Section 4: Looking at light and shade
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Section 4: Looking at light and shade

Key Focus Question: How can we integrate science with other areas of the curriculum?

Keywords: light; shadow; reflections; patterns; evaluate; prediction; investigation

Learning outcomes
By the end of this section, you will have:

- supported pupils in carrying out their own investigations;
- encouraged your pupils to develop the science skill of prediction;
- developed your own skills and confidence in integrating different areas of the curriculum.

Introduction
As a teacher of science, you need to help your pupils look carefully at things often taken for granted. Light, dark, shade, shadow, colour and reflection are very much part of our daily lives, but we often pay little attention to the science involved.

This section looks at how light behaves on different surfaces and objects. It suggests using active learning to help pupils understand how light is used for different purposes and develop their skills at prediction. It also builds on the links between science and the arts and technology. This should help pupils develop an understanding of applications of science.

Note: Resource 1: Safety advice for teachers has important safety advice relating to this topic.

1. Exploring Shadows

Start by investigating light and shade for yourself, using pictures from magazines or photographs. Which parts of the picture stand out because they are directly in the light? Where do you see shade or shadows? Can you work out where the light source is coming from? When do we see a silhouette (the dark outline of an object or person)? Try this out for yourself, perhaps with a colleague.

You are now investigating 'cause' and 'effect' with regard to light by considering the evidence you have observed and you are thinking scientifically. You might want to try this investigation with some of your pupils.

Case Study 1 shows how it is important for pupils to experience the science they are talking about. In Activity 1, you encourage your pupils to think about effects they observe and to recognise patterns when doing experiments with light.
Case Study 1: Categories of possibility

Busiku was going to read her class a story about a child losing their shadow. First, she planned for them to notice their own shadows more consciously. Outside in the morning sun they traced their shadows on large sheets of paper. The shadows were shaded in, carefully cut and proudly displayed and talked about in the class and at a school assembly.

The popular story of the lost shadow was reread many times. In this story, a child loses their shadow, but finds a way to get it back again. By now, the original shadows were getting a little damaged. ‘Yes! Yes!’ they clamoured when Busiku suggested they repeat the activity. This time she specifically took them out at noon. They, too, were losing their shadows! The pupils were confused and worried. Wisely, Busiku chose deliberately to leave them like that.

Over the next few weeks, the class talked about this experience, relating it to other observations. They slowly built up their understanding of what had happened to their shadows.

Activity 1: Exploring what can be done with light and shadow

With your class, discuss the creative game played at night using hands to make shadow images on a wall (see Resource 2: Wall shadows). Set them a homework task of inventing images that can be made.

They should find out what they must do to make (cause) the shadow picture to be bigger or smaller (effect).

Pupils must come back tomorrow ready to demonstrate what they have found out.

Set up a way for pupils to demonstrate their wall shadows in the classroom.

Help them record what they have found out by:

- listing the different images they demonstrate (pupils do drawings to show the shape of their hands);
- writing down the ‘cause and effect’ findings.

If nobody mentions it, ask them to investigate what causes the effect that some images are blurred while others are clear?

Finally, use everyday objects (a cup, a comb, scissors, a hammer etc.) to pose problems. The pupils should only see the image and not the object or how it is held. Hold different objects in a range of positions to cast interesting shadows. Ask your pupils to work out what the object is and explain why they think this.

2. Using games and pictures to explore reflection

Reflection plays a large role in how we see or perceive light and colour. In fact, without reflection, we would see nothing. (See Resource 3: Information on light for more about the properties and behaviour of light.)

In this part, we look at ways you can help your pupils explore what happens when light is reflected off different surfaces. Your aim should not be to provide them with the ‘right’
answers, but to give them a range of experiences that make them thoughtful and interested in this topic. In **Activity 2**, you encourage your pupils to observe carefully examples of reflection around them. **Case Study 2** shows how one teacher’s work on reflection encouraged some pupils to become better artists.

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**Case Study 2: Thinking about the reflection of light**

Mrs Pikom teaches a combined primary class. She had carefully collected and mounted on card good pictures from old magazines for language, literacy and communication work.

When she read the introduction to part one of this section, she realised she could use her pictures again for science. She could see so many different sorts of reflections in the photographs (not only shadows and shade). There was light glistening on the water, reflections in glass windows, the sparkle of shiny objects, as well as the glow on the skin of an apple. She realised that even the glint in someone’s eye is in fact a reflection.

First, Mrs Pikom explained to her class some of the facts she knew about light and reflection (see **Resource 3**).

