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Published by Hopscotch, A Division of MA Education Ltd,
St Jude's Church, Dulwich Road, Herne Hill, London SE24 0PB
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Series design by Blade Communications

ISBN 1-978-1-904307-90-7

Thinking skills and Science

The aim of this book is to make more explicit the role of thinking skills in the teaching and learning of science for children aged five to 11 years.

Thinking skills underpin good primary practice in all subject areas. Promoting these skills helps to empower young children to become independent learners and to prepare them for taking up their role as well informed, constructively critical citizens.

A vital part of developing using thinking skills in any subject is to set aside time for free ranging discussion. With the constraints of the modern curricula it is often this time that is shaved thinly or even left out completely. There needs to be time for quiet thought. Often children staring into the middle distance are likely to be taken to task for suspected indolence! Yet very few people are capable of thinking on their feet all the time. They need to pause and take stock, then re-plan before continuing with the task. There can be no effective 'doing' without 'thinking'.

It is essential to work with the children to help them to build their confidence and self-esteem. To achieve this they will need to be supported when they try out new experiences. They must feel safe to express their thoughts and realise that it is perfectly acceptable for them to be wrong, as long as they try to learn from their errors.

There are five main thinking skills that are being taught through the activities in this book:

Information-processing skills (IP)

These are concerned with the identification of relevant information and its acquisition. The information can then be sorted, classified and organised into sequences. It can be compared and contrasted and any relationships analysed.

National Curriculum links

KS1: Sc1 2a
KS2: Sc1 2a

Reasoning skills (R)

Children must come to decisions after drawing inferences and making deductions from information gathered from books or experiments. They should be encouraged to give reasons for their opinions and actions.

National Curriculum links

KS1: Sc1 2h, 2i, 2j
KS2: Sc1 2i, 2j, 2k, 2l

Enquiry skills (En)

This is part of the implementation part of the process. The children should be encouraged to ask relevant questions and to pose and define problems. This will lead them into the realm of planning exercises which include prediction of outcomes, anticipation of consequences and testing and improving of ideas.

National Curriculum links

KS1: Sc1 2b, 2c, 2d
KS2: Sc1 1b, 2b, 2c, 2d

Creative thinking skills (CT)

Further implementation occurs when children generate their own ideas, extending them and producing hypotheses. They should also be able to seek out alternative and innovative outcomes.

National Curriculum links

KS1: Sc1 1a
KS2 Sc1 2a

Evaluation skills (Ev)

This is concerned with the children being able to judge the value of what they read, hear and do and of other people's work and ideas.

National Curriculum links

KS1 Sc1 2i, 2j
KS1 Sc1 2l, 2m

In this book the thinking skills are highlighted and practised through simple non science-based activities before moving on to the science activities. This enables the children to apply what they have learned to the science task.

Science is essentially a practical subject. It is often best to acquire thinking skills through seeing or doing experiments. We should remember the old maxim:

I hear, I forget
I see, I remember
I do, I understand

The thinking skills are not mutually exclusive. Each suggested lesson targets just one aspect of one of the five skills, although the others may be involved. Suggestions for ways to access these other thinking skills are made in each chapter.

Using notebooks

Every child should have a science notebook. The exact type is unimportant. It could be a spiral bound shorthand pad, a cheap exercise book or even an old diary.

The notebook should be entirely for the child's use and not used for assessment. For that reason the writing in it can be untidy and abbreviated and interspersed with drawings and diagrams. What it will provide is a sense of permanence and form to the science activities as well as being a paper memory.

All important scientists keep a notebook in which they record thoughts, ideas and observations. They are never intended for publication. It is known that Charles Darwin made rough notes and sketches for many years before he launched his evolutionary theories. Perhaps this shows the importance of notebooks. Through them thinking is improved, patterns begin to emerge and ideas reach a new clarity.

Many children believe that the thinking process is merely a matter of waiting for inspiration. They need to be shown that thinking has to be developed through planning and the recording of ideas and reasons.

Drawings are a good way of recording, as they do not require the same level of language as the use of written descriptions. The child can express more complex ideas with greater facility for, if recording becomes a chore, it can stand in the way of progress.

