We're living in rocks and SOIL!

QCA Science Unit 3d "Rocks and soils."

The lessons provided in this unit help teach the QCA Science Unit 3D *Rocks and Soils.* They will also partially fulfil the objectives of the adapted Year 3 Geography QCA unit *"Investigating our local area."* This is a teacher and child friendly unit. It uses easily accessible resources, often building materials, which have originally been obtained from quarries.

The lessons incorporate a music composition activity, a "rock and soil expert" (the earthworm), plus some "fun" practical science activities which overlap with the curricula for both design and technology and education for sustainable development.

Unit 3D – Rocks and Soils
Science Year 3
We're living inside rocks and SOIL!

Overview Teacher Introduction:

The lessons provided in this unit, *We're living inside rocks and SOIL!* are designed to be used to help teach most of the QCA Science Unit 3D *Rocks and Soils.* Some of these lessons will also partially fulfil the objectives of the Year 3 QCA Geography unit *"Investigating our local area."*
A version of this unit *The investigators-What's beneath our feet?* is also available on this *Virtual Quarry* website. Teaching both units simultaneously could promote more holistic learning and more efficient use of teaching time.

This unit is designed to be "teacher friendly." Most of the additional "rock and soil" resources can easily be acquired from a local builder's merchant.
The lessons provided are particularly useful for school children who live in areas where material they perceive as "rocks" are not easily visible. E.g. some urban areas and parts of Eastern England. Although these pupils cannot easily see "rocks" they can see the products that are manufactured from quarried materials. E.g. bricks, concrete blocks, roof tiles, cement etc.
The link between rocks and quarried products is explored in the science activities and by using ICT and music.
All of the accompanying worksheets have been designed to be displayed and completed on an interactive white board. However they can easily be modified and be presented and completed on paper.

The section of the QCA science unit on "soils" is linked to the opening section on "rocks" by a "rock and soil expert," the earthworm. Soils and some quarried materials (sand and gravel) are examined and compared with the particular needs of this creature in mind.
The unit concludes with two "fun" activities. Children learn how to sort soils and other materials composed of particles by sieving and then devise a test to find the strongest sand or soil castle. Teachers should fulfil the final QCA objectives by presenting the last lesson described in the original QCA Unit.

"We're living inside rocks and SOIL!"

Unit 3D Rocks and soils Science Year 3

ABOUT THE UNIT

Through this unit children should come to recognise that underneath all surfaces is rock which they may not be able to see, that rocks get broken down into pebbles and soils which we can often see, and that there are different sorts of rock with different characteristics. Pebbles and soils from different rocks consequently have different characteristics.

Experimental and investigative work focuses on:

- considering whether a test is fair
- measuring volumes of liquids using appropriate apparatus
- making comparisons
- drawing and suggesting explanations for conclusions.

Work in this unit also offers opportunities for children to use their understanding of science to explain observations about rocks and soils, for children to collect evidence to test ideas, and to recognise hazards and risks. The children will begin to learn about the value of these materials and some of the impacts on the environment caused by human activity.

This unit takes approximately 10 hours.

WHERE THE UNIT FITS IN

Builds on Unit 1C 'Sorting and using materials' and Unit 2D 'Grouping and changing materials'

Children need:

- to understand rocks are naturally occurring
- to know vocabulary used to describe characteristics of materials
- to know how to construct a bar chart.

Links with Units 3B, 3C, 4C and geography.

VOCABULARY

In this unit children will have opportunities to use:

- names of different rocks and soils *eg slate, marble, chalk, granite, sand, clay*
- words relating to rocks and soils *eg rock, stone, pebble, texture, absorbent, organic*
- words relating to manufactured building materials e.g. *manufactured, concrete, cement.*
- expressions of reason using 'because'.

RESOURCES

- collection of secondary sources *eg CD-ROMs, The Virtual Quarry*
- Worksheets downloaded from this site
- Interactive whiteboard
- rocks including at least one permeable rock *eg chalk, sandstone* and one non-permeable rock *eg granite, marble plus coal, slate and limestone*
- processed quarried materials e.g. brick, concrete block, roof tile, floor tile, plastic pipe and guttering.
- hand lenses
- sieves, timers and measuring jugs or cylinders
- containers for soil tests, *eg transparent plastic tubes with gauze covering the bottom*
- samples of different soils
- Untuned percussion instruments
- Hammer and nails or knitting needles of different diameter
- Wooden rolling pin
- Plastic sheeting
- Tennis ball

EXPECTATIONS

at the end of this unit

most children will:	name and give characteristics of several rocks; explain that rocks are used for different purposes; recognise that there is rock under all surfaces and that soils come from rocks; recognise when a test or comparison is unfair, measure time and volume of water carefully and say what their experiments and investigations show
some children will not have made so much progress and will:	name one or two rocks; say that there are rocks under surfaces and make measurements of time and volume
some children will have progressed further and will also:	explain how to make a test fair and explain what their experiments and investigations show in terms of the characteristics and uses of the soils and rocks tested

LEARNING OBJECTIVES CHILDREN SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES CHILDREN	POINTS TO NOTE
• that rocks and other quarried materials are used for a variety of purposes	♦ Review children's understanding of materials which are naturally occurring, and those which are not, through a game in lesson 1. Visit to look at different types of rock and building materials used in a local environment *eg school or shopping centre* (Lesson** "Our local area"). Explain that rocks are naturally occurring and that many other building materials *eg bricks* are not. Understand in simple terms how these natural and processed products are obtained. (Lesson 2)	• identify some rocks *eg marble, granite, slate* and explain why they are used for a particular purpose *eg slate for a roof* • identify other common building materials and know they are obtained from out of the ground. (Lesson 1)	It may be helpful to clarify with children that 'stones' and 'pebbles' are small pieces of rock and that the word 'stone' is sometimes used instead of 'rock'. **SAFETY** – All off-site visits must be carried out in accordance with LEA/school guidelines.
• that rocks can be grouped according to observable characteristics • to observe and compare rocks.	♦ Present children with a collection of rocks to observe and group in terms of texture *e.g. size, shape and arrangement of particles* and appearance *e.g. range of colours.* Ask children to choose a criterion for grouping and ask other children to guess what this is.	• group rocks according to differences in texture and record and justify the groupings • allocate an additional rock to a group and explain the decision	It is helpful to children to make clear that they should look at the particles in the rock as well as colour. If possible, have different sized samples of the same rock. This helps children to understand that the same material can be 'pebbles', 'stones' and 'rock'. At this stage children are not expected to recall the names of all the rocks they see.
• that differences between rocks and quarried materials can be identified by testing	♦ QCA Unit Compare rocks and products made from quarried materials for differences in permeability by dropping small quantities of water on to rocks and observing whether it remains on the surface or not. ♦ This unit (Lesson 3) compare the noise made by dropping stone onto different surfaces	• use results of their tests to rank rocks in order of permeability • to recognise unfair factors in a test • To recognise surfaces that may reduce noise pollution in a quarry	At this stage children should test for permeability by observing whether a rock absorbs small amounts of water and how quickly it does so.

