter 6
9. Chapter 2
10. Year 8

Slide 2.4

Show **slide 2.4** and give a very brief description of each section of the Framework.

The structure of the Framework — Slide 2.4

- Introduction
- Science at Key Stage 3
- Raising standards in science
- Planning
- Teaching and learning strategies
- Assessment and target setting
- Inclusion and differentiation
- Related publications and websites
- Appendix 1 – From Key Stage 2 to Key Stage 3
- Appendix 2 – Yearly teaching objectives for scientific enquiry (Sc1)
- Appendix 3 – Scientific vocabulary

Tell participants that they will study a section of the Framework in more detail in the next activity.

Task B

25 minutes

Divide the participants into groups of four.

Ask each group to summarise two topics from the following list.

- Long-, medium- and short-term planning
- Teaching strategies (not 'Effective lessons' – there is a section devoted to this in session 3)
- Assessment

- Setting targets and tracking progress
- Inclusion and differentiation
- SEN pupils

In each group of four, one pair summarises one of the chosen topics, the second pair summarises the other. The summary should record the main messages of that section as bullet points on flipcharts.

Each pair then teaches the main messages of their section to the other pair and answers any questions raised.

Display all the flipcharts.

Take a brief report back about each section, allow brief discussion and answer any questions.

Scientific enquiry, key scientific ideas and yearly objectives

25 minutes

Task C

Divide participants into six groups.

Each group should skim read 'Scientific enquiry' or one of the key scientific ideas and associated yearly objectives. Ask them to identify the impact it will have on their teaching. Allow 10 minutes for this.

Take feedback from each group in turn, summarising responses on a flipchart.

Plenary

10 minutes

Handout 2.5

Give out **handout 2.5**.

Summary and action points — Handout 2.5

Finding your way around the Framework

What have you learned in this session that will help you in your planning and teaching?

What do you need to find out more about or study in greater detail?

Ask participants to reflect on the session and to complete the summary as fully as they can.

Explain that this, together with summaries from the other sessions, will enable them to complete the final evaluation and provide feedback on future training needs.

Slide 2.1

Objectives for session 2

- To improve participants' knowledge of the Framework and its structure
- To understand some of the main messages of the Framework
- To increase understanding of the key scientific ideas and the yearly objectives

Slide 2.3

Answers for handout 2.2

1. Chapter 2
2. Appendix 1 (and in each key idea)
3. Chapter 3
4. Chapter 4
5. Chapter 6
6. Chapter 7
7. Under each key idea subheading in chapter 2
8. Chapter 6
9. Chapter 2
10. Year 8

Slide 2.4

The structure of the Framework

- Introduction
- Science at Key Stage 3
- Raising standards in science
- Planning
- Teaching and learning strategies
- Assessment and target setting
- Inclusion and differentiation
- Related publications and websites
- Appendix 1 – From Key Stage 2 to Key Stage 3
- Appendix 2 – Yearly teaching objectives for scientific enquiry (Sc1)
- Appendix 3 – Scientific vocabulary

What do you know about the Framework?

Handout 2.2

1 Where would I find guidance about teaching Sc1?

2 Where would I find information about what science pupils have experienced before Key Stage 3?

3 Where are the roles of the head of science and Key Stage 3 science coordinator described?

4 Where would I find specific guidance about planning lessons?

5 Where would I find specific guidance about marking?

6 Where would I find guidance about teaching pupils with special educational needs?

7 Where would I find out why there are five key ideas in Key Stage 3 science?

8 Where would I find guidance on target setting?

9 Where would I find out about the yearly teaching objectives?

10 In which year are most pupils expected to attain level 5?

Summary and action points

Handout 2.5

Finding your way around the Framework

What have you learned in this session that will help you in your planning and teaching?

What do you need to find out more about or study in greater detail?

Session 3

Effective science lessons

Objective

- To familiarise participants with features of an effective science lesson

Resources

For tutor

Slides 3.1–3.8, 3.10

For participants

Copies of all slides

Handout 3.9 Writing objectives and outcomes

Handout 3.11 Why have a plenary?

Handout 3.12 Possible plenary activities

Handout 3.13 Summary and action points

Framework for teaching science: Years 7, 8 and 9

DfES/QCA scheme of work for science

Session outline

85 minutes

Introduction		10 minutes
The structure and features of effective science lessons	Talk	
Looking at the appropriate section in the Framework		
Starter activities		45 minutes
Participants experience and review a range of starter activities, reflect on the reasons for using such activities, and practise writing lesson objectives and outcomes	Talk, modelling	
Task D	Group work (threes)	
Task E	Group work (pairs)	
The plenary		20 minutes
The purposes of a well-planned plenary and the types of activities that can be used	Talk	
Task F	'Buzz' pairs	
Task G	Group work	
Plenary		10 minutes
Participants reflect on what they have learned in this session and their future training needs	Individual reflection and recording	

Introduction

10 minutes

Slide 3.1

Show **slide 3.1** and explain the objective for this session.

Objective	Slide 3.1
• To familiarise participants with the features of an effective science lesson	

Slide 3.2

Structure of effective science lessons	Slide 3.2
• Starter • Main teaching activities • Plenary	

Show **slide 3.2**, which outlines the structure of effective science lessons.
Make the following points.

- Like other guidance in the Key Stage 3 Strategy, the science strand recommends a three-part lesson (default model) with clear lesson objectives. The beginning, middle and end allow teachers to prepare pupils for what they will learn, teach the lesson, and then help pupils recognise what they have learned.
- Session 3 will focus on activities for starters and plenaries, and on lesson objectives.

T

Additional guidance

See the CPD unit 'Effective lessons in science' for detailed guidance on lesson structure.

Slide 3.3

Features of effective science lessons	Slide 3.3
• High expectations and clear objectives • Planned starter and plenary • Appropriate exposition, demonstration, practical work to engage pupils • Challenging questions • Appropriate assessment • Inclusion of relevant local and contemporary science examples • Opportunities for extended discussion • Use of models and analogies	

Show **Slide 3.3** and briefly explain each point.
Refer participants to the section in chapter 5 of the Framework that gives guidance on effective science lessons.

Tell participants that the use of models and analogies will be covered in session 4 of this course.

Explain the section in the Framework on flexibility and the need to use professional judgement in different types of lessons while retaining the three-part structure.

Starter activities

45 minutes

Slide 3.4

Starter activities — Slide 3.4

- Arrival activities
- Sharing learning objectives
- Warm-up or switch-on
- Attention grabbing

Model a starter activity by quickly asking participants how confident they are in delivering an effective science lesson. Use the 'traffic lights' technique (or something similar) as an example.

Show **slide 3.4**, which lists reasons for using starter activities.

Slide 3.5

Arrival activities — Slide 3.5

- Establish routines to prepare pupils for learning
- Provide an engaging task
- Establish an ordered start for the lesson
- Provide time for the teacher to orientate themself

Tell the participants that they will experience and review some examples of these different types of starter activities during this session.

Arrival activities

Show **Slide 3.5**, which lists reasons for using arrival activities.

Activities that pupils can engage in as they arrive without support from the teacher are particularly useful for supply teachers who may need time at the beginning of a lesson to check that resources are available. They are also useful when pupils may be arriving from several different locations.

Use the following scenario (or something similar) to illustrate what might happen.

As pupils arrive, the teacher: challenges some pupils over not bringing their homework; confronts another pupil for forgetting their textbook; goes off at the deep end over pupils being late; decides this is the morning to make a scene about wearing trainers; is trying to find the textbooks he expected to use; is setting up a demonstration for later in the lesson. Meanwhile, pandemonium reigns in the lab.

Is this the start of a lesson in which effective learning is likely to take place?

Slide 3.6

Examples of arrival activities Slide 3.6

- Transfer targets from exercise books into planner
- Answer 'What if…' questions, such as 'What if there were no electricity?'
- Draw a picture to represent a science word from the current topic
- Do a word search
- Read a paragraph on a handout and underline the ten most important words
- Read a newspaper article and underline the 'science bits'
- Do science puzzles (from a bank of cards) such as solving Pictionary™-type clues for science terms

Slide 3.7

Task D will illustrate a preferable scenario **15 minutes**

Pupils' confusion with lesson objectives Slide 3.7

- Pupils may not understand the language in which the objectives are written
- Objectives or titles written on the board may 'give the game away'
- Pupils may forget the objectives during the lesson

Ask participants in groups of three to think of at least three arrival activities.

After 10 minutes, take feedback from each group and list the activities on a flipchart.

Slide 3.8

It may be possible to have this list typed up and circulated to participants at a later date.

Strategies for sharing lesson objectives and outcomes Slide 3.8

- 'We are learning to' – the lesson objective
- 'What I am looking for is' – the learning outcome
- 'This is because' – explains the wider context, rationale, the wider picture

Show **slide 3.6**, which gives some examples of arrival activities.

Handout 3.9

Sharing lesson objectives

Writing objectives and outcomes Handout 3.9

Choose an activity from a unit from the DfES/QCA scheme of work for science.

Identify the lesson objectives for Sc2, Sc3 or Sc4.

State these objectives in a form that pupils could understand more easily, by completing the following stems:

- *We are learning to/about*

(The objective)

- *What I am looking for is pupils who*

(The outcome)

- *This is because*

Make the following points.

