Why&How? Magazine

Autumn 2025: Issue 25

Special 25th Issue:

A look back at previous articles and resources

Supporting excellent teaching and learning in primary science
Why & How? is the magazine of the Primary Science Teaching Trust

In this issue...






PSTT recommends that before undertaking any of the practical investigations contained in this publication you engage with the guidance and up-to-date advice from your Health and Safety adviser / organisation on how to do so safely.

In England, Wales & Northern Ireland refer to CLEAPSS (cleapss.org.uk) and in Scotland to SSERC (serc.org.uk).

Why & How? is the brand name of the Primary Science Teaching Trust

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Connect with us:

Welcome

Welcome to Issue 25 of Why & How? – and the final issue of our magazine in this format.

Over the past year, we've been reflecting on how the Primary Science Teaching Trust (PSTT) can best use its resources to support classroom practice across the UK. We want to make sure that teachers at all stages of their careers – from initial training to senior leadership – can access high quality advice and professional learning from PSTT.

It is a real pleasure to produce Why & How?, and to share such an engaging range of classroom activities, ideas and opportunities with you all. Each issue has involved significant research, writing and editing from our dedicated team and partner organisations. We've now decided to rest the magazine in its current format, so that we can invest our efforts in new ways to support the development of primary science teaching.

To bow out in style, we've collated a selection of the very best the magazine has offered over the past eight years. In these pages you'll find our expert advice on how to work with common science misconceptions; a selection of our most interesting Pictures for Talk to use in the classroom; free PSTT resources that link cutting-edge science to the curriculum; activities to engage children with climate science, microplastics and UK wildlife; and strategies for early years and science clubs.

We look forward to sharing more primary science news with you, so please stay subscribed to our mailing list – we have exciting projects and activities in the works.

Martin Pollard, CEO

Looking for more primary science support?

PSTT supports teachers at all stages of their journey with primary science.
Find out more about our full range of events and the support offered by our **expert Regional Mentors**.

Our programme in 2025-26 includes:

- **Science for Early Career Teachers** – free webinar series offering clear, practical training across the academic year
- **Festive Science Investigations** – recorded lessons providing fun, seasonally themed science investigations for all age groups
- **Early Years Science** – one-day course to develop effective science provision for ages 3-5
- **Additional Learning Needs** – helping you to support learners with additional needs in the science classroom
- **Online Science Days** – live science lessons from our award-winning teachers, taking place during British Science Week