Ref: QCA/98/210W

LEARNING OBJECTIVES CHILDREN SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES CHILDREN	POINTS TO NOTE
• that rocks are chosen for particular purposes because of their characteristics. (Details of this lesson are not included in this unit)	♦ Children review, using secondary sources *eg books, CD-ROMs,* the uses of different rocks and link these to their characteristics.	• relate the use of particular rocks to their characteristics and explain why they are used *eg that granite is often used for steps to buildings because it doesn't wear away easily, that marble is used because it is attractive to look at*	
• that beneath all surfaces there is rock. • that fragments of rock are one of the main constituents of soil.	♦ Show a series of pictures (Lesson 4) *e.g. cliffs, quarries, mountains with rock faces, fields/moors with rocky outcrops, muddy fields, and town streets.* Ask children to point out where the rocks are. Ask them to suggest why they can see rocks in some pictures but not in others. ♦ To understand the basic constituents of soil by considering some information about a worm's behaviour and lifecycle.	• explain why they can't see the rock in some pictures *eg by saying because it is covered with soil or buildings.* • to know the names and origins of some different soil constituents.	**SAFETY** – This activity provides an opportunity for pointing out the dangers of quarries, cliff tops, etc.
• that there are different kinds of soil depending on the rock from which they come	♦ Show a video or a series of pictures showing different soils. Ask children to compare these with a sample of soil from the local environment.	• describe how the soils differ from those in the local environment	It may be helpful to show children that a soil can be made up of several layers of different colours.

- to observe differences and make comparisons
- that organic matter is useful for living organisms but is not need in the manufacture of quarried products
- that particles of different sizes can be separated by sieving

- Lesson 5 Present children with samples of different soils plus sand and sand and gravel. Ask them to observe and record differences in colour, texture and what makes up the soil.
- Lesson 6 Suggest children use a sieve with large mesh to separate out large particles. Use graded sieves to separate the dry soil sample. Ask children to describe and explain what they found out about the soils.

- separate particles using the equipment provided
- rank soils in terms of usefulness to living organisms in the soil (worms) changing colour and particle size, justifying the ranking in terms of their observations
- describe how the soil particles are separated *eg by saying the stones were too big to go through the holes*

Graded sieves can be made by pushing holes in margarine tubs from the inside.

At this stage 'particle' is used to refer to 'very small pieces' of rock or soil.

SAFETY – Collect soil samples from areas free of broken glass etc and unlikely to be contaminated with dog faeces. Wash hands after handling soil.

LEARNING OBJECTIVES CHILDREN SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES CHILDREN	POINTS TO NOTE
• to use simple apparatus to measure volumes of liquids and to measure time • to recognise when a test is unfair Alternative or additional lesson 7 • to devise a test using simple apparatus. • To recognise when a test is unfair. • To know that some human activities can cause environmental damage.	♦ Ask children about, or show pictures of, puddles or floods on different surfaces *eg fields, dry sandy beaches, school fields* and ask why puddles stay longer in some places than in others. Demonstrate that water flows more quickly through sand than through clay *eg by pouring a specific volume of water which children have measured on to both soil types, placed in containers with small perforations at the bottom.* During demonstrations, do the test unfairly and challenge children to decide whether the test was fair or not. ♦ Children take part in a structured test to see which material (sand, soil or sand and gravel) makes the best sand castle. An unfair element is introduced when different amounts of water are added to the materials.	• explain why the test was unfair and describe what should have been done • use apparatus provided to measure volume of water carefully • to understand that many human activities can impact on the quality of the environment.	If children have already done Unit 3C they may have made some measurements of volumes of liquids. At this stage, accept children's use of 'amount' for 'volume'. It will be important to establish correct use of terms *eg volume, weight* later in Key Stage 2.
• to plan a fair test • to make and record measurements of time and volume of water • to use their results to make comparisons, and draw and explain conclusions (Details of this lesson are not included in this unit)	♦ Ask children to investigate the relationship between type of soil and ease of water flow through it. Remind them of earlier work on the characteristics of different soils. Help them to plan what to measure and what apparatus to use *eg how much water flows through in a given time or how long it takes the same volume of water to flow through different soils* and to plan a fair test and remind them about how to measure volumes of water. If necessary, provide children with a prepared table. Discuss children's results with them and ask them to explain the differences and what this shows about the different soils.	• explain how their test is fair make careful measurements • of time and volume • explain their results	This activity offers children the opportunity to carry out a whole investigation. It may be helpful to concentrate on the aspects of investigation highlighted in the learning objectives. It is helpful to use the same soils that children observed and sieved in the earlier activity.

Lesson 1: Valuable materials from out of the ground.

Prior Knowledge / Work:
As in the QCA unit. It would help if the children have completed Science Units 1C "Sorting and using materials" and 2D "Grouping and changing materials."
Learning Objectives:

- To review children's knowledge of materials, used in their environment. I.e. which are naturally occurring and which have been processed?
- To identify, observe and compare some rocks and common building materials.
- To know that most of these materials are obtained from "out of the ground."
- To know that these materials are used for a variety of purposes.

Subject Links:

- Geography, QCA Unit 6 *"Investigating our local area."* (POS 3d,3e.)
- English, Speaking and listening. (POS 1a, 2e, 3a, 3c.)

Resources:

- A collection of examples of locally used building materials obtained from a builder's merchant. These should include: Some naturally occurring quarried materials such as slate, limestone, sand and gravel; some "processed" quarried products such as brick, concrete blocks, roof tiles, etc; building plastics (guttering, drainage pipe etc.).
- Cardboard identification tabs and felt tip pen.

Background Information:
There are many schools in situations where it is very difficult to easily see materials that young children would define as "rock." Examples include urban areas and parts of the UK where the underlying geology is clay or sand.
To make the topic of *Rocks and soils* relevant to these children, this initial lesson includes processed quarried materials in the form of bricks, concrete blocks, roof tiles, etc. which are easily visible in most parts of the UK. The lesson also shows how important quarried materials are in our lives.

Rocks used as basic building materials
Originally, locally occurring rocks that naturally or easily broke into mainly cuboid shaped blocks were used for constructing buildings. Examples include limestone,

sandstone, slate and granite. They were all fit for their purpose i.e. they could be easily arranged in the construction and would not crumble or squash.

Limestone, granite, slate and other "naturally occurring materials."