- It is essential that pupils understand what the lesson is going to be about.
- Lessons do not always appear to pupils to develop in logical steps.
- Science teachers have good subject knowledge and will have spent

considerable time planning their lessons. Their familiarity with the subject knowledge ensures that the science makes sense to the teachers and the sequence of steps they have constructed in their lesson plan will seem to them a logical development of the ideas they wish to communicate.

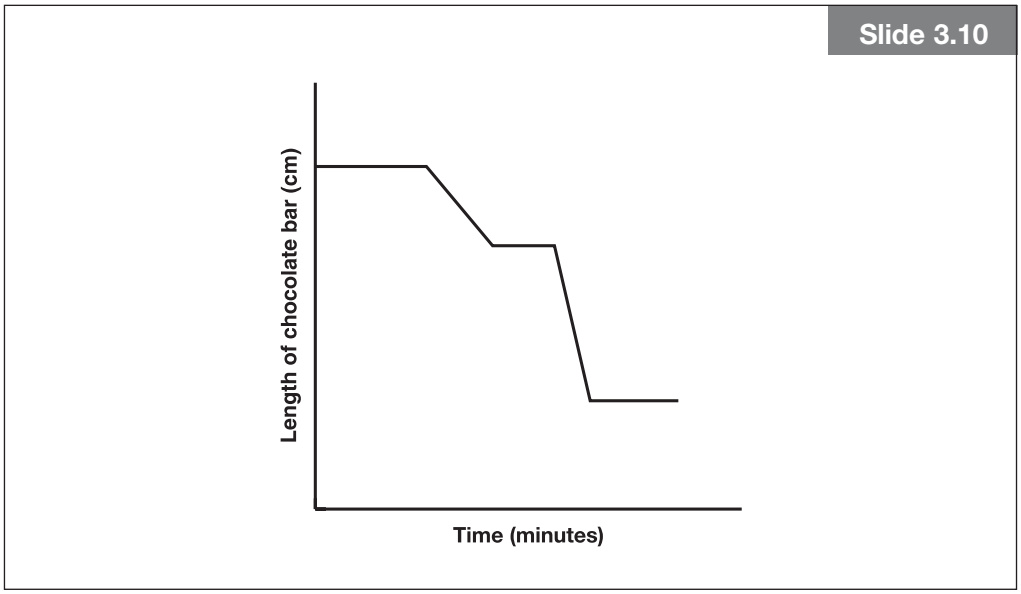
Use the following example.

An initial question-and-answer session on conditions required for photosynthesis, followed by counting Elodea bubbles and a Year 9 test question to be completed for homework, may seem to many pupils to be totally unconnected.

- Effective teachers make the connections between activities explicit. They share their map of the lesson with the pupils and point out the landmarks and important sites as they journey together.

An initial step is to share lesson objectives with pupils.

Slide 3.10



T

Show **slide 3.7**, which outlines possible sources of pupils' confusion over the objectives of a lesson.

Make the following point.

- The situation described in the second point (on the slide) is not uncommon – where the title of an activity tells the pupils exactly what they are trying to discover or prove.

Show **slide 3.8**, which gives some useful phrases teachers can use to share lesson objectives and outcomes with pupils at the beginning of a lesson.

Task E

10 minutes

Handout 3.11

Give out **handout 3.9**.

Why have a plenary? Handout 3.11

- To reinforce the key learning points
- To pick up any misconceptions that may have arisen
- To check if pupils have fully understood the implications of the experimental activity
- To make sure connections between the various parts of the lesson are clear
- To check if the lesson objectives have been achieved
- To find out how many pupils have coped or struggled with the learning in the lesson
- To inform the starting point for the next lesson
- To set homework
- To highlight pupils' progress and remind pupils of their targets

Use selected units from the DfES/QCA scheme of work for science.

Ask participants in pairs to choose one activity from one unit in the scheme and identify the lesson objectives. Do not use Sc1 objectives, as these will be covered in session 5.

Handout 3.12

Ask participants to complete handout 3.9, redrafting the lesson objectives into a form that could be shared with pupils, starting with the stems:

- 'What I am looking for is pupils who…'; and
- 'We are learning to/about ...'; then
- 'This is because…'.

T

Allow a few minutes for the participants to work in pairs, then ask each pair to share their objectives with the whole group.

Possible plenary activities Handout 3.12

- Word splat
- Write down what you have learned today – snowball activity
- Questioning
- List the evidence you have to answer the question posed at the beginning of the lesson
- Make a glossary of today's key words
- Sequence activity (for a practical activity they have just done)
- Report back – include 'stop points' at which other pupils can ask questions
- Hot seat
- Write down three facts you have learned, share them and build a list
- Write one sentence that summarises the lesson; share your sentence with a partner
- Envoys
- Loop card game – if this has been used as a starter, use the plenary to see how much quicker it can be completed
- Use writing frames such as 'What I have learned ...' , 'What I found difficult ...', and 'I need to improve ...'
- Extend into homework, for example:
  - prepare a quiz on the lesson: try it out as starter next lesson;
  - write a description of the lesson identifying things that were easy, difficult, etc.;
  - design a page for a textbook based on today's lesson;
  - design a web page to help remember an aspect of today's lesson.

Warm-up or switch-on

Make the following points.

- Some starter activities can be used to switch pupils on to the focus for the lesson.

For example, in a lesson that is going to focus on the interpretation of graphs, the teacher could tune pupils in to the process they will be using by asking them to tell the story of a graph.

Show **slide 3.10** as an example. Invite participants to explain what is happening.

Attention grabbing

Make the following points.

- These types of activity can be used to excite, motivate and stimulate pupils.
- Examples can include video clips, stories or short practical activities.
  An example of a practical activity could be to give every pupil a wild oat seed to hold. Tell them to place a drop of water on their seed and watch what happens. The oat seed will twist around. This is a mechanism that enables the wild oat seed to bury itself in the ground and therefore speeds up germination. It is also an effective method in preventing competition from other plants.

Ask participants to share examples of attention-grabbing activities they have used, seen used or could use.

Additional guidance

Have some other examples you can use as illustrations. Examples can be found on the Key Stage 3 LEA support website www.standards.dfes.gov.uk/keystage3.

Handout 3.13

Summary and action points — Handout 3.13

Effective science lessons

What have you learned in this session that will help you in your planning and teaching?

What do you need to find out more about or study in greater detail?

The plenary — 20 minutes

Task F — 5 minutes

Organise participants into 'buzz pairs' and ask them to consider the purposes of a plenary.

Take feedback from each pair and record their suggestions on a flipchart.

Handout 3.11 is available if you wish to use it as a checklist.

Make the following points.

- The final plenary of a lesson is often the least successful part of the lesson.
- Often teachers do not plan a plenary.
- If time is tight, it is usually the plenary that is sacrificed.
- Teachers may do all the work and tell pupils what they have learned. Then they cannot ascertain how much the pupils have actually learned.

Slide 3.1

Objective

- To familiarise participants with the features of an effective science lesson

Slide 3.2

Structure of effective science lessons

- Starter
- Main teaching activities
- Plenary

Slide 3.3

Features of effective science lessons

- High expectations and clear objectives
- Planned starter and plenary
- Appropriate exposition, demonstration, practical work to engage pupils
- Challenging questions
- Appropriate assessment
- Inclusion of relevant local and contemporary science examples
- Opportunities for extended discussion
- Use of models and analogies

Slide 3.4

Starter activities

- Arrival activities
- Sharing learning objectives
- Warm-up or switch-on
- Attention grabbing

Slide 3.5

Arrival activities

- Establish routines to prepare pupils for learning
- Provide an engaging task
- Establish an ordered start for the lesson

Slide 3.6

Examples of arrival activities

- Transfer targets from exercise books into planner
- Answer ‘What if…’ questions, such as ‘What if there were no electricity?’
- Draw a picture to represent a science word from the current topic
- Do a word search
- Read a paragraph on a handout and underline the ten most important words
- Read a newspaper article and underline the ‘science bits’
- Do science puzzles (from a bank of cards), such as solving Pictionary™-type clues for science terms

Slide 3.7

Pupils' confusion with lesson objectives

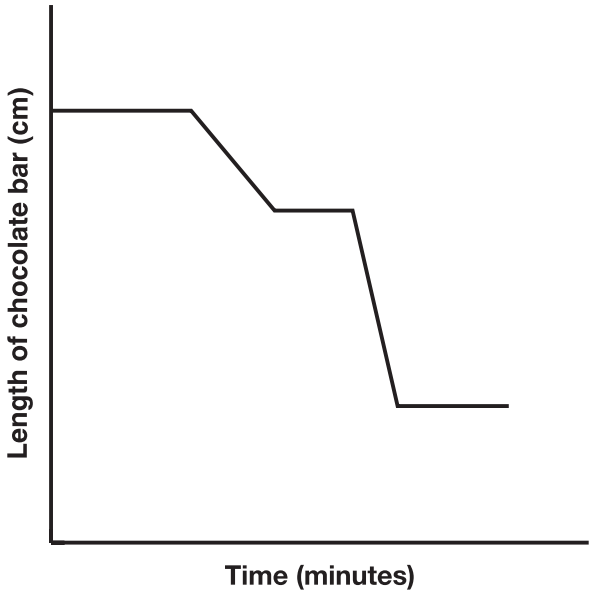
- Pupils may not understand the language in which the objectives are written
- Objectives or titles written on the board may 'give the game away'
- Pupils may forget the objectives during the lesson

Slide 3.8

Strategies for sharing lesson objectives and outcomes

- 'We are learning to' – the lesson objective
- 'What I am looking for is' – the learning outcome
- 'This is because' – explains the wider context, rationale, the wider picture

Slide 3.10



Writing objectives and outcomes

Handout 3.9

Choose an activity from a unit from the DfES/QCA scheme of work for science.