One measure of discipline in the use of notebooks should be encouraged. Any entry needs to be titled and dated. It is easy to forget the reasons why a column of figures were recorded. In the case of experimental results, the child may add a simple note of the conditions under which it was performed. At a later date these may be important.

When children are aware that their notebook will be personal to them, they will lose many of the inhibitions they may have in its use. The teacher's side of the arrangement is to respect this privacy and to avoid critical examination of what has been written. If this respect is shown, the child will be enabled to test out their thinking and learn how to improve it.

About this book

This book contains three lesson plans for each of the years from Year 1 to Year 6.

The book aims to:

- develop children's thinking and science skills through diversified and challenging activities;
- support teachers by providing examples of how to incorporate thinking skills into science lessons so that they can then apply these ideas to other lessons and subjects;
- encourage enjoyment and curiosity as well as develop skills of interpretation and response.

Each lesson contains:

- **Science aims –** this lists the science aims for the lesson.
- **Thinking skills aims –** this lists the thinking skills aims for the lesson.
- **Organisation** and **Resources –** these outline the resources needed and how the children can be grouped.
- **Introductory thinking skills** activity – this provides the teacher with a non-science example of how to introduce and practise the thinking skill that will be explored in the science lesson. It is important for the teacher to read this section through carefully before planning the lesson.
- **Teaching tips: Science –** this provides important background information for the teacher in carrying out the lesson. It may also help the teacher to answer any questions the children may have about the outcomes of the lesson.
- **The science task –** this suggests how the teacher could carry out the lesson and often includes relevant questions to ask the children.
- **Other thinking skills appropriate to this topic –** this provides the teacher with ideas for developing the lesson further.
- **Ideas for further work –** this provides the teacher with ideas for further lessons or extension work.
- **Safety note –** some lessons may require a safety note that reminds the teacher of any hazardous issues that may arise during the lesson.

Each lesson is also accompanied by several photocopiable pages. Some of these pages relate to the non-science part of the lesson where the children are being introduced to the particular thinking skill for that lesson. The other pages relate directly to the lessons themselves. Some of these are information pages and others are used for recording. All the pages are presented as suggestions only and the teacher may choose to prepare his/her own resources for each lesson instead.

Although there are only three sample lessons for each year group, the approaches and ideas used in one year group could easily be adapted and applied to a different topic in another year group. This makes the book very versatile and can be relevant to any teacher across the Key Stages.

Growing plants

Information-processing skills: Analysing Relationships

Science aims

- To make careful observations of plants and to record these in a simple chart or table
- To conclude that plants need water to grow
- To conclude that green plants need light to grow well

Thinking skills aim

- To work out the relationships between external factors and outcomes

Organisation

Small groups

Resources

- Photocopiable pages 8 and 9
- 7 plants (such as potted geraniums) of a similar size and condition
- Measuring jug, water
- Box
- Measuring tapes, rulers

Introductory thinking skills activity

Explain that things that happen (external factors) can affect the way other things have to change (outcomes). Divide the class into small groups and ask them to think about the following situation: Three children have planned to go on a picnic. They are ready to go when it starts to rain. How might their plans have to change? Encourage them to think beyond simply stating that they would not be able to go. Prompt them by asking questions such as "What will happen to the picnic food?", "Will their parents know where they are?" and "How heavy is the rain?". In this example the rain is the external factor and what they decide to do are the outcomes. Discuss the groups' ideas and share them with the class.

Ask the children to think about any plants that they have at home. Where are they (garden, bathroom, living room and so on)? What is done to care for them? They should try to remember what happens if they are not cared for properly. In the plant growth experiment, what are the external factors? What are the outcomes of using them? (In other words, how will they affect plant growth?)

Teaching tips – Science

The water experiments can be carried out on any plants, but for comparisons including the light experiments, green plants are best. Green plants are those that have leaves. The plants chosen will depend on the time of year. Trays of cress from a supermarket are always obtainable. Pansies or primroses are good to use in spring. Potted geraniums are larger, so may be more visible for whole-class work.