Next, she gave them the pictures to look at and she was surprised at just how much detail they were able to notice. They were much more aware about the effects of light on different surfaces. She was totally amazed when some of the children, more interested than others in drawing, began to experiment with shading and drawing in the reflections on round objects so that their drawings became more realistic.

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**Activity 2: Investigating mirrors –reflections and reversals**

Start with this game. In pairs, children take turns to act as the mirror image of the other. One pupil carefully leads, and the other copies (mirrors) the slow deliberate movements. Let pupils do this for a few minutes.

Discuss the experience. Do they realise that if the leader winks with the left eye, then the follower (‘mirror image’) winks with the right?

**Reversals in reflections**

Now use lipstick or eyeliner to mark the cheeks and hands of some pupils. Write ‘L’ or ‘R’ in the palm of each hand and the letters ‘AB’ on the right cheek and ‘OB’ on the left. Let them observe what they find when they look at themselves in real mirrors. Discuss their observations.

(More activities to stimulate speculation and investigation are outlined in **Resource 4: Additional reflection activities**).

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3. **Using Science to solve a problem**

We try to make sense of our world and then we use what we have found out to help us do things. It is the same with science. Results from investigations can sometimes be used to solve problems we face in life. This is linking science and technology and helps pupils to understand why it is important to study science.
The **Key Activity** (read this now) builds on knowledge gained from **Activity 2** to solve a technological problem. How will you assess your pupils in this activity? After the activity, think about how your pupils reacted to this way of working – did they work well in groups? Would you do anything differently next time you do this?

In **Case Study 3**, a teacher encourages his pupils to use what they have found out from **Activity 1** to plan and present shadow-puppet plays.

### Case Study 3: A shadow-puppet play

Mr Mbuli projected shadows of mystery objects on a screen when doing **Activity 1**. Three pupils stayed behind to investigate and play with the items used. He watched them as he tidied the classroom.

They realised that the scissors or the pliers seemed to ‘speak’ if you moved the parts. ‘Hello, I am Mr Scissor-mouth. I am a very sharp guy!’

‘And I am Mr Heavy Hammer and I am going to beat you to death!’

They soon improvised a plot for a short play where Mr Hammer threatens Mr Scissor-mouth. But Mr Scissor-mouth is rescued by Mr Long-handle Pliers! Mr Mbuli gave them a chance to present their shadow-puppet play to the class.

The class became very interested in shadow puppets. Some pupils made cut-out puppet characters and discovered how to join parts that could move, using thin wire or dry grass-stalks for rods and supports. The way they used what they had learned in science amazed Mr Mbuli. They made the puppets appear larger and smaller, clearer and more blurred, and they were able to create different shapes with the same puppet by holding it at different angles to the screen. (See **Resource 5: Ideas for creating shadow puppets**.)

### Key Activity: Problem solving – applications-led science

Write this question on the board:

‘What is the problem if you are a short person standing near the back of a crowd at a soccer match?’

You can’t see! Ask your pupils how might you solve your problem? What about mirrors? Design something to solve the problem of seeing over something higher than you.

In groups of three/four, pupils design, make, compare and assess their own device to see around corners or over the top of a high obstacle.

Before they start, pupils need to discuss the following points in their groups:

- How many mirrors will you need?
- What angles will the mirrors need to be placed at?
- How will you hold, fix or support the mirrors safely and securely?
- Draw a plan for the device.

Then, before pupils start building their devices, discuss with them the criteria you will use to evaluate their devices. Draw up a list and display it during the activity.

**Resource 6: Periscopes – ideas to get you started** has design ideas for periscopes and some suggestions for evaluating the finished periscopes.
Resource 1: Safety advice for teachers

- Background information / subject knowledge for teacher

Not looking at the sun

It is really important that you warn children to NEVER look at the sun directly. Tell them our eyes have built-in lenses that act like magnifying glasses and will focus the HEAT as well as the light energy from the sun onto the tender back of the eyeball, the retina, which helps us see. This heat can burn and destroy forever the cells of the retina, just like a magnifying glass can burn and destroy paper. (Using things like binoculars would be even more dangerous.) Tell them that nobody should ever take chances with something as precious as their sight.

Don’t get burnt

Most other direct light sources also involve quite intense heat. Only insects like fireflies and glowworms seem able to produce light without heat. Supervise children carefully when flames are involved. Also, make sure that matches are kept safe and used properly.