Today each of these rocks is quarried at particular locations throughout the UK. Each rock is processed in some way before use. For example, limestone is often crushed and different sized particles are used in varying products such as cement or chippings. Granite and slate are often cut or trimmed into rectangular solid shapes prior to use.

Bricks are mainly made from clay. The clay is mixed with water, moulded, dried and then fired in a kiln. The colour of the brick depends on the mineral content of the original clay and the way that it is fired.

Clay is a sedimentary rock, made up of tiny mineral particles that were originally part of another quite different rock. The original rock may have been changed by the Earth's heat and movement, by chemical action and erosion. The particles were probably deposited in ancient seas and lakes that occupy the space where the UK is today.

Cement is made from either limestone or chalk. Both are rocks that were originally formed from material derived from coral or shell organisms that accumulated as sediment in ancient seas. To manufacture cement, the rock is quarried, crushed, mixed with small amounts of other minerals (clay or shale) and then heated to about 1450^{o} Celsius. The material is cooled, powdered, sometimes mixed with other additives and then packed in waterproof bags. Builders mix the cement powder with sand and water and use it as an adhesive, called *mortar* to hold bricks and other building materials together.

Concrete is widely used in the building industry. It has been described as "the most versatile building material in the world. It can made into blocks or can be taken to site in a liquid form and set into any moulded shape as a solid. It gets stronger with time as crystals grow and interlock."

Concrete is a mixture of sand, cement, and gravel, crushed rock or recycled building waste to which water is added.

Concrete blocks are made from this mixture plus a combination of other materials which affect the final properties of the product. These other materials can include recycled cinders, ash and slag from other industrial processes e.g. coal fired power stations, iron and steel smelting. To manufacture the blocks the concrete is poured into a mould. The blocks are usually larger than bricks and the building process can consequently often be completed more quickly. The properties of the blocks can include strength, relatively light weight and good heat insulation.

Glass is an obvious material in many buildings. The main ingredient in glass is sand. If heated to 1700° Celsius the silica in sand would fuse to produce a glassy substance. However, by adding "soda ash" (Sodium Carbonate) to the sand, the fusion process takes place at much lower temperatures. Soda ash is made from a chemical process involving both limestone and salt.

Sand and gravel are also sedimentary rocks. These materials are often quarried in the same location then sieved to separate them. Their origins are similar to those of clay. However the particle size of sand and gravel is larger than that of clay. There are large reserves of clay, limestone, chalk and sand and gravel in the UK. These materials are quarried in many locations (link to the map).

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Building plastics. Although children will have already used vast amounts of plastic in their lives, most will be unaware of where it comes from.

Plastic is mainly derived from crude oil which is pumped from beneath the ground. Apart from pictures of a sticky black treacly substance polluting beaches most children (and adults) will have no real experience of crude oil.

Most scientists accept that crude oil is a finite fossil fuel that was formed in warm seas millions of years ago. Plants and small creatures, called plankton, thrived in the sea. When they died their remains sank to the ocean floor where they were covered by silt and sand. Over millions of years the pressure from accumulations of further silt and sand, plus heat from the earth's core, has changed the remains of these organisms into crude oil.

Crude oil is obtained by drilling oil wells and pumping the substance to the surface. Then, by heating, different useful substances are separated from it. Young children will recognise several of these other products, i.e. petrol, diesel, and 'natural gas'. They may be surprised that most plastics, some fabrics, chemicals, paints and polishes are derived from crude oil too. Sand and limestone are both often added to plastics as "fillers."

Activity:

Tell the children that they are going to play a game to help them learn more about some important materials that we use everyday in our lives.

Show, identify and label each of the examples of building materials.

Then, together sort the materials into those which are "natural" (limestone, slate, sand, gravel.) and those which have been "manufactured." Explain that all these materials came "out of the ground" and in simple terms what happened subsequently to each quarried material.

Now play a game with the children. Describe one of the labelled materials selecting an observable characteristic (colour, texture, shape) and a possible purpose. Reinforce the terms "natural" and "manufactured" in the questions.

E.g. Which building material am I describing? This is red and manufactured for building walls? Answer: brick.

Which natural smooth material is used on roofs? Answer: slate.

Lesson 2: How they get building materials out of the ground.

Prior Knowledge / Work:
It would be useful if the children have had experience at using a variety of untuned percussion instruments and created "sound pictures." An alternative literacy lesson which addresses the same non musical learning objectives is provided in the companion geography unit *The investigators- What's beneath our feet?(Lesson 3)*

Learning Objectives:

- To understand how some materials are quarried and manufactured from rocks.
- To musically interpret the quarrying sequence with untuned musical instruments.
- To develop musical composing, appraising and performance skills.
- To understand that the quarrying can potentially be a noisy process.

Subject Links:

- Music performing, composing and appraising skills. (POS 1b, 1c, 2a, 3a, 3c.)
- Geography knowledge and understanding of places, patterns and processes plus environmental change and sustainable development. (POS 3a, 3e, 4b, 5a, 5b.)

Resources:

- On line Virtual Quarry.
- A selection of untuned percussion instruments.
- A collection of examples of locally used building materials obtained from a builder's merchant. (see Lesson 1)
- Worksheet 1 displayed on an interactive white board or computer screen or printed copies of each page of the worksheet. (This depends on the way you plan to develop the lesson. See below.)

Background Information:
Once planning permission for a quarry has been obtained and the top soil removed (This is often used to build embankments to screen dust and noise.) there is a basic sequence of activities that take place. The following describes this sequence for a limestone quarry.

1. Drilling. Holes are drilled in area of rock face. The holes are filled with explosives.
2. Explosion. Following a sequence of warning sirens the explosive is detonated.

3. Excavation. When a siren indicates that the detonation is safely complete a huge mechanical excavator lifts the pieces of broken rock into a dumper truck.
4. Transportation. The huge dumper truck carries a massive weight of rock and tips it into the crushing machinery.
5. Crushing. The rocks are crushed and carried on mechanical conveyors to sieves.
6. Sieving. The rock is sieved into different sizes and taken to a store.
7. Transportation. The quarry products are transported away from the quarry by road and rail.

Often, after the quarried rock has been sieved and stored, it is manufactured into products such as cement, ready mixed concrete and asphalt within the confines of the quarry. This reduces the environmental and economic cost of transporting "virgin" rock.

The quarried material is taken away and used in the construction and repair of roads and the manufacture of building materials and other products (E.g. toothpaste, farm soil improver, cleaning materials, treating and cleaning water etc.).

Activity:
Remind children of the contents of the first lesson in this unit. Use the examples collected from a local merchant to remind children that building materials are very important and that most are dug out of the ground.
Show the children the Virtual Quarry and discuss each of the different stages in the process.
Sit the children in a circle and give each child an untuned musical instrument. Some quarried products such as bricks, tiles and slates could be tapped with sticks and used as instruments.
Tell them that together they are going to compose a set of sounds that could represent the activities in the *Virtual Quarry.*

Show the children the enlarged copy of the first page of worksheet 1. *The drilling process.*
Together, using the children's acquired experience from other sources, develop a sound picture that matches the activities in this list.