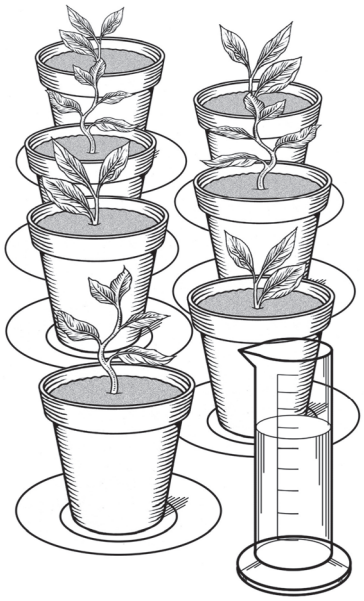
All plants need water for growth and general health. It is taken in through the roots and used for transporting minerals from the soil. Water also fills the cells of the stem, helping it to stand upright. Lack of water will cause the plant to wilt and eventually die. Too much water can swamp the plant, eventually causing rotting and death.

Green plants need light to carry out the process of photosynthesis. This is the production of nutrients from water and carbon dioxide, using the green pigment (chlorophyll) and sunlight to drive the process. Lack of any light causes a green plant to lose its colour. The stem may become long and spindly as the plant seeks out light.

Children should recognise the relationship between the amount of water and the health of the plant. Similarly between light level and health. The healthiest plants should be those in the warm, light room with the medium amount of water. Any experiments with living things can give varied results as many external factors can affect them. To reduce the chances of rogue results it is a good idea to set up parallel sets of experiments, which can be shown to the children if necessary.

The science task

Show the children the seven plants and tell them that they are going to find out if plants need water and light to grow well. Use four of the plants for the water experiment – one plant should be given a large amount of water, one a medium amount, one a small amount and one none at all. These amounts will need to be measured. Use a measuring jug, a measuring cylinder, a syringe or a marked yoghurt pot. The exact amounts used will depend on the size of the plant and the pot in which the plant is growing. For a pot of around 8–10cm in diameter at its top, a medium amount of water would be about 30ml, a small amount about 15ml and a large amount about 50ml. Try this out first to determine the most suitable amounts. Place the pots on saucers. The plants should then be kept in a warm, light room and watered to the same extent once a week.



Use the other three plants for the light experiment. One should be in the same warm, light room as for the previous experiment, one should be in a warm room with low lighting and one in total darkness (in a box for instance). They should all be watered to the same extent using a medium amount of water. Ask the children to predict which plants they think will grow the best.

After three days, eight days and fourteen days the children should look at all seven plants and make a note of what has happened to them. Photocopiable pages 8 and 9 can be used to record the results. Before recording begins, discuss with the children how they will decide whether the plants are healthy or not and how they will measure how the plants have grown. (For example, they might look at how well the stems support the plant, how green the plants are and how firm the leaves are. For growth they might measure the height and the distance around the plant in centimetres or make a note of how many shoots or stems it has.)

Ask the children to work in small groups to share their ideas about the relationships between the external factors of amount of water and light with the health of the plants. They need to agree how they are assessing the health of the plants. They should write down what the group has agreed about the effects of water and light on plants. Ask the groups to share their ideas with the rest of the class.

Other thinking skills appropriate to this topic

- Instead of telling the children how the experiment was set up and showing them the results, they could be asked to pose their own questions about the effects of light and water on plant growth. (EN)
- Evaluation of the results from the questions investigated above. (EV)

Ideas for further work

- Find out if temperature has any effect on the way plants grow.
- Try to find out if there is any connection between the health of a plant and the use of fertilisers.

  (Teaching note – It is not appropriate at this stage to do tests for individual minerals. Use water-soluble commercial plant foods and supply them as weak solutions.)

Safety note

Fertilisers can be harmful. Care should be taken and the children should wash their hands after using them.

Name _____

Plants and water

Record what happens to the plants here.

amount of water	after 3 days		after 8 days		after 14 days	
	health	growth	health	growth	health	growth
large						
medium						
small						
none						

Name _____

Plants and light

Record what happens to the plants here.

amount of light	after 3 days		after 8 days		after 14 days	
	health	growth	health	growth	health	growth
bright						
dim						
none – darkness						