Identify the lesson objectives for Sc2, Sc3 or Sc4.

State these objectives in a form that pupils could understand more easily, by completing the following stems:

- *We are learning to/about*

(The objective)

- *What I am looking for is pupils who*

(The outcome)

- *This is because*

Why have a plenary?

Handout 3.11

- To reinforce the key learning points
- To pick up any misconceptions that may have arisen
- To check if pupils have fully understood the implications of the experimental activity
- To make sure connections between the various parts of the lesson are clear
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- To highlight pupils' progress and remind pupils of their targets

Possible plenary activities

Handout 3.12

- Word splat
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  - design a page for a textbook based on today's lesson;
  - design a web page to help remember an aspect of today's lesson.

Summary and action points

Handout 3.13

Effective science lessons

What have you learned in this session that will help you in your planning and teaching?

What do you need to find out more about or study in greater detail?

Session 4

Using models and analogies

Objectives

- To establish the importance of models and analogies in understanding key scientific ideas
- To appreciate how models and analogies can be used effectively in teaching key scientific ideas

Resources

For tutor

Slides 4.1–4.5, 4.8, 4.10

Paper cups (one per participant)

Packet of small sweets

For participants

Copies of all slides

Handout 4.6 Teaching science at Key Stage 3 using models and analogies: a summary

Handout 4.7 Alternative models for teaching energy at Key Stage 3

Handout 4.9 Dennis the Menace

Handout 4.11 Summary and action points

Session outline

60 minutes

Introduction The use of models and analogies to teach science	Talk	10 minutes
Using models and analogies in the classroom Strategies for using models	Talk	10 minutes
Developing models of energy Two alternative models for teaching energy Task F	Talk Reading Active participation	30 minutes
Plenary Participants reflect on what they have learned during this session and their future training needs	Individual reflection and recording	10 minutes

Introduction

10 minutes

Slide 4.1

Show **slide 4.1** and explain the objectives for this session.

Objectives — Slide 4.1

- To establish the importance of models and analogies in understanding key scientific ideas
- To appreciate how models and analogies can be used effectively in teaching key scientific ideas

Make the following points.

- Research science and teaching science are often about developing models that can help us visualise and explain the world.
- We often use different models to explain ideas, and there is often no one universal model. Sometimes one picture may help us explain some ideas, while another picture can help us to explain others.
- Pupils need to understand this, and it should be made explicit in teaching.
- Many of our descriptions and explanations in science are through models and analogies.
- Many of the scientific ideas developed at Key Stage 3 are themselves models, for example particle theory.
- All models have strengths and weaknesses and we need to take account of this in our teaching.
- Models and analogies help pupils visualise not only abstract ideas by making them concrete, but also objects and processes that cannot easily be seen.
- During this training you, the tutor, will model some teaching strategies. Leading teachers, consultants and advanced-skills teachers also do this.

T

Additional guidance

To illustrate this last point, it would be helpful if you could draw participants' attention to some strategies you have already used that they could use themselves in the classroom.

Slide 4.2

Show **slide 4.2** which differentiates between scientific models and teaching models.

Models — Slide 4.2

- Scientific models – often pictorial but sometimes mathematical
- Teaching models – pictorial, three-dimensional, analogies, etc.

Explain that we use the term 'model' in a variety of different ways to mean different things.

Scientific model
This is the accepted or consensus view of the concept or idea: for instance, that a force is needed to make something start to move or slow down, and that this force is either a push or a pull. This is an explanatory theory. Other examples are the particulate nature of matter, the abstract idea of energy, the cell as a basic building block of living things and the germ theory of disease.

Teaching model
This is something that can help pupils grasp or visualise an idea: for instance, using the ball-bearing three-dimensional model to illustrate the kinetic theory of matter, or a plastic bag filled with water to illustrate a cell. It could, however, be an analogy, as, for example, the water flow model to represent the flow of electricity in a circuit.

Using models and analogies in the classroom

10 minutes

Point out that there are various strategies for helping pupils use models.

Slide 4.3

Show **slide 4.3**.

Developing sequences of 'good enough' models — Slide 4.3

- Introduce the scientific idea (e.g. particle theory) early in the key stage
- Use a clear teaching model to help pupils visualise the idea
- Encourage pupils to apply their model to explain new phenomena
- Increase the sophistication of the model or change it as necessary

Make the following points.

- When planning teaching sequences, consider what models or analogies are 'good enough' at a particular stage to explain phenomena: for instance, the 'billiard ball' model for particles is good enough for explaining many physical changes but not chemical changes.
- Supply teachers need to find out which models are used in the department to teach different key scientific ideas, such as energy and particles.

Slide 4.4

Show **slide 4.4** and use examples to illustrate each point.

Encouraging pupils to identify the strengths and weaknesses in a model — Slide 4.4

Discuss the model and encourage pupils to:

- identify what each part represents;
- think about the strengths and weaknesses of the model and what it can and can't explain;
- suggest improvements for the model.

Provide other models that are problematic and encourage pupils to:

- identify what is wrong with the models;
- consider what alternative conceptions they might generate.

Make the following points.

- Discussing with pupils the merits of a model or an analogy helps them realise that these are the ways we often visualise science, and that all models have their limitations.
- Encouraging critical thought develops pupils' ability to reason and helps them appreciate that modelling is a useful way of thinking.
- Discussing strengths and weaknesses of models helps pupils make good progress in developing their understanding of science.
- Constructive criticism of other people's models can be motivating.

Slide 4.5

Show **slide 4.5**.

Encouraging pupils to develop their own models or analogies — Slide 4.5

- Helps reveal misconceptions
- Is motivating and requires creative thought
- Enables pupils to explore their own understanding of an idea

Handout 4.6

Summarise the points from this section using **handout 4.6**.

Teaching science at Key Stage 3 using models and analogies: a summary — Handout 4.6

To lift pupils' achievement, plan to:

- give pupils 'pictures' so they can talk about and explain their ideas in science;
- agree what 'pictures' will be used consistently within the department;
- teach the scientific ideas using explicit teaching models.

During lessons, encourage pupils to:

- apply the scientific idea (model) to explain new phenomena;
- think about the strengths and weaknesses of models;
- develop and test out their own models and analogies;
- improve their model (or those of others) by making it more sophisticated or by changing it.

Developing models of energy

30 minutes

Make the following points.

- In this section you will explain how using models can help pupils understand the concept of energy.
- Energy is a new idea for pupils at Key Stage 3. It is not dealt with in Key Stage 2, although they will have used the word in their everyday language.
- There have been many debates about how energy, energy transfer and conservation should be taught.

Handout 4.7

Give out **handout 4.7**

Alternative models for teaching energy at Key Stage 3 Handout 4.7

Energy transfer

In this model, the energy is located in one place and when something happens energy is transferred from that place to another.

Typical language to use

'The energy in the battery is transferred ***to*** the bulb ***by*** electricity and then ***from*** the bulb ***to*** the air ***by*** light. Some energy is transferred ***to*** the air ***by*** heating.'

'Energy ***from*** the Sun is transferred ***to*** the leaf cells ***by*** light.'

'Energy is transferred ***from*** the chemical reaction between magnesium and hydrochloric acid ***to*** the surroundings ***by*** heating.'

'A weightlifter transfers energy ***from*** his muscles ***to*** the bar ***by*** lifting (moving) his arms.'

Energy transformation

In this model energy takes on different forms, such as chemical, heat and light. Energy is transformed or changed from one form or type to another when a change occurs.

Typical language to use

'The ***chemical energy*** in the battery is ***transformed*** into ***electrical energy*** in the wires, then to ***light energy*** and ***heat*** in the bulb.'

'The ***light energy*** from the Sun is ***changed*** into ***chemical energy*** in the leaf.'

'Chemical energy in magnesium and hydrochloric acid is ***changed*** into ***heat*** when they react together.'

'The ***chemical energy*** in the weightlifter's muscles is ***changed*** into ***kinetic energy*** when the bar is lifted, then ***changed*** into ***potential energy*** at the top of the lift.'

Neither of these approaches is right or wrong. The two points of substance are that:

- pupils need to be aware that either energy transfer or energy transformation might be used in different text books, tests or examinations;
- teachers in a science department need to adopt a consistent approach to teaching energy across the science curriculum.