To represent each activity on the list encourage the children to:
- Experiment with different kinds of sound;
- Combine different sounds;
- Change volume;
- Include rhythm;

- Use different speeds.

As "conductor" you will probably need to narrate and perhaps mime each activity on the list.

Once the children have experimented with sounds to interpret the drilling process the lesson can develop in several ways. Here are some possibilities:

- The class could practice and refine their composition for *The drilling process;*
- The class as a whole could develop the sound picture for the next quarry process *The BIG Explosion;*
- The class could divide into at least three groups and compose sound pictures for *The Big Explosion, Excavating the Rocks plus Moving and Crushing.*

Which ever way the lesson develops allow time at the end of the lesson for children to both perform and appraise their sound picture.

Notes for teachers

To use this worksheet on an interactive white board select:

- View – Reading Layout;

Please delete this text box prior to use.

Worksheet 1
The drilling process.

1. The worker walks across loose stone and switches on the power supply for the drilling machine.

2. The worker strides back to the drill and the machine begins to turn powerfully.

3. The drill grinds into the rock and several holes are made.

4. The worker walks back to the power supply and the machinery is switched off. Silence

The BIG explosion

1. The worker walks quietly to the vehicle and opens the safe holding the explosives.

2. The explosives are carefully removed, the container is closed, and the worker walks cautiously back to the holes.

3. The explosives are carefully put in the holes and the worker walks to a safe place. The warning siren sounds loudly.

4. The explosives DETONATE and the rocks break and fall.

5. The worker returns and checks the area. The "all clear" siren sounds.

Excavating the rocks

1. The huge mechanical excavator is started.

2. The excavator is driven to the pile of broken rocks.

3. A massive dumper truck is driven alongside the excavator.

4. The excavator lifts broken rocks and lets them fall into the dumper truck.

Moving and Crushing

1. The dumper truck, filled with rock, drives away from the excavator.

2. The dumper gathers speed and crosses the quarry.

3. The dumper stops and the warning beeper sounds before it reverses.

4. The dumper tips the rock into the powerful crushing machine.

5. The rock is smashed into small pieces by the strong crusher.

6. The crushed rock is sieved and pieces pour onto the storage piles.

Lesson 3: Which makes most noise?

Prior Knowledge / Work:
This lesson is an alternative to those suggested in the original QCA unit i.e. tests involving either rubbing rocks together or dropping water onto rocks to assess permeability. You could substitute either of those suggestions in this unit and include building materials made from quarried products in the testing procedure.

This lesson introduces children to the concept that noise can be a form of pollution and enables pupils to record the test results on an interactive whiteboard.

Learning Objectives:

- To devise a test that assesses the noise made by rocks falling on different surfaces.
- To understand that noise can be a form of pollution and that the environment can be changed to reduce it.
- To assess the level of noise using a democratic process.
- To recognise unfair factors within the test.
- To know that people manage their environments to reduce noise pollution.

Subject Links:

- Other QCA science units, particularly 3C "Characteristics of Materials."
- Design and technology, evaluating processes and products plus knowledge and understanding of materials. (POS 3c, 5a)
- Geography, knowledge and understanding of environmental change and sustainable development. (POS 5a, 5b)
- ICT. Using an interactive whiteboard (POS 5b)
- Citizenship. Making decisions democratically (POS 2g, 5d)

Resources:

- Two similar shaped and sized stones or two half bricks.
- A small concrete slab or a collection of bricks arranged to simulate a horizontal solid rock surface.
- Appropriate surfaces onto which the stones can be dropped including a wooden board, plastic container, rubber backed carpet, metal biscuit tin, bucket containing soil etc.
- Interactive white board with worksheet 2 displayed.
- The *Virtual Quarry*

Background Information:

Effects of Noise Pollution

The World Health Organisation suggests that noise can affect human health and well being in the following ways:

- Creating feelings of annoyance;
- Disturb sleep;
- Interfere with communication particularly listening;
- Interfere with learning;
- Cause anti social or aggressive behaviour;
- Cause hearing loss.

Reducing the effects of noise in the Quarrying Industry

Quarrying activities are potentially very noisy. The industry makes strenuous efforts to reduce the noise produced by its activity and mitigate the effects on workers and neighbours of the noise produced.

Protecting neighbours

The rock faces within a quarry can often provide a barrier to protect neighbours from noise pollution. Many of the potentially noisy quarrying operations such as crushing and sieving are carried out on the floor of the quarry to make use of the "rock face barrier."

Noise baffles or screens are usually constructed around the perimeter of quarries. If there is sufficient space these can take the form of wide mounds built from top soil and quarry waste. These can be planted with native species to increase their noise screening effectiveness, act as a natural filter for quarry dust and provide a habitat for wildlife.

If space around the quarry perimeter is limited then noise limiting fences may be constructed.

Protecting neighbours and workers

Within the quarry many strategies are used to reduce the amount of noise produced. These include:

- Restricting the speed of vehicles by speed humps etc.
- Using noise absorbing rubber matting on the floor of rock transporting vehicles.
- Reducing the volume of audible vehicle alarms (reversing etc.) particularly at night.
- Using new sound absorbent materials in machinery such as screens and sieves. E.g. polypropylene.
- Ensuring workers are properly protected from noise e.g. sound insulation in vehicle cabs and providing appropriate ear protection.

About the test

The suggested test will help children:

- Recognise the sound absorbing qualities of some materials;

- Use comparison and simple benchmarking techniques;
- Recognise obvious unfair elements.

The purpose of the test is to discover, in the context of a quarry, which surface reduces the noise pollution of dumping stones.
In each part of the test two fairly identical stones are dropped onto two surfaces. One surface will always be a simulated "rock" surface made from a small concrete slab or collection of bricks. The other surface will vary and could be metal, plastic, wood, fabric, rubber paper etc.
T he children compare the noise made on impact with both surfaces and record the results with "smiley" faces on an interactive whiteboard display.
The "identical stones" could be replaced by half bricks if the former are too difficult to find.
It is best to test the different surfaces on the classroom floor rather than on a table. The latter may increase the volume of the sound and make comparison more difficult.
There are some spaces on the recording sheet for children to suggest other noise absorbing surfaces. Screwed up paper, fabric or sand could all be used.

The discussion about unfair elements in the test could include:
- The height from which the stones were dropped varied;
- Inaccurate dropping so that the stone missed its target;
- The surfaces were of different shapes and sizes;
- Background noise interfering with the listener's assessment.

