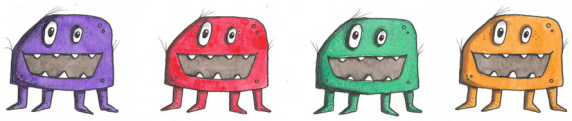
Primary Science Skills and How to Teach Them

Getting to Grips with Scientific Enquiry



Sample Pack

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Introduction to the series

Scientific enquiry is essentially a thinking process. For children to undertake effective science enquiries in the classroom, they need to know how to collect useful data and how to interpret them. Simply meeting science skills during practical activities is rarely enough for them to be learned and embedded.

Primary Science Skills and How to Teach Them has been developed for children aged 7 – 11. It is based on two books written by Anne Goldsworthy, Rod Watson and Valerie Wood-Robinson. Originally created for children aged 9-13, *Getting to Grips with Graphs* (1999) and *Developing Understanding* (2000) were the outcomes of the AKSIS project: a three-year research collaboration between the Association for Science Education and King's College London, funded by the Wellcome Trust.

Building on the more open-ended, exploratory approach of lower primary, *Primary Science Skills and How to Teach Them* provides teachers with simple strategies and short activities to support upper primary children (aged 7-11) to develop a range of disciplinary knowledge and skills, which can subsequently be applied in their own scientific investigations. The materials cover the skills required at each stage of a scientific enquiry and are mapped to different scientific enquiry types, providing teachers with a comprehensive choice of activities.

Sample Pack

This sample pack contains exemplar pages from the teacher notes and children's activities from Units 1 and 2 of the series.

Contents:

Sample pages from Unit 1

Sample pages from Unit 2

Unit 1

Encouraging Exploration

About this unit

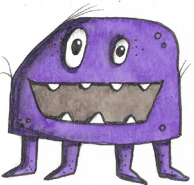
Before planning the detail of a scientific enquiry, children need to focus on the context of the enquiry.

Module 1 suggests different ways of involving children in initial explorative practical activities. Providing plenty of opportunities for children to experience things in a hands-on way will encourage and increase their curiosity. This also allows them to get a feel for what they are about to study. Too often, little time is spent on this focusing stage. However, when children do get immersed in exploratory work, they usually become more motivated and make greater sense of their enquiry.

Suggesting an idea or raising a question is the starting point of a scientific enquiry. Whilst children may not do this for every enquiry, they need some opportunities to offer their own ideas and ask their own questions. Without a stimulus, children do not often raise questions or offer their own ideas for science enquiry. **Modules 2, 3 and 4** suggest teaching strategies that support children who do not find it easy to devise their own questions. In **Module 2**, close observation of topic samples helps children to think about similarities and differences and pose questions about how these might apply to further samples. **Module 3** looks at how the way that teachers phrase questions can influence children's generation of ideas, while **Module** 4 explores using texts to promote curiosity about science themes.

Health & Safety Guidance

Reasonable care has been taken to ensure that activities in this publication do not suggest practices that might be dangerous, and safety warnings are given where appropriate. However, ASE has not tested the activities suggested and can therefore give no guarantee of safety. For further advice on health and safety matters in primary science education, see 'Be Safe! Health and Safety in School Science and Technology for Teachers of 3- to 12-year-olds' (4th edition, ASE, 2011).



Module 1 – Trying Things Out

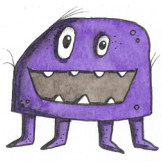
Learning Objective:

To engage children's interest and allow them to experience phenomena before starting a scientific enquiry.

Background Information:

Before children begin planning a scientific enquiry, it is a good idea to raise their interest in what they will be investigating through initial explorative activities.

As well as motivating them, such an explorative, practical approach can help them make better attempts at planning an investigation. They can make relevant observations, pick up clues about variables involved and get a feel for other issues such as timescale and quantities. They also have an opportunity to clarify their scientific knowledge.



Activity 1a – Soils

What to do

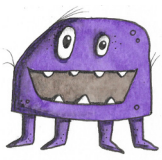
Source two different soil samples for children to investigate. Children may wish to bring in their own soil sample from home. Each pair will need a handful of both soils. (If finding different samples proves difficult, use commercial topsoil, which can be bought from a garden centre, to compare with a local soil sample from the school grounds or a garden.) Children will also need hand lenses.

Ask children to use the prompts to explore the soils, completing the table as they work.

As a class, share children's observations and thoughts on why there are differences.

Use this as a starting point for children to research what soil is made from, how it is formed and how that affects its properties and use.

* Please refer to health and safety guidance when working with soils.



Activity 1a – Soils

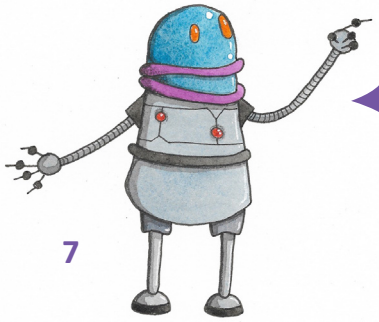
You are going to explore different soils.

What is the same?