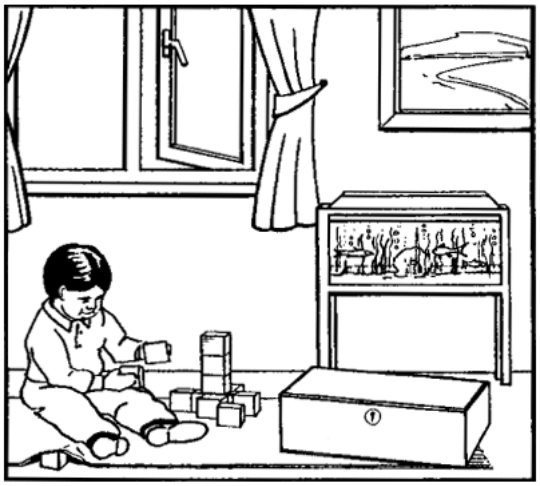
Give participants time to read the handout, and then make the following points.

- Sometimes models do not develop in sequences, and there may be alternative ways of looking at things. Energy presents us with just such a case.
- There are two ways of looking at and describing energy: one way is to talk of energy transformation or change; the other is to talk of energy transfer. Neither is wrong: they are simply alternatives, and in many ways both models are needed to help pupils develop their understanding of energy.
- The energy transformation model helps pupils 'see' the energy – some authors talk of 'putting on your energy spectacles'.
- The energy transfer model can be used to explain energy conservation and a range of phenomena such as why current is not used up in a circuit. The energy transformation model cannot do this.

Slide 4.8
Handout 4.9

Show **slide 4.8** to introduce Richard Feynman's analogy for energy and ask participants to read **handout 4.9**.

Slide 4.8



Dennis the Menace (Adapted from Richard Feynman) Handout 4.9

Imagine Dennis, who has blocks that are absolutely indestructible and cannot be divided into pieces. Each is the same as the other. Let us suppose he has 28 blocks.

His mother puts him with his 28 blocks into a room at the beginning of the day.

At the end of each day, being curious, she counts them and discovers a phenomenal law. No matter what he does with the blocks, there are always 28 remaining.

This continues for some time until one day she only counts 27 blocks, but with a little searching she finds one under a rug. She realises she must be careful to look everywhere.

The next day she can only find 26 blocks. She looks everywhere in the room, but cannot find them. Then she realises the window is open and the two missing blocks are found outside in the garden.

Another day, careful counts show there are 33 blocks. This causes considerable dismay, until she realises that Dennis's friend Bruce came to visit bringing his blocks with him and left a few.

She removes the five extra blocks and gives them back to Bruce, and all returns to normal.

- We can think of energy like this, except that there are no physical blocks.
- We can use this idea to track energy transfers during changes. At each transfer we need to be careful to look everywhere to ensure that we can account for all the energy.

Allow participants time to read the handout (about three minutes), then ask them to discuss the analogy with their neighbours. Why is this analogy thought to be a good one? Allow a few minutes for group discussion, then take brief feedback.

Make the following points.

- Richard Feynman, a Nobel laureate, was renowned for his ability to communicate scientific ideas.
- His idea of using bricks to represent little packets of energy, and looking carefully to locate all the energy, has been used by many teachers as a basis for an energy transfer model. The bricks set a limit on what can be transferred.

Task F

15 minutes

Slide 4.10

Show **slide 4.10** to introduce the task.

Using energy transfer to explain why current is not used up in an electric circuit

Slide 4.10

Modelling the electric circuit:

- the teacher holds a supply of small sweets;
- pupils form a ring (representing a circuit); each pupil has a paper cup; one pupil is asked to represent the bulb;
- the cups are passed round the circuit and the teacher places small sweets (two) in each cup as it passes the 'battery' (teacher);
- the 'bulb' eats a small sweet as it passes.

The moving cups represent the current or flow of electrons.

The small sweet represents a unit of energy.

The teacher holding the sweet packet represents the cell.

Organise participants to form a 'circuit' and carry out the modelling activity. See *Additional guidance* below for further details.

Make the following points.

- We can use the energy transfer model to explain why the current is not used up in an electrical circuit.
- While the majority of teachers use different forms of energy, such as chemical, heat and light, in descriptive terms, the energy transfer model helps us explain a range of phenomena, such as photosynthesis, absorption of light, conduction and convection, and radiation.
- Energy itself is difficult to define and it is important for us not to say that energy 'causes changes' or 'makes things happen': rather, it defines the limits of what is possible.

T

Additional guidance

This is an opportunity for participants to take part actively and learn a useful analogy. As tutor, you can take the role of the teacher. You will need some paper cups and a supply of small sweets. Ask a participant to represent the bulb and tell them to eat a sweet each time one passes. Ask questions: 'What does the cup

represent?', etc. Hopefully, at least one person acting as the wire will break the rules and eat a passing sweet. If you see this, ask the group, 'Did you see that? Do you think the wire would do that?' This should lead to a discussion about energy transfer by the wire to the air by heating. If you don't spot anyone (other than 'the bulb') eating a sweet, you could, and then invite discussion. Point out that this model can be developed further to model series and parallel circuits.

Invite participants to consider how they might extend the model, for example by using two teachers ('cells') to represent an increase in voltage, or what shortcomings there are in this model.

Plenary

10 minutes

Handout 4.11

Give out **handout 4.11**.

Summary and action points — **Handout 4.11**

Using models and analogies

What have you learned in session 4 that will help you in your planning and teaching?

What do you need to find out more about or study in greater detail?

Ask participants to reflect on the session and to complete the summary as fully as they can.

Explain that this, together with summaries from the other sessions, will enable them to complete the final evaluation and provide feedback on future training needs.

Slide 4.1

Objectives

- To establish the importance of models and analogies in understanding key scientific ideas
- To appreciate how models and analogies can be used effectively in teaching key scientific ideas

Slide 4.2

Models

- Scientific models – often pictorial but sometimes mathematical
- Teaching models – pictorial, three-dimensional, analogies, etc.

Slide 4.3

Developing sequences of 'good enough' models

- Introduce the scientific idea (e.g. particle theory) early in the key stage
- Use a clear teaching model to help pupils visualise the idea
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- Increase the sophistication of the model or change it as necessary

Slide 4.4

Encouraging pupils to identify the strengths and weaknesses in a model

Discuss the model and encourage pupils to:

- identify what each part represents;
- think about the strengths and weaknesses of the model and what it can and can't explain;
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Provide other models that are problematic and encourage pupils to:

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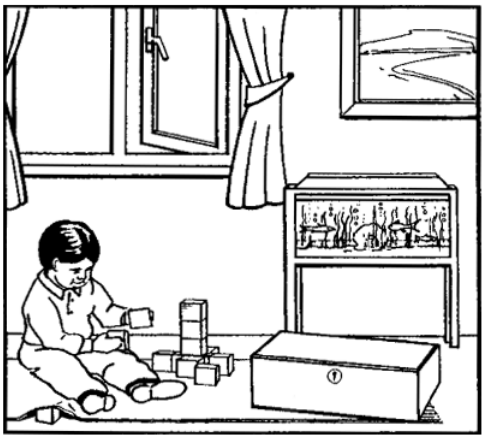
Slide 4.8



Slide 4.10

Using energy transfer to explain why current is not used up in an electric circuit

Modelling the electric circuit:

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Handout 4.6

Teaching science at Key Stage 3 using models and analogies: a summary

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Alternative models for teaching energy at Key Stage 3

Handout 4.7

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Typical language to use
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- pupils need to be aware that either energy transfer or energy transformation might be used in different text books, tests or examinations;
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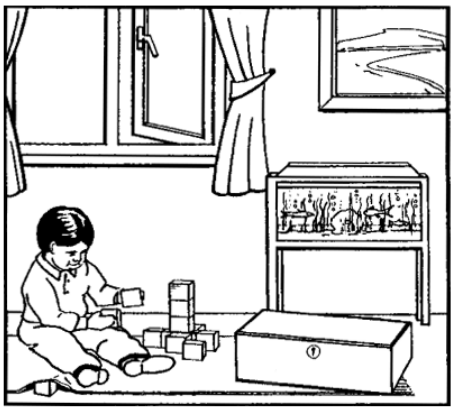
Dennis the Menace

Handout 4.9

(Adapted from Richard Feynman)



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His mother puts him with his 28 blocks into a room at the beginning of the day.

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Another day, careful counts show there are 33 blocks. This causes considerable dismay, until she realises that Dennis's friend Bruce came to visit bringing his blocks with him and left a few.

She removes the five extra blocks and gives them back to Bruce, and all returns to normal.

- We can think of energy like this, except that there are no physical blocks.
- We can use this idea to track energy transfers during changes. At each transfer we need to be careful to look everywhere to ensure that we can account for all the energy.

Six Easy Pieces by Richard Feynman (Penguin, 1998)

Summary and action points

Handout 4.11

Using models and analogies

What have you learned in session 4 that will help you in your planning and teaching?

What do you need to find out more about or study in greater detail?