Finally, as with the abrasion test in the original QCA unit, there are safety considerations:
- Sit the children well away from the place where the stones are dropped;
- A fall of 30 -50 centimetres produces sufficient noise and shouldn't produce dangerous particles.

Activity:
Tell the children that together they are going to organise and take part in a scientific test about noise.
Explain and discuss:
- The term *pollution* (Something that accidentally spoils the space that humans or other animals live in.);
- That noise can be a form of pollution;
- The effects of noise pollution.

Remind children of the activities seen in the Virtual Quarry in a previous lesson.

Discuss which of the quarrying activities could cause noise pollution to neighbours and workers. All of the main quarrying the activities (drilling, explosion, excavation, transportation, crushing and sieving) have the potential to cause noise pollution.

Tell the children that:

- They can test the noise that quarried material makes when it is dropped on different surfaces;
- Different surfaces may make help to reduce noise pollution

Show the children worksheet 2 on the interactive white board.
Explain that they are going to:

- Drop two similar stones onto different surfaces. One stone will always be dropped onto the solid rock surface. The other surface will change.
- How the solid rock surface will be simulated i.e. bricks or concrete slab.
- Listen and compare the noise produced by each dropping stone.

Show and explain to the children demonstrating if necessary:

- The key and symbols on the worksheet;
- How each child can listen and then vote for the appropriate symbol after listening to each pair of sounds;
- On the interactive white board how the appropriate symbol can be dragged and dropped into the result section from the symbol bank.

Discuss why there are so many symbols in the symbol bank.

Test the suggested surfaces and record the results.
Ask the children to suggest two other surfaces that would make less noise pollution. Add their names to the result table and test them.

In the plenary discuss the results of the test and whether the test was fair.

Ask the children how they could improve the test.

Finally reshow the children the Virtual Quarry.
Show and discuss how the neighbours and workers of the quarry are protected from noise pollution.

Worksheet 2 *Quarry workers don't want noise pollution!*

Listen to the noise made by a stone falling onto solid rock.
Compare it to the noise of a stone falling onto a different surface.

Notes for teachers

To use on an interactive white board select:

- View – Reading Layout;
- On the toolbar select 'actual page' and the 'multiple page' option.

Please delete this text.

Key

This surface makes LESS noise than solid rock ☺

This surface makes MORE noise than solid rock ☹

This surface makes the SAME noise 😐

What is the other surface is made of?	Noise
Wood	
Plastic	
Metal	
Rubber	
Soil	

Symbol Bank

☺	☺	☺	☺	☺	☺	☺
☹	☹	☹	☹	☹	☹	☹
😐	😐	😐	😐	😐	😐	😐

Lesson 4: I'm a rock and soil expert

Prior Knowledge / Work:
This lesson can be used as part of the companion geography unit "The investigators- What's beneath our feet?"
It is described as an interactive whiteboard lesson. However the could be modified and a printed worksheet given to each child.

Learning Objectives:

- To know that beneath all surfaces there is rock.
- To understand that rock particles are a major constituent of soil.

Subject Links:

- Geography QCA Unit 6 *"Investigating our local area"*
- ICT using an interactive whiteboard (POS 5b)

Resources:

- ICT
- The Big Book "I'm a rock and soil expert!" downloaded from this *Virtual Quarry website*.
- Interactive whiteboard and worksheet 3.
- Examples of rock which includes slate, coal, chalk and limestone.

Background Information:
The rock and soil expert is a worm.
Worms
Worms live in the soil. As they burrow they ingest the smaller soil mineral (rock) particles of sand, clay, dust and mud and digest any dead organic matter (e.g. leaves, roots, manure, muck etc.) in it.
The mineral/rock particles in the soil that are ingested act "as teeth" and help break down the organic matter. The latter is the worm's energy source.
Worms are important decomposers of organic material. They often come to the surface of the soil at night and remove organic material with them into their burrow. Without them the surface of the earth would be a messy place.
Worms need water to survive. They take in oxygen through their moist skin. In addition, the moisture in their skin adheres to the side of their underground burrows, effectively keeping these tunnels from collapsing. In damp and wet conditions worms can easily be found in the top few centimetres of soil. When it is dry they can burrow deeper into the soil. This deep burrowing is useful for growers

as the worms aerate and loosen the soil and excavate minerals and nutrients that help plants grow.
In the discussion about worms try to be gender neutral. Worms are hermaphrodite and have both male and female reproductive organs. Worms mate by lying head to tail alongside each other. Sperm is exchanged through temporary canals in the skin. Once they have mated a ring like organ moves along the worm collecting the sperm and fertilising the eggs. Eventually this ring separates from the worm and infants develop inside it.
Some children believe that worms reproduce by being cut in two pieces by a spade etc. This is a myth. Although a worm may be able to regrow some body segments and survive, many die from such accidents.

Soil

This lesson introduces *soil* into the topic.
The basic constituents of soil are mineral particles usually derived from locally occurring rock. The size of the individual particles in the soil has a big effect on the drainage, temperature and fertility of the soil. Clay soils have the smallest particle size. They may have poor drainage, be slow to warm up in spring but be naturally fertile. Sandy soils have a larger particle size, good drainage, often warm up quite quickly in spring but are less fertile than clay soils.
As well as mineral particles soils contain varying amounts of organic matter. Organic matter is the remains of plants and animals. The soil nearest the surface, the top soil, is likely to contain most organic matter. The deeper sub soil contains less organic matter and as a consequence may be a completely different colour to the top soil.

Health and Safety

One answer to the first word search on worksheet 3 is the word *muck*. It is used in this context to refer to the excreta/manure produced by animals. It provides a good opportunity to discuss Health and Safety issues in handling soil.
Micro-organisms, such as bacteria and fungi feed and depend on organic matter, such as *muck,* in soil. Most of these micro-organisms are both harmless and essential in the recycling of plant nutrients. However, it makes sense for children to learn that:

- These organisms are present;
- Some may be harmful.

Children need to know that hygienic practices are essential when handling soil. Your school or local authority may have specific guidelines for children when handling soil. E.g. they should wear disposable gloves or practice scrupulous hand washing.

Where are the rocks?

The photographs in the Big Book show the following:

1. A sea cliff with rocks, sandy foreshore and sea. The rocks are in the cliffs, on the foreshore and beneath the sea. There is sand on the seashore and mud or sand on the sea bed.
2. A field with a rocky outcrop alongside a road. There is soil beneath the grass. There is rock, and perhaps soil, beneath the road.
3. A quarry. The soil overlays the quarry faces. The soil was removed prior to quarrying.
4. A field with grazing animals with mountains in the background. There is soil and rock beneath the field. There is rock and possibly soil beneath the mountains in the background and the road in the foreground.
5. A town street. There is rock and possibly soil beneath all structures.