Electric shocks

All the usual necessary precautions need to be taken when electrical appliances are being used in the classroom as sources of light. (No damaged cables, no faulty connections, plugs properly wired, and no water near electricity).

Finally, it is not nice to think of any pupil getting hurt, burnt or injured, but make sure that you have thought about the possibility that it might happen to you or a colleague, and be prepared to take the proper first aid action.

Resource 2: Wall Shadows

- Teacher resource for planning or adapting to use with pupils
Resource 3: Information on light

- Background information / subject knowledge for teacher

Sources of light

- The sun – major source of light and heat here on Earth.
Stars – distant suns. We can just see the light of these but don’t feel the heat.
The moon and planets – reflect the light of the sun.
Lightening flashes during thunderstorms.
Fire, flames, sparks, heated metals and glowing embers.
Electric lights.

Colour

When white light is refracted (bent) by certain transparent surfaces, even raindrops, it is split and reveals the seven colours of the rainbow.
Coloured things absorb all the other colours but reflect their own colour. So a red car reflects only red light, red glass in a car’s brake light transmits only red light.

Light travels

Nothing travels faster than light.
Like sound, light travels as waves of energy. We talk of sound waves, but light ‘rays’ or ‘beams’ of light.
Light rays generally travel in straight lines that radiate out from a source.
We see things because light rays bounce off them (get reflected).
Darkness is because of an absence of light. If there is no source of light to reflect off things we get blackness and cannot see anything.

What happens to travelling light?

It passes straight through transparent things (glass, water, clear plastic, etc.).
It partly passes through translucent things (wax paper, tissue, tinted or frosted glass, mist and clouds, etc.).
Light is blocked by opaque things – this causes shade and shadows.
Light is also reflected by opaque things.
Very shiny surfaces (mirrors, polished metal etc.) reflect a clear image/picture.
Dull surfaces scatter the light that they reflect.
When light is neither transmitted or reflected, it is absorbed.
When all the light is absorbed by anything we see it as black.

Mirror Images

When we look into a mirror, the image we see seems to come from behind the mirror.
A mirror image turns things otherwise (lateral inversion). That is why we can’t easily read a page held up to a mirror.
Try to shake hands with your own image in a mirror – you will see that as you hold out your right hand, the mirror image ‘holds out’ its apparent left hand.

Resource 4: Additional reflection activities

Teacher resource for planning or adapting to use with pupils
Are we really two-faced?
Are the two halves of our face exactly the same? Pupils might enjoy an activity where you look at full-face passport photographs that they or you bring.

Stand a small hand mirror down the midline of the face in the photograph so that the reflected half makes one face with the uncovered half. Now do the same to the opposite side. Isn’t it amazing how different the two faces are? That is because our faces are not exactly symmetrical.

**Shaking the wrong hand**

Try to shake hands with your own image in a large mirror – when you hold out your right hand, it offers you its apparent left hand.

Repeat this, but this time, arrange two mirrors at right angles. Look into the corner and you will see one image of yourself. Offer to shake hands.

What hand does the image in the two mirrors offer this time?

Can you work out why this happens?

**Using reflection**

Brainstorm uses of mirrors:

- Which devices contain mirrors?
- Where are they useful?
- How could mirrors be useful in a shop to help security?

**Scary reflections**

Experiment with looking at reflections in curved pieces of metal like spoons and kettles.

- What happens to the reflection?
- What patterns can you notice?

**Light and dark**

Gather together a collection of different shiny materials and objects. Experiment with looking at them:

- in normal classroom light;
- in a ‘black box’ where there is very little light;
- when a torch is shone on them.

Which objects are the shiniest? Can you put them in order of shininess? What happens when you put them in the box? What happens when you shine a torch on them? Can you see any patterns in your observations?

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**Resource 5: Ideas for creating shadow puppets**

- Teacher resource for planning or adapting to use with pupils
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Three Methods of Working:

- Palette — Lever principle of movement
- Vertical Rod
- Horizontal Rod

Knee joint loosely pivoted will give incidental movement.
Resource 6: Periscopes – ideas to get you started

Teacher resource for planning or adapting to use with pupils

Start by finding two mirrors.
Hold one in each hand and see if you can use them to peer over a wall or see round a corner.
When you have a good image over the wall or round the corner, stop. Look at how the mirrors are arranged – what do you notice about the angles?
Now you can use your observations to build a periscope. The images below give you some ideas of how to do this.
How will you evaluate your periscope? Are any of these criteria useful? Can you think of any more?
Draw up a table of the criteria you choose and use it to record judgements on everyone’s periscope.

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