Session 5

Scientific enquiry

Objectives

- To consider the place of scientific enquiry in the *Framework for teaching science: Years 7, 8 and 9*
- To examine the teaching of particular skills in the context of scientific enquiry

Resources

For tutor

Slides 5.1, 5.2, 5.5

For participants

Copies of all slides

Handout 5.3	Scientific enquiry
Handout 5.4	Enquiry skills
Handouts 5.6a–c	Planning posters
Handout 5.7	Using the scientific enquiry posters
Handout 5.8	Summary and action points

A3 laminated copies of the planning posters (one for every two participants)

Small sticky notes – two colours

DfES/QCA scheme of work for science

Framework for teaching science: Years 7, 8 and 9

Session outline

70 minutes

Introduction		10 minutes
An overview of the place of scientific enquiry in the National Curriculum	Talk	
Teaching and developing scientific enquiry skills		50 minutes
Participants will be shown how to specifically teach scientific enquiry	Talk	
Task G	Group talk	
Progression in scientific enquiry		
Activity for explicitly teaching scientific enquiry	Modelling	
Task H	Group work	
Plenary		10 minutes
Participants reflect on what they have learned during this session, how it will change their teaching and their future training needs	Reflection	

Introduction

10 minutes

Slide 5.1

Show **slide 5.1** and explain the objectives for this session.

Objectives — Slide 5.1

- To consider the place of scientific enquiry in the *Framework for teaching science: Years 7, 8, and 9*
- To examine the teaching of particular skills in the context of scientific enquiry

Slide 5.2

Show **slide 5.2**, which outlines some important features of scientific enquiry (Sc1). Participants will be familiar with this to some extent, so do not spend long on the slide. The reasons for drawing attention to these features are given below.

Features of Sc1 — Slide 5.2

The programme of study for scientific enquiry (Sc1) at Key Stage 3 emphasises:

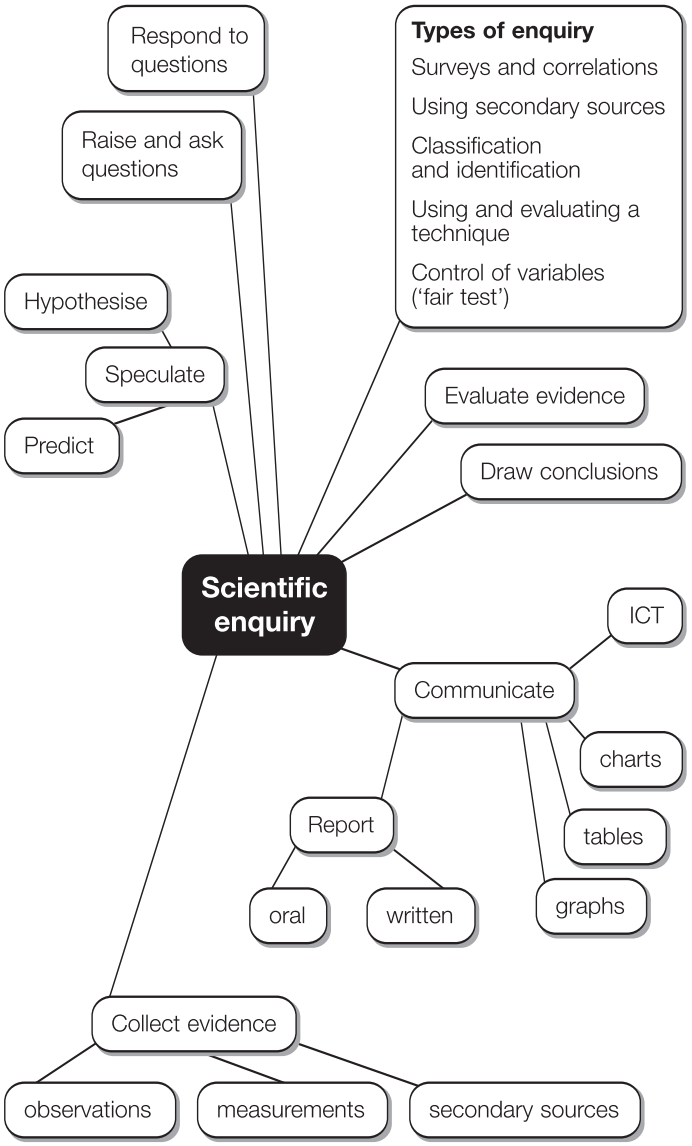
- 'ideas and evidence' based on statements about the 'nature of science' from the 1995 introduction to the programme of study and other statements about systematic enquiry;
- choosing an approach and what data are to be collected in order to answer a particular question;
- carrying out investigations using secondary data;
- the importance of evaluating the strength of evidence;
- clear communication, representing data in an appropriate way, particularly in quantitative work.

Make the following points.

- Statements about 'the nature of scientific ideas' are now more explicitly detailed in the 2000 programme of study, under the sub-heading 'Ideas and evidence'.
- Similarly, the requirements to use ICT are now more explicit in Sc1.
- There is more emphasis on deciding what approach and what data are appropriate for a particular investigation and how to collect reliable data, and less emphasis on fair testing.
- The breadth-of-study statement 'using first-hand and secondary data to carry out a range of scientific investigations, including complete investigations' (1e), and the programme-of-study statement 'decide whether to use evidence from first-hand experience or secondary sources' (2b) make it clear that investigations can make use of secondary data.
- The introductory statement emphasises evaluation of evidence, use of a wide range of resources and clear communication. There is a link with the first section of Sc1, 'Ideas and evidence'.
- There is also an emphasis on the importance of quantitative work.
- Sc1 should be taught in the context of Sc2, Sc3 and Sc4.

Scientific enquiry

Handout 5.3



Give out **handout 5.3** illustrating the range of activities that are part of scientific enquiry. Allow participants time to read the handout, then take any comments or questions.

Draw participants' attention to the different types of activities that can be part of a lesson containing scientific enquiry.

Make the following points.

- Pupils in Key Stage 3 will probably be most familiar with 'fair test' investigations.
- It is important that the various skills in scientific enquiry are planned for and that the lesson objectives for scientific enquiry are identified and shared with pupils.
- The many skills shown in handout 5.3 do not have to all be taught in each investigation.

Handout 5.4

Enquiry skills **Handout 5.4**

Focus of enquiry skills in different units of the DfES/QCA Key Stage 3 scheme of work for science

Surveys and sample size

Unit 7A Cells

Unit 7C Environment and feeding relationships

Unit 8D Ecological relationships

Using experimental models

Unit 8A Digestion

Unit 8G The rock cycle

Unit 8I Heating and cooling

Using and evaluating techniques

Unit 9K Speeding up

Unit 9M Water content of apples

Using secondary sources

Unit 7B Reproduction

Unit 7L Solar system and beyond

Unit 8L Sound

Recognising risks

Unit 7E Acids and alkalis

Teaching and developing scientific enquiry skills

50 minutes

Introduce this part of the session by explaining that participants will be considering some issues relating to the specific teaching of scientific enquiry.

Lesson objectives and scientific enquiry

10 minutes

Remind participants of the material covered in session 3 on lesson objectives and outcomes.

Task G

Ask participants in pairs to choose a unit from the DfES/QCA scheme of work for science. Ask them to select an objective for scientific enquiry and, using the same stems as they used in task E (session 3; handout 3.9), redraft the objective in a form that would be suitable for pupils.

Take feedback from a few pairs.

Make the following points.

Slide 5.5

Activity Slide 5.5

This part of the session will look at an activity that:

- forms part of a planned development of skills;
- focuses on one particular skill;
- has specific objectives for developing that skill.

- It is just as important to share lesson objectives for scientific enquiry with pupils as it is to share objectives linked to knowledge and understanding.
- Some aspects of Sc1 are more relevant to particular areas of science than to others. For example:
  - skills relating to carrying out surveys and looking for correlations are often important in Sc2 topics;
  - skills relating to working safely with hazardous materials are frequently required in Sc3 topics;
  - the need to make repeated measurements is particularly important in some Sc4 topics.
- The full range of enquiry skills is developed through the use of lesson objectives across all of the units in Key Stage 3.

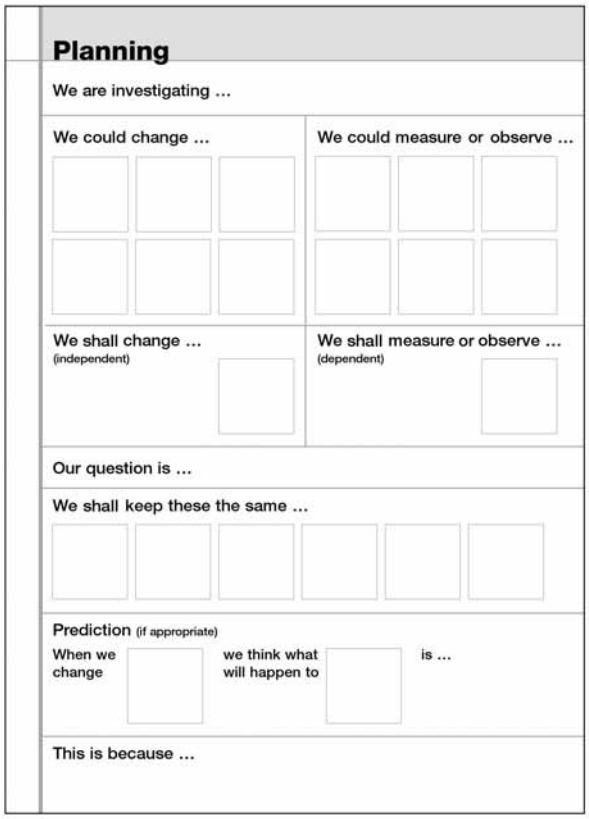
Science departments will have a health and safety policy, which should include a short brief about health and safety for supply and other temporary staff. Supply teachers should ask their head of science for a copy of the policy and for an opportunity to discuss any health and safety issues which might arise from the lessons they have been asked to teach.