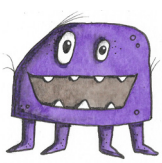
What is different?

Work in pairs to answer the questions and complete the table below:

	Soil 1	Soil 2
How does the soil look? How big are the grains? What colour are the grains?		
How does the soil feel? a) Take a handful of soil and squeeze it – is it dry, moist or wet?		
How does the soil feel? b) Rub some between your fingers with some water – does it feel gritty or smooth?		
What else did you find in the soil? e.g. plant matter, worms, stones, other materials.		
Do you notice any other differences?		



Why do you think there are differences?



Strategy – Comparing and contrasting

Leaf example

What to do

Children will need to see the same two leaves to examine closely, e.g.

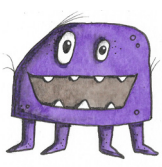
This can be through a photo, or real examples of each per pair. Real samples are always preferable as more senses can be used when observing, and children can also get a better sense of size.

- Hand out the Activity Sheet. (See end of Module 2 for template.)
  You will need one for each pair.
- Tell the children that they are going to focus on making careful observations to help them think of some questions to investigate.
- Ask the children to complete the table, observing both samples and spotting differences and similarities*.
- Take in responses from groups and record on a copy of the activity sheet each time, for example:

They both have:
■ One main vein along the centre of the leaf
■ Side veins coming from the main vein in pairs
■ Green stem
■ Light green underside

Only this has:
■ Smooth, waxy surface
■ Spikes
■ Two colours

Only this has:
■ One colour
■ Toothes edges
■ Spear shape



- Work with them to turn their observations into questions that can be investigated,

e.g. using the 'They both have…' facts:

Both of our examples have x, so…

- Do all leaves have one main vein running along the centre of the leaf?
- Do all leaves have side veins coming from the main vein in pairs?
- Do all leaves have a light green underside?
- Do all leaves have a green stem?

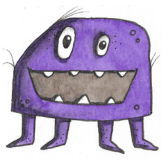
e.g. using the 'Only this has…' facts:

Only one of our leaves has x and y, so…

- Do all smooth, waxy leaves have two colours?
- Are all spiky leaves smooth and waxy?
- Are all tooth-edged leaves spear-shaped?
- Are all tooth-edged leaves one colour?

- Discuss how these questions might be answered through observing more samples or through research. Ensure that children realise that it would be very easy to find evidence to answer the questions with 'No' – it would only take one leaf that did not fit the description. However, it would be harder to answer questions with a 'Yes'. Discuss how many leaves children would have to observe to feel confident enough to do this.

*Illustrated vocabulary sheets can be used to help children describe samples.



Unit 2

From Questions to Enquiry

About this unit

There are many ways to collect scientific evidence about the world around us. Different scientific enquiries require different strategies for planning and evaluating. Children need to know about some of the main ways of collecting evidence so that, when faced with a variety of questions, they can suggest an appropriate approach.

Module 1 helps children to recognise some of the approaches that are available to use in their enquiries and to choose an appropriate approach. They are also asked to consider which questions cannot be tackled through any type of scientific enquiry.

Following on, **Module 2** suggests strategies to help teachers deal with the large number of questions created when children are given free rein to generate their own questions, allowing them to answer as many of their own questions as is practical in class or at home.

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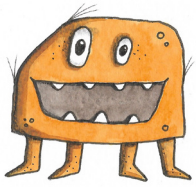


Module 1 – What kind of question, what kind of enquiry?

Learning Objective:

To identify questions that can be addressed through scientific enquiry and to choose the appropriate kind of enquiry.

Background Information:

Children need to know something about the main categories of scientific enquiry so that, when faced with questions, they can suggest an appropriate approach.

For example, if they are finding out more about minibeasts, they may have a range of questions and how each is answered will depend on the nature of the question. For example, 'Where do ants live?' – this could be answered through first-hand exploration.

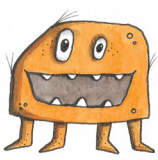
'Do woodlice prefer dark places or light places?' – this could be answered through a comparative test enquiry.

'How do caterpillars change?' – this could be answered by observing over time.

'Are spiders in other countries different from spiders at home?' – this could be answered through researching online.

Children also need to recognise that some questions cannot be addressed through scientific enquiry; for example, responses to questions of opinion depend on aesthetic, emotional or other criteria, e.g. 'Are moths beautiful?'

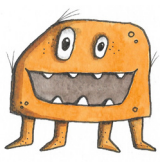
This module aims to give children an opportunity to suggest ways of tackling a range of different questions.



Activity – What kind of question, what kind of enquiry?