Activity:

Sit the children around the interactive white board. Explain that they are going to share a big book called "I'm a rock and soil expert!"

Introduce the children to the worm, "the rock and soil expert," on the first page.

Discuss with the children:

- Where worms live?
- What they eat?

Explain during the discussion that soil is composed of particles of rock.

Show the children the examples of rock and then look at each of the pictures in the big book. As each picture is viewed, together answer the questions posed in the text. Stress and point out:

- Where rocks can easily be seen?
- Where there are rocks that cannot be seen?

Establish that:

- There are rocks beneath <u>every feature</u> on the photographs;
- There may also be sand or mud on the sea bed and soil beneath many of the non rock surface features;
- Using examples with which they are familiar (playground, school, their own home etc.), there are rocks everywhere below the surface of the Earth.

Show the children worksheet 3 on the interactive whiteboard.

Discuss the cartoon diagram. Make sure that children understand that it represents different layers of soil covering some rocks beneath the earth's surface.

Tell the children to look at the first word search. As they find a word show them how to highlight it on the interactive whiteboard and then drag and drop it into one of the first three rectangles.

When the children identify the word *muck* explain what it is and the health and safety issues about handling soil.

When they have completed the first word search go to the second. Ask the children to find the names of the rocks they find in the final rectangle.

Answers:

1. The things the worm gobbles up when it burrows through the soil are: *sand, clay, roots, mud, dust, muck and leaves.*
2. The things that are probably too big for the worm to ingest are: *pebbles, bones and stones.*
3. The other creature in the soil is a *slug*.
4. The rocks are: *slate, coal, chalk and limestone.*

The children may rightly query some of the answers. For example the worm may eat very small pebbles or not eat very large leaves. Use this session to explain in simple terms the functions of both the mineral and organic matter in the worm's diet. Finally, show the children examples of slate, coal, chalk and limestone rock and stress that these are found in different places on the surface of the earth.

Notes for teachers

To use this Big Book select:

- View – Reading Layout;
- On the toolbar select the multiple page option..

This Big Book has been designed to be viewed on an interactive white board or large visual display unit.

You may prefer to substitute local photographs to make the book even more relevant to your children.

Please delete this text box prior to use.

The rock and soil expert!

"Do you know why I am an expert on rocks and soil?

This is a great place to find rocks!

Where can you see rocks in this picture?

I know where there are some rocks
that you can't see!

Where do you think they are?

Here are some more rocks by the side of a road.

Think carefully. What else is hidden under the grass?

Here is a clue!
I live in it!

What do you think is beneath the road?

It is easy to see the rocks here.

Why are people digging up the rocks?

Can you see the soil where I live?

What happened to the rest of the soil before the quarry was dug?

Look at the field in this picture.

I hope you're becoming experts too!

What two things are under the grass?

What about other parts of the picture?

What's beneath the hills?

Finally look at this picture.

Do you know where rocks are hidden here?

Do you know where there might be some soil hidden as well?

Now, you
are rock and soil experts too!"

Notes for Teachers
To use this worksheet on an interactive white board select:
- View – Reading Layout
- On the toolbar select 'actual page' and the 'multiple page' option.

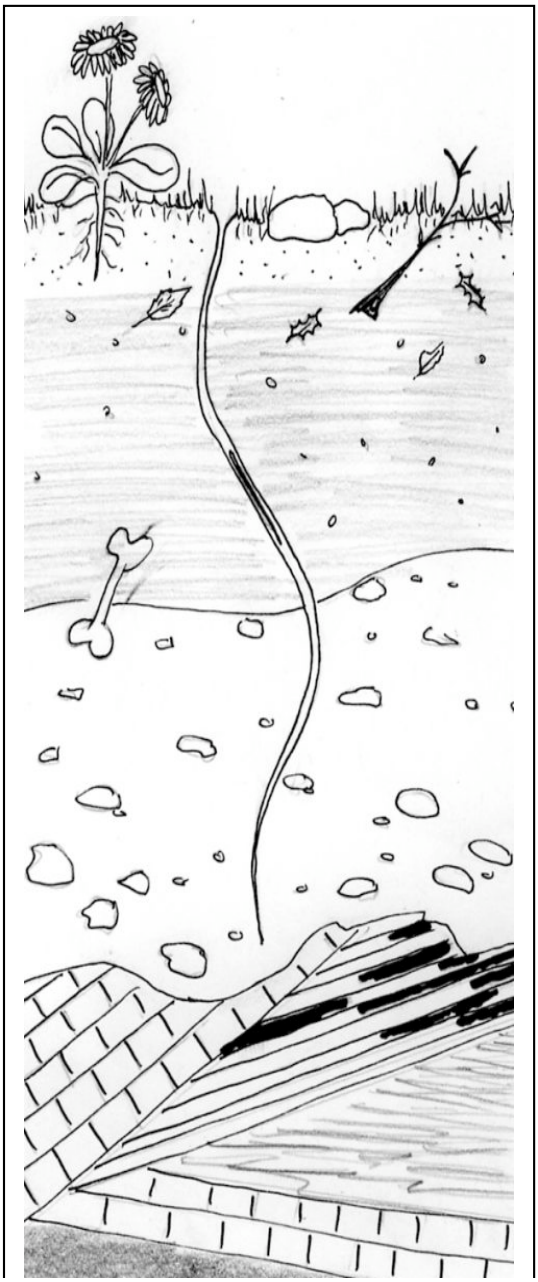
Please delete this text box prior to use.

Worksheet 3

Search with the rock and soil expert.

"Can you see me in the diagram below?
Now help me do this word search!"

s	a	n	d	a	b	o	n	e	s	d
o	c	l	a	y	o	r	o	o	t	s
m	u	d	v	p	e	b	b	l	e	s
s	l	u	g	a	l	b	o	n	e	s
e	s	t	o	n	e	s	d	u	s	t
m	u	c	k	i	l	e	a	v	e	s



1. "Look in the word search. Can you find some bits of things I gobble up when I burrow in the soil?"

2. "Find some things in the word search that might be too big for me to gobble up?"

3. "There's another creature in the first word search that shares the soil with me?"

4. Find some rocks down here that are too

a	s	l	a	t	e	g	a	f	r
c	o	a	l	e	c	h	a	l	k
m	l	i	m	e	s	t	o	n	e

hard for me to go through?

Lesson 5: "Which is my favourite soil?

Prior Knowledge / Work:
If you are completing the Geography Unit *The Investigators – What's beneath our feet?* alongside this science work, you'll need to look at that unit (lesson 6) and make one small modification to this lesson. The modification is described in that lesson.

Learning Objectives:

- To observe the some of the different constituents of soil.
- To observe differences and make comparisons.
- To know that sand and gravel is quarried and that it is widely used in buildings and other structures.