Handout 5.4 provides examples of investigations that can be used to focus on developing particular enquiry skills. All these examples have been selected from the DfES/QCA exemplar scheme of work for Key Stage 3 science.

Handout 5.6

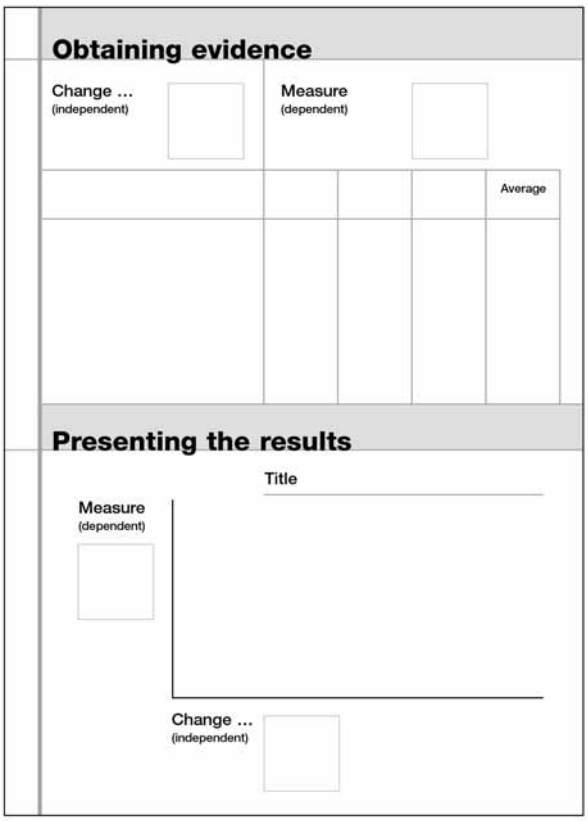
Planning posters

Handout 5.6a

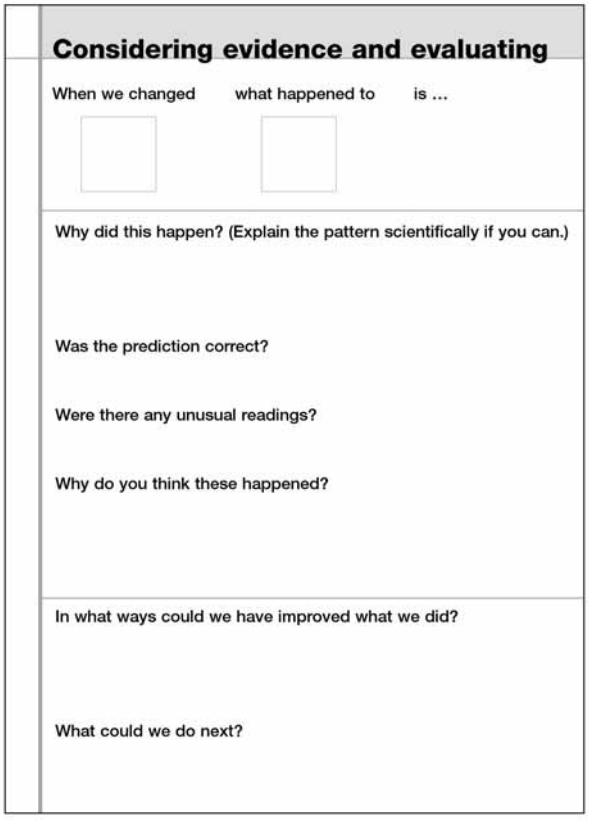


Planning posters

Handout 5.6b



Planning posters **Handout 5.6c**



Progression in scientific enquiry

10 minutes

Ask participants to refer to Appendix 2 in the *Framework for teaching science: Years 7, 8 and 9.*

Using one or more strands as examples, explain how to achieve progression.

Make the following point.

- The scheme of work a department uses should take account of progression in the teaching of the skills for scientific enquiry.

Give participants the opportunity to share their experiences of how scientific enquiry is planned in different schools they have worked in.

Activity for explicitly teaching scientific enquiry 30 minutes

This part of the session uses an example to show how skills can be taught. Use **slide 5.5** to introduce the activity.

Task H

Make the following point.

- Participants should check with the school whether a member of staff has attended the Strategy training 'Scientific enquiry', and whether the teaching strategy of using planning posters is used in the department, in particular, with the classes they will be teaching.

The task consists of a teaching and learning approach that has been developed for use with the whole class. It focuses on how elements of the planning process may be taught more effectively.

You will model the planning process, then participants will complete one or two examples of their own.

The investigation is designed to answer the question 'What is the best way to treat indigestion?' (linked to unit 7E 'Acids and alkalis').

Discuss how an investigation looking at the best way to cure indigestion might be introduced, for example by a discussion with pupils about digestion, what causes indigestion and what measures people take to cure indigestion.

If necessary, the discussion might include reference to the difference between antacid treatments (e.g. Alka Seltzer™) and agents that inhibit acid production (e.g. Zantac™).

Discuss other issues that might need to be raised with pupils. For example: 'We're only looking at antacids. We want to do a controlled test in the lab, and we're not using human volunteers. How can we reproduce conditions in the stomach?'

Introduce participants to the planning poster for a fair test investigation (based on materials produced by Anne Goldsworthy and Rosemary Feasey in the ASE publication *Making sense of primary science investigations*, revised edition 1997, and materials from AKSIS publications, modified for Key Stage 3). The planning poster is one of a series of three, and all have been included in this unit as **handout 5.6 (a–c)**.

Handout 5.7

Using the scientific enquiry posters **Handout 5.7**

Introduce the activity, which involves planning an investigation to answer a broad question. Discuss issues that might need to be pointed out to pupils, such as practical constraints of equipment, etc.

Introduce pupils to the planning poster for a fair test or comparison. On a sticky note, write the broad question for the investigation.

Now ask pupils to identify the factors that could be changed to find the answer to the question. Write each factor on a sticky note and stick the notes on the poster. (If they come up with more than six factors, just squeeze them on.)

Say to the class, 'If we change this' (the factor already identified) 'what can we measure or observe to see if this has made a difference?'. Here the pupils should identify the dependent factors. Write these on sticky notes of a different colour and stick them in the appropriate place on the planning poster.

Take the factor to investigate, and what to measure or observe, and move these sticky notes to the appropriate places on the planning poster.

At the same time, refine the question so that it is more focused on the planned investigation. Write the refined question on a sticky note and put it in the 'Our question is' box on the planning poster.

Ask the class, 'What do we need to keep the same to make it a fair test or comparison?'. They are likely to identify each of the factors still in the 'We could change' boxes in turn. Move the appropriate sticky notes to the 'We shall keep these the same' boxes as the pupils list them.

The sticky notes can be easily returned to their original positions to demonstrate the fair test or comparison stage again, by choosing to test a different factor. This helps more of the pupils to realise that only one factor is changed, while the rest are kept constant.

The sticky notes for the dependent and independent variables can be moved from the planning poster to the poster for obtaining evidence and presenting the results. In the first part, they provide clear guidance to pupils on how to organise their results table; in the second part, on how to structure a graph of the results.

Finally, the sticky notes can be moved to the poster for considering evidence and evaluating, to guide pupils towards a sentence expressing their conclusion. The other prompts on this poster help pupils to reflect on their investigation – to explain their findings and consider whether these were what they expected, and to think of improvements and extensions.

On sticky notes, write the broad question 'What's the best way to cure indigestion?'

Make the following points.

- At this stage a broad question, in which the definition of the word 'best' is left open, is used so that pupils can be involved in making decisions about the factors to be investigated.
- If we ask 'Which indigestion remedy works the quickest?', we have already identified for the pupils the two variables – type of remedy and time to

T

neutralise!

- It may be necessary to explain to pupils (especially in Year 7) that they need to identify and make decisions about two key variables:

  – what to measure or observe (output or dependent variable); and

  – what to change or alter that is under their control (input or independent variable).

- Ask the participants to identify what factors could be changed to find out the best way to cure indigestion. Write each factor on a sticky note and add them to one of the laminated posters.

Factors might include:

- type of remedy;
- quantity of remedy;
- type of acid;
- quantity of acid;
- whether the remedy is ground up or in tablet form;
- temperature;
- how long you leave it;

Handout 5.8

Summary and action points Handout 5.8

Scientific enquiry

What have you learned in session 5 that will help you in your planning and teaching?

What do you need to find out about or study in greater detail?

- whether you stir it.

The next stage is to identify what to measure or observe.

Make the following points.

- If we ask pupils 'What can we measure?', they will repeat some of the factors identified above.
- We want to elicit the dependent variable. What we say to pupils at this stage is important.
- We say 'If I change one of these things' (the factors already identified), 'what can we measure or observe to see if it has made a difference?'.

Here the participants should identify factors such as:

- the time to neutralisation of the acid;
- the one that becomes the most alkaline (highest pH);
- whether litmus turns blue (change from acid to alkaline pH).