What to do

- Choose which set of questions you want your class to use.
- Copy the Question Cards (pages 10-13) and cut out the questions to make sets of cards. Include two or three blank cards in each set. You will need a set for each group.
- Prepare copies of the How We Can Find Answers headings (page 9) and Activity instruction sheet (page 8) for the activity – you will need a copy for each group.
- Sort the class into groups of three or four children, giving each group a set of Question Cards, How We Can Find Answers headings and an Activity instruction sheet.
- Ask children to decide how they could find answers to the questions. Make it clear to children that, unlike in most lessons, they are not being asked to answer the questions on the cards. Children should be aiming for the approach that is the most practical and the most effective. *Full descriptions of each enquiry type can be found on p.20.
- Let them discuss the Question Cards, in groups, for about 15 minutes.
- Ask children to stick the cards under the relevant How We Can Find Answers headings on a large sheet of paper.
- If they have time, children could add their own questions about the topic by writing on the blank cards.
- Collect and compare children's ideas and discuss similarities and differences in the groups' arrangements. Discussion of the diverse answers is as valuable as coming to a consensus.



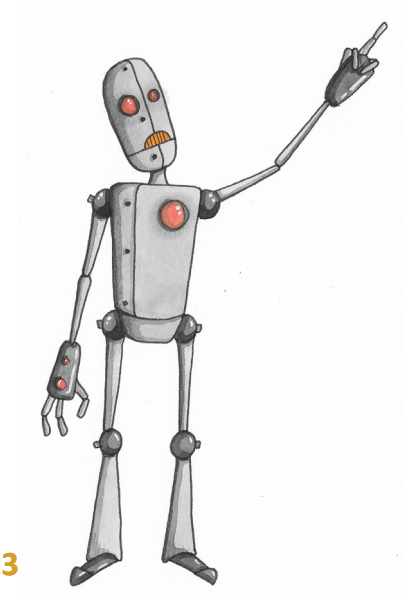
Activity – What kind of question, what kind of enquiry?

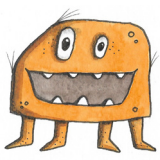
Read the question cards

This task is different from most lessons: do not try to answer the questions!*

- In your group, decide which approach you would use to answer each question, using the **How We Can Find Answers** cards to help. You should choose the most practical and effective method.
- Group the **Question Cards** using the **How We Can Find Answers** headings.

  *Warning – some cannot be answered through scientific enquiry.
- If you have time, write some more questions about the topic on blank cards.
- For each new question, decide how you could find out the answer.
- Be ready to share your ideas with the class and to explain why you put each question under its heading.





Activity – What kind of question, what kind of enquiry?

How can we find answers?

Comparative and Fair Testing
Change one variable and observe or measure the effect on something else while keeping all other variables the same.

Pattern-seeking
Do a survey or keep a record of a lot of examples to see if you can spot a link between what is changing and what is being measured/observed when other variables cannot be kept the same.

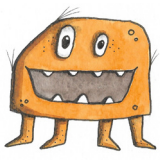
Identification and Classification
Match a specimen to something with a name, group things or allocate a specimen to a defined group. This may be a real specimen or a description or picture of one.

Research
Look it up in an information text or online or ask somebody who knows about it *if there is no way of finding out through first-hand, practical enquiry.* The source must be reliable.

Observation Over Time
Observe or measure how something changes. You may need to observe or measure over a short time or a long time. It may be 'remote' observation by studying a film.

Exploration
Explore and try to observe it yourself. Equipment may be needed.

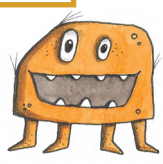
Cannot be answered through scientific enquiry
This question cannot be answered through scientific enquiry.



Activity – What kind of question, what kind of enquiry?

Question Cards – Magnets

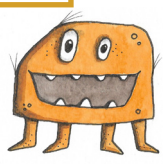
Which part of a magnet are things attracted to?	Are bigger magnets better?
What do people use magnets for?	What materials are attracted to magnets?
How are magnets made?	Are bigger magnets stronger?
Are all metals attracted to magnets?	If we magnetise a pin, how long does it stay magnetised for?
Can magnets attract things without touching them?	How does a magnet work?
What do magnets repel?	Does the shape of a magnet affect how strong it is?



Activity – What kind of question, what kind of enquiry?

Answers – Magnets

Which part of a magnet are things attracted to? Explore – testing with a range of magnets and a magnetic material	**Are bigger magnets better?** Cannot be answered through scientific enquiry – 'better' needs defining
What do people use magnets for? Research – children could look for uses in the home and beyond	**What materials are attracted to magnets?** Classification – test materials with a magnet to assign to a group
How are magnets made? Research	**Are bigger magnets stronger?** Pattern-seeking – test a range of magnets: number of paperclips held in a chain, distance paperclip attracted from or thickness of material that magnet works through
Are all metals attracted to magnets? Research or classification – test metals with a magnet to assign to a group	**If we magnetise a pin, how long does it stay magnetised for?** Observation over time
Can magnets attract things without touching them? Explore – slowly move magnets towards metal objects or try moving metal objects through a solid such as a table top	**How does a magnet work?** Research
What do magnets repel? Explore – observe what happens when like poles and opposite poles are placed together	**Does the shape of a magnet affect how strong it is?** Comparative test – test a range of magnets: number of paperclips held in a chain, distance paperclip attracted from or the thickness of material that magnet works through



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Disclaimer

ASE advises teachers to refer to either the CLEAPSS website or SSERC website for up-to-date health and safety information when planning practical activities for children.

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