Subject Links:

- Design and Technology (POS 5b)
- Geography QCA Unit 6 *Investigating our local area*.

Resources:

- Three "soil" samples for children to examine. Two of the samples should be of soil containing varying amounts of organic matter (one sample should be obtained from on or near the school site to meet the objective of the Geography unit). The third sample should be sand and gravel mixture. Each material should be in a large numbered container (bucket).
- Empty used plastic containers (Yoghurt pots, margarine tubs etc.), one for each pair of children.
- ICT. Download the section of the *Virtual Quarry* that shows how sand and gravel is quarried, washed and sieved plus worksheet 4.
- Magnifying glass and spatula. One of each for every pair of children.
- A copy of worksheet 4 for each pair of children.
- Identify visible buildings and structures where either cement mortar or concrete have been used, or, a collection of pictures of local familiar structures which contain either cement mortar or concrete.

Background Information:
This lesson uses the information on the feeding habits of the worm in the previous lesson to establish a purpose for examining soil and similar materials. In addition, the children will see some of the important processes in preparing some useful

materials from quarries for their future use. I.e. the excavated material is sieved in order to grade different sized mineral particles.
This will help children in the design and technology curriculum to begin to evaluate both processes and products.

Sand and gravel

From a strictly geological point of view sands and gravels are rocks. They are the broken down fragments of other rocks that existed way back in geological time. Sometimes these and clay materials are described as "soft rocks." This distinction isn't important to this lesson, unless of course some children ask about it.
Although sand and gravel is quarried in many parts of the UK it is important for children to understand that the valuable material is not found everywhere.
When the potential material is located, the quarrying company has to go through a lengthy discussion and planning process before extraction can begin. The company has to take into account environmental considerations such as traffic volume, dust, noise minimisation, screening, reinstatement plus effects on local ecology, archaeology and water supply.
Once quarrying starts:

1. The top soil is removed and sand and gravel are quarried.
2. The quarried material is then screened for oversize material.
3. The remaining material is washed to remove organic matter. If organic material is left in the material it will eventually biodegrade (rot away) and effect the quality of the final product.
4. Sand and stones are sorted by sieving into different sized resources.
5. The material may be processed into other products such as cement mortar and concrete.
6. Products are transported away to be used.

Cement mortar

Cement mortar is a mixture of cement, sand and water that has been used by builders to join bricks, concrete blocks or stone. It has been commonly used since the 1920's.
The manufacture of cement is described in the background to Lesson 1 above.
Cement hardens after it has been mixed with water. Cement and water could not be used by themselves to join bricks etc. because the mixture would shrink and crack as it dries. Mixing at least three times the volume of sand with the cement helps prevent this shrinkage.
Children will probably have seen cement mixed with both sand and water in mixing machines to produce cement mortar.
Six times as much sand as cement is often used in the brick building mortar mix.

Concrete

Concrete is a mixture of cement, sand, gravel, crushed rock or recycled building waste (e.g. glass, old concrete etc.) to which water is added.

Concrete is used in two main ways. *Mass concrete* is commonly used in the foundations of structures. *Structural* or *reinforced concrete* contains some sort of metal reinforcement. The metal, often steel, is embedded within the material and adds both strength and flexibility to the final product. Children may recognise structural concrete in the spans of bridges on motorways for example.

Soil samples

The best places to find soil containing organic matter are either from woodland or a hedgerow area or an organically managed vegetable garden. Soil that has been regularly cultivated but not "fed" with compost will have less organic matter in it. Remember the health and safety note from the previous lesson.

Activity:

Give each pair of children a copy of worksheet 4.

Read aloud the paragraph at the top of the worksheet and ensure children understand how both the mineral and organic particles in the soil help a worm survive.

Using the class whiteboard, with the children's help, compile a vocabulary list of different soil constituents:

- Mineral particles. *Clay, mud, dirt, sand, grit, pebble, stone, rock, etc.*
- Organic particles. *Stick, leaf, roots, manure, insect, bone, hair.*

Help the children extend the list from their observations as the lesson progresses.

Explain to the children that in pairs they are going to examine some different kinds of materials to find out which would be best for a worm to live in.

Give out a magnifying glass, a spatula and an empty used plastic container to each pair of children.

Put a sample of one soil (the local soil if you're also completing the geography unit) in each plastic container.

Tell the children not to touch the soil with their hands, reminding them of the health and safety issues raised in the previous lesson.

Tell the children how to:

- Use the magnifying glass.
- Move the soil around with the spatula
- Work as a team, one child observing and the other recording on the worksheet what the other sees. Explain that they will reverse roles with another sample.
- Exchange soil/ building material samples when they have completed each observation and recording.

Tell the children to complete the questions on the worksheet.

In the plenary discuss the children's observations and answers. You could use the interactive whiteboard and a copy of worksheet 4 to summarise the children's answers.

Hopefully the children will identify the soil with the most organic matter as being most suitable for worms.

Ask the children to explain why the sand and gravel sample:

1. Would not be useful for worms to live in;
2. Is very useful for humans.

Finally, to illustrate the second point (above), using the *Virtual Quarry* and ICT, show how the *sand and gravel* mixture:

- Is quarried, washed and sieved;
- Used to make cement mortar and concrete.

Show the children, either through the classroom window or with photographs, local familiar structures which contain either cement mortar or concrete.

Notes for teachers
To use this worksheet on an interactive white board select:
- View – Reading Layout;
- On the toolbar select 'actual page' and the 'multiple page' option.

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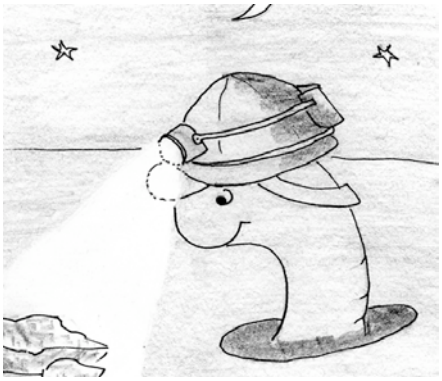
Worksheet 4 "Which is my favourite soil?"



"Worms like me are very interested in soils!
We tunnel in the soil. We gobble up all the tiny pieces that are in our way. We use the tiny bits of rock to help us munch up bits of dead plants and animals.
Dead plants and animals are our food!"

1. "Look closely at these three kinds of soils.
List down all the different things you can see in each soil."

1. First sample	2. Second sample	3. Third sample

2. "Which of these soils would I like to live in?"

I like

3. "Why do you think I would like to live in it?"

It is best because

Lesson 6 "Sorting our own sand and gravel."

Prior Knowledge / Work:
The purpose of this lesson will be clearer if pupils have seen the *Virtual Quarry.*
Learning Objectives:

- That particles of different sizes can be separated by sieving.