These outcomes should be written on sticky notes of a different colour and stuck on the appropriate place on the planning poster.

Slide 5.1

Objectives

- To consider the place of scientific enquiry in the *Framework for teaching science: Years 7, 8, and 9*
- To examine the teaching of particular skills in the context of scientific enquiry

Slide 5.2

Features of Sc1

The programme of study for scientific enquiry (Sc1) at Key Stage 3 emphasises:

- 'ideas and evidence' based on statements about the 'nature of science' from the 1995 introduction to the programme of study and other statements about systematic enquiry;
- choosing an approach and what data are to be collected in order to answer a particular question;
- carrying out investigations using secondary data;
- the importance of evaluating the strength of evidence;
- clear communication, representing data in an appropriate way,

Slide 5.5

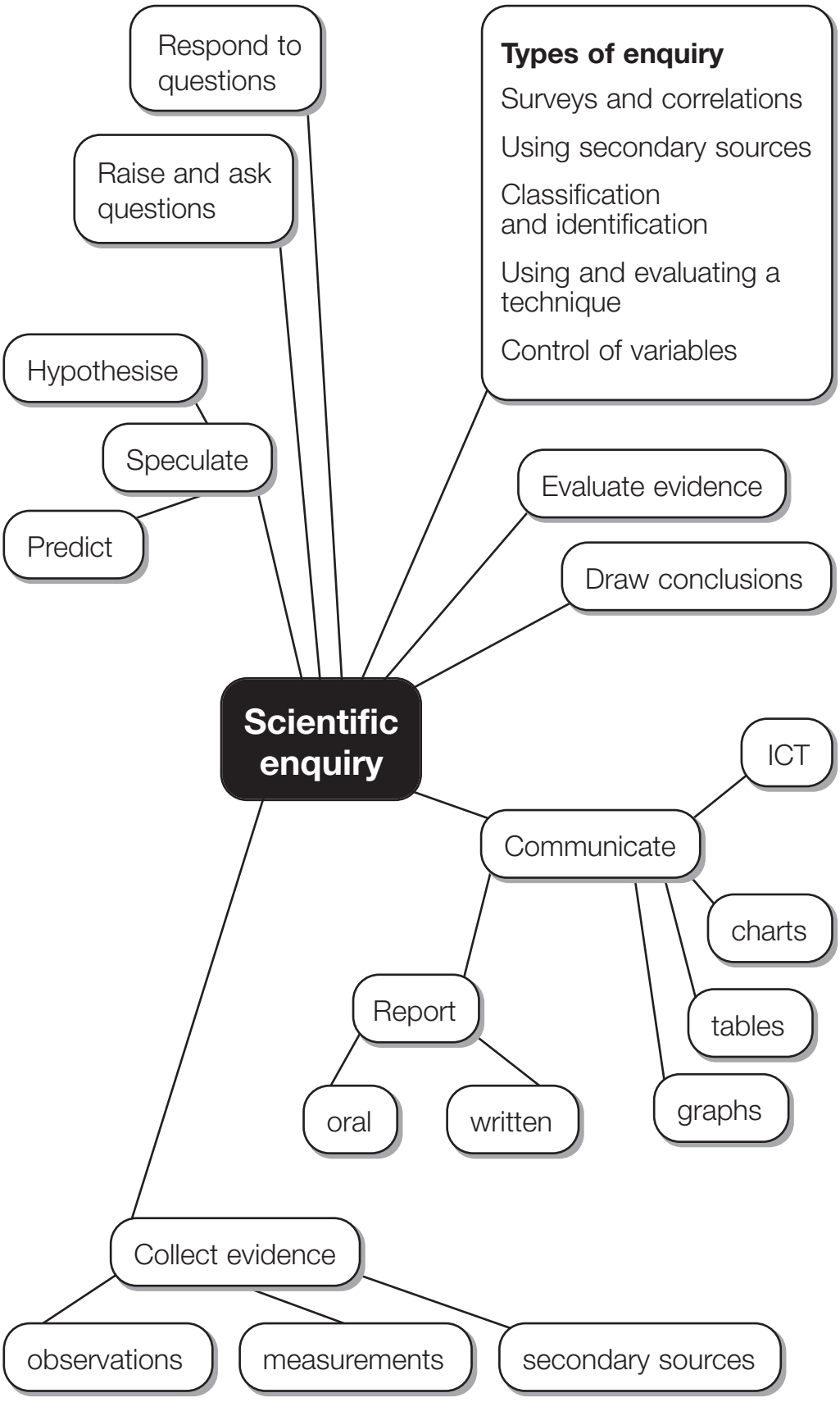
Activity

This part of the session will look at an activity that:

- forms part of a planned development of skills;
- focuses on one particular skill;
- has specific objectives for developing that skill.

Scientific enquiry

Handout 5.3



Enquiry skills

Handout 5.4

Focus of enquiry skills in different units of the DfES/QCA Key Stage 3 scheme of work for science

Surveys and sample size

Unit 7A Cells

Unit 7C Environment and feeding relationships

Unit 8D Ecological relationships

Using experimental models

Unit 8A Digestion

Unit 8G The rock cycle

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Unit 9K Speeding up

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Unit 7B Reproduction

Unit 7L Solar system and beyond

Unit 8L Sound

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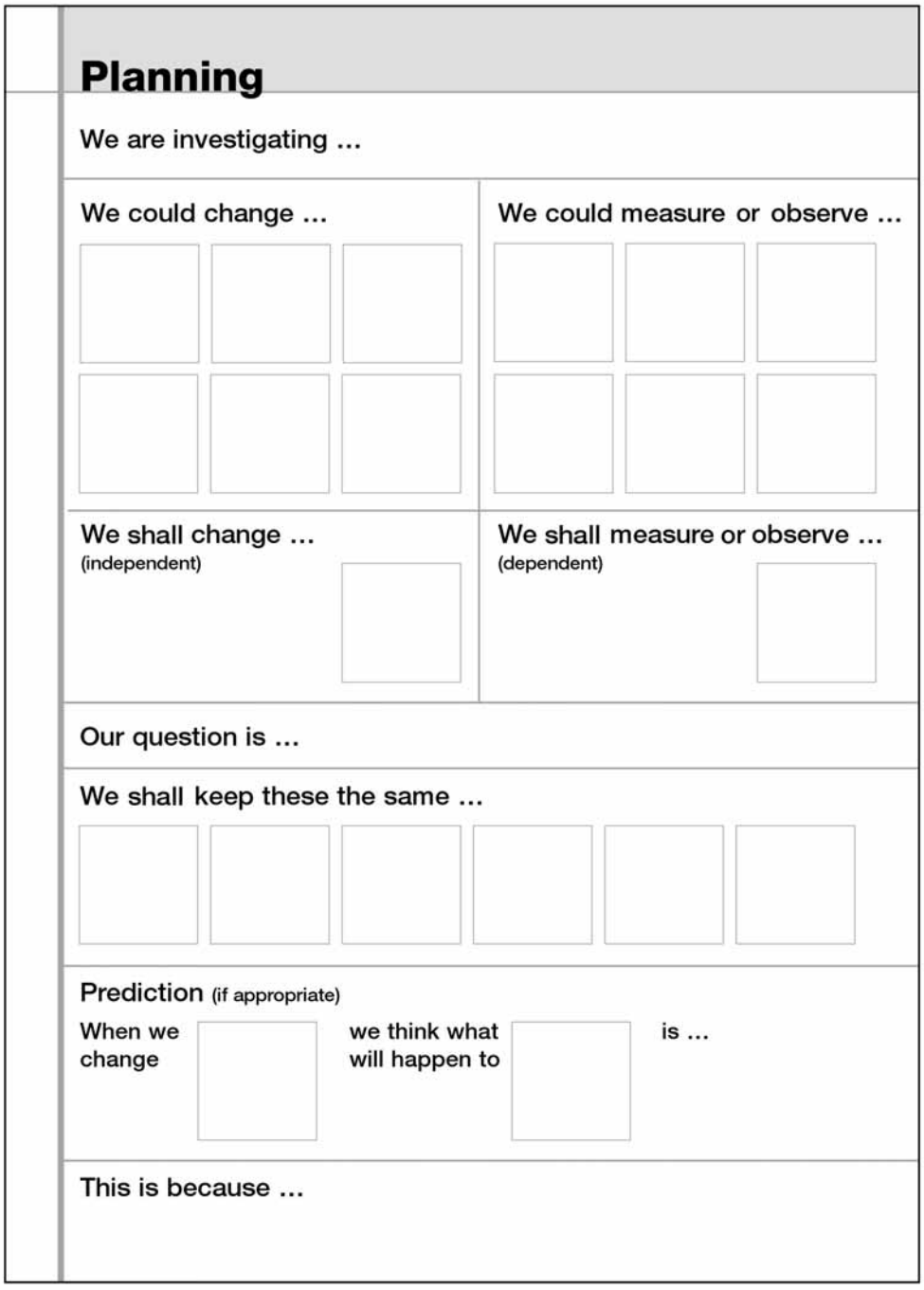
Unit 7E Acids and alkalis

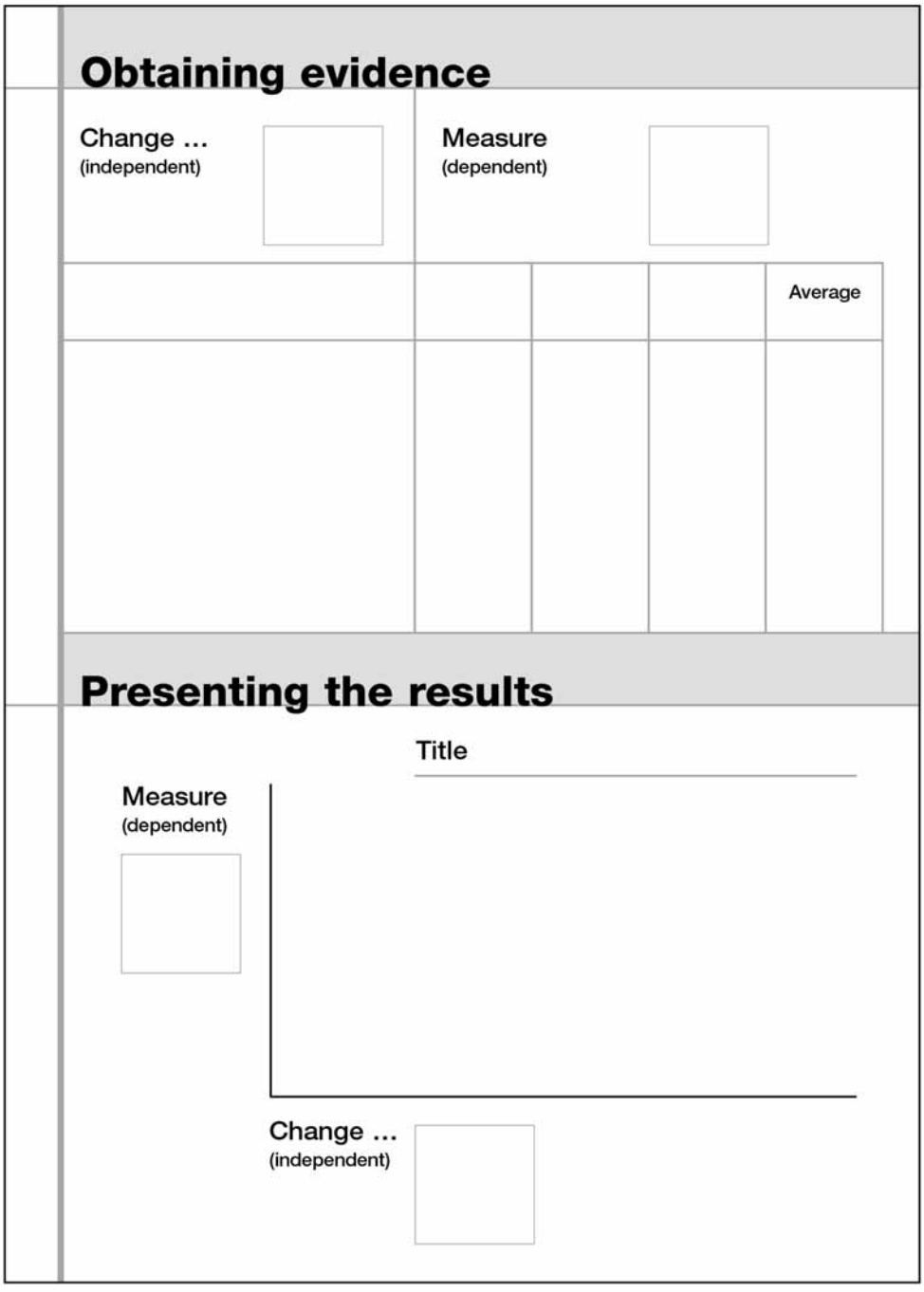
Planning posters

Handout 5.6a



Planning posters

Handout 5.6b



Planning posters

Handout 5.6c

Considering evidence and evaluating

When we changed ____ what happened to ____ is ...

Why did this happen? (Explain the pattern scientifically if you can.)

Was the prediction correct?

Were there any unusual readings?

Why do you think these happened?

In what ways could we have improved what we did?

What could we do next?

Using the scientific enquiry posters

Handout 5.7

Introduce the activity, which involves planning an investigation to answer a broad question. Discuss issues that might need to be pointed out to pupils, such as practical constraints of equipment, etc.

Introduce pupils to the planning poster for a fair test or comparison. On a sticky note, write the broad question for the investigation.

Now ask pupils to identify the factors that could be changed to find the answer to the question. Write each factor on a sticky note and stick the notes on the poster. (If they come up with more than six factors, just squeeze them on.)

Say to the class, 'If we change this' (the factor already identified) 'what can we measure or observe to see if this has made a difference?'. Here the pupils should identify the dependent factors. Write these on sticky notes of a different colour and stick them in the appropriate place on the planning poster.

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The sticky notes for the dependent and independent variables can be moved from the planning poster to the poster for obtaining evidence and presenting the results. In the first part, they provide clear guidance to pupils on how to organise their results table; in the second part, on how to structure a graph of the results.

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Summary and action points

Handout 5.8

Scientific enquiry

What have you learned in session 5 that will help you in your planning and teaching?

What do you need to find out about or study in greater detail?

Session 6

Plenary

Objectives

- To reflect on the unit and the impact it will have on participants' teaching
- To identify future training needs

Resources

For participants

Handout 6.1 Summary and action points

Evaluation form

Session outline

15 minutes

Reflection Participants reflect on what they have learned, changes they will make to their teaching and what their future training needs are	Individual reflection Group work	10 minutes
Evaluation Participants complete the evaluation form	Individual reflection	5 minutes

Reflection

10 minutes

Handout 6.1

Ask participants to complete **handout 6.1**. They should use the summaries they have produced at the end of each of the earlier sessions.

Summary and action points — **Handout 6.1**

What have you learned today that will help you in your teaching?

What changes will you make to your teaching as a result of today's training?

What other training do you need in Key Stage 3 science?

Organise participants in pairs and ask each participant to share with their colleague at least one change that they intend to make to their teaching as a result of the training.

Ask participants to share with the whole group their future training needs for Key Stage 3 science. You will need to make a note of these to enable you to complete the evaluation summary form.

Evaluation

5 minutes

Ask participants to complete and return the evaluation form.

Summary and action points

Handout 6.1

What have you learned today that will help you in your teaching?

What changes will you make to your teaching as a result of today's training?

What other training do you need in Key Stage 3 science?

Key Stage 3 National Strategy: key messages from the science supply teachers' training

This leaflet is for teachers who were unable to attend the national training and it summarises the main points.

Other Key Stage 3 National Strategy materials can be found on the website at www.standards.dfes.gov.uk/keystage3.

About the Key Stage 3 National Strategy

The Strategy aims to raise standards by strengthening teaching and learning across the curriculum for all 11–14-year-olds.

Some myths about the Key Stage 3 National Strategy

It's compulsory. It's not. But you have to be confident that you have something just as strong and detailed.

It expects the earth tomorrow. It doesn't. It expects a commitment to improve and realistic action points to bring it about. The package of material is substantial and teachers are invited to select what they need.

They think we're doing a bad job. No one thinks that, but education needs a way of identifying, sharing and supporting the best practice. An honest look at the videos and training will tell you that the ideas represent the best practice in schools, even in challenging situations.

It's all political – just a way of meeting the targets. Targets refer to numbers of pupils who improve, so it may be no bad thing to have them. It's true that education enjoys political priority at the moment, and that there is money available to raise standards. That's why we have to be quick in getting the best practice into the system. The Strategy is not run by politicians but by professional staff, every one of whom has been a teacher.

It's prescriptive. It's not. Schemes of work prescribe what goes on in the classrooms, but this is not what the Strategy does. The Strategy offers scaffolds for planning in the form of frameworks. It offers training in the principles and practices that are known to work, and consultants to help you to tailor and interpret the ideas in your own school.

Key Messages from the unit

The Framework for teaching science: Years 7, 8 and 9

The Framework is a key document for science teachers, and every science teacher needs their own copy. It was developed during the science pilot and can help you to:

- plan the teaching of scientific enquiry (pages 11–13);
- understand the five key scientific ideas that underpin Key Stage 3 science (pages 14–22);
- ensure progression (pages 22–30);
- teach effective lessons (pages 37, 41–47);
- get to grips with assessment (pages 49–53);
- include all pupils in science lessons (pages 55–63);
- introduce scientific vocabulary more systematically (pages 73–77).

Effective science lessons

The three-part lesson (default model) is an effective model for teaching science. Starter activities and plenary sessions need to be planned. When used effectively they improve learning.

Using models and analogies

The use of appropriate models and analogies can improve pupils' understanding of key scientific ideas. The models to be used in teaching should be agreed within a department.

Scientific enquiry

The skills pupils need to develop to ensure an understanding of scientific enquiry need to be explicitly taught. These skills need to be identified in the scheme of work and in short-term planning as lesson objectives.

Implications for supply teachers

- You need to ensure that you are informed of the models and analogies the department has agreed to use.
- Check where and when skills for scientific enquiry are taught.
- If the school is an additional support school, ask to see the summaries of the key messages teachers have brought back from their training.
- If you are on long-term supply, ask about the possibility of accessing training and consultant support.

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