Subject Links:

- Design and Technology (POS 5)

Resources:
Soil samples from the previous lesson, sand and gravel samples;
Different grades of sieve;
Sheets of newspaper;
Wooden rolling pin or similar for crushing soil particles;
Plastic sheets.

If you don't have different grades of sieve you can construct your own using:
Nails or knitting needles of different diameter;
Hammer;
Flat wooden surface;
Used margarine tubs or ice cream cartons, etc.

Constructing a homemade sieve
Place a margarine tub on a flat wooden surface. Then either using a knitting needle or a nail and hammer, repeatedly push or gently tap separate holes through the base of the margarine tub from the inside.

Background Information:
This is an activity that is best completed by a small supervised group. It could be structured as a whole class demonstration activity.

Activity:
Prior to the activity, with the children, you will need to wash the two separate samples of soil obtained for lesson 5. You'll need to try and remove as much organic matter as possible, especially small, visible, living soil organisms. These samples will need to spread out on a plastic sheet and left to dry for a day or so.

At the beginning of the lesson remind the children of the previous lesson. Show the children the samples of sand and gravel and discuss how they are obtained.
Tell the children that they are going to see if they can sort some sand and gravel from the two soils they tested in lesson 5.

Now in a method consistent with the school's policy on handling soil (See lesson 3):

1. Show how dried soil can be split into small separate particles by gently crushing with a rolling pin on a hard surface.
2. Show the children the different grades of sieve.
3. Discuss a sensible way to sieve some of the soil. Remind children of the *Virtual Quarry.* Large heavy material was screened out first.
4. Let children in turn sieve onto sheets of newspaper the progressively reducing samples of soil gradually separating the stones that were too big to go through the holes. Keep small piles of separated material.

Finally display some of the dried original soil, the sample of sand and gravel, the materials separated in the class and the sieves. Ask the children to record or explain how they sorted their soil sample and how it differs from the sand and gravel sample.

Lesson 7: The strongest sand or soil castle

Prior Knowledge / Work:
This is a structured class or group activity which could be completed either in addition to, or as an alternative to, the penultimate activity in the QCA unit. It uses soil and quarried products (sand and sand and gravel). This can be an enjoyable testing activity in which pupils measure simple volumes of material. An element of unfairness is introduced into the test.

Learning Objectives:

- To plan an enjoyable test using simple apparatus.
- To carry out the test and recognise unfair elements.
- To use their results to make comparisons and draw and explain conclusions.

Subject Links:

- Design and technology. Evaluating products (POS 3b)
- Numeracy (Understanding measures).
- ICT. Using an interactive whiteboard (POS 5b)
- Citizenship Making decisions democratically (POS 2g, 5d)

Resources:

- Fairly dry samples of soil, sand and sand and gravel from previous lessons in separate waterproof containers.
- Six identical plastic cartons to be used as "castle" moulds. I.e. empty yoghurt pots or cream cartons.
- Water.
- A piece of plastic guttering between one and two metres in length.
- Tennis ball or alternative. (see background below)
- ICT. Interactive whiteboard and worksheet 5.

Background Information:

The test.

Try the version of the test described in the activity section below before you attempt the lesson with the children. Check that:

1. The "dry" materials are not too dry and friable and will make "castles."
2. The tennis ball is heavy enough to damage a "dry" sand castle with the gradient that is achievable with the resources you have available. If necessary replace the tennis ball with a lighter plastic ball or a heavier cricket or rounders ball.

Two obvious unfair elements introduced into this test are:

- How hard the children compress the material into the plastic carton to make the castle;
- The volume of water used to improve the performance of their castle.

Activity:

Remind children of the times when they have been in a nursery class or on a beach and made a "castle" using a bucket and sand. Tell the children that they are going to use the soil, sand and sand and gravel from the previous lessons in a competition.
Explain that together they will find out which material makes the strongest castle.

Make a demonstration castle using a plastic carton and dry sand.
Ask the children what you mean by "strongest castle." Elicit the idea that it is the most difficult to knock down.

Ask the children how they could fairly test the strength of the castle. You might have to stimulate the discussion by suggesting some tests with obvious shortcomings. I.e. *we could see how many jumps it takes to flatten it. We could throw a ball at it and see how many throws until it is knocked down.*
Carefully develop the children's ideas questioning elements that might be unfair.

At an appropriate time, show the children the length of plastic guttering and a tennis ball. Elicit from discussion that:
- One end of the guttering could be raised and supported on something like the seat of a chair;
- A castle could be built on the floor at the end of the guttering;
- The tennis ball could be put on the guttering at a sensible place and allowed to roll into the castle;
- The children could decide how much damage was caused to the castle.

Make a castle out of one material and demonstrate the test. Explain that other castles could be built and tested in the same way.

Show the children *worksheet 5* on the interactive whiteboard.
Explain the key to show the damage to each castle cause by the ball in the test.
Select children to quickly make the castles from the three separate dry materials.
Test each castle in turn. Ask pupils to:
- Vote to decide on the amount of damage caused to each castle;
- Use *drag and drop* on the interactive whiteboard and insert the correct symbol from the "bank" beneath the result table.

Suggest that the children retest the castles but that they dampen the material first.
Help the children add modest quantities of water to each material to *make it damp but not soggy!*
Then remake the castles and retest them. Don't draw children's attention to the inequality of the amount of water added.
Record the results and then ask the children to complete the questions at the end of the worksheet.

In the plenary, using the interactive whiteboard, discuss:
- Which castle was the strongest and the reasons the children gave for its strength;
- How they would make strong sand castles next time they are playing on a beach;
- The unfair elements in the test.

Notes for teachers
- Select View – Reading Layout;
- On the toolbar select 'actual page' and the 'multiple page' option.

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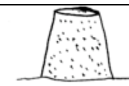
Worksheet 5 "The strongest sand or soil castle"

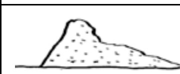
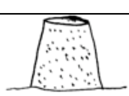
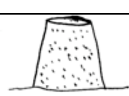
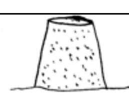
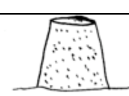
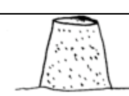
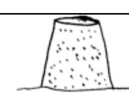
This key shows how much damage is done to the castle in the test.

Destroyed	Very damaged	Some damage	Intact
			

1. What happened to each castle?

The material that was used to make the castle	What happened?
Sand	
Soil	
Sand and gravel	
Wet sand	
Wet soil	
Wet sand and gravel	

Symbol bank Drag and drop pictures

2. Which of the castles that we tested was the strongest?

3. Why do you think this castle was strong?

4. Which parts of the test were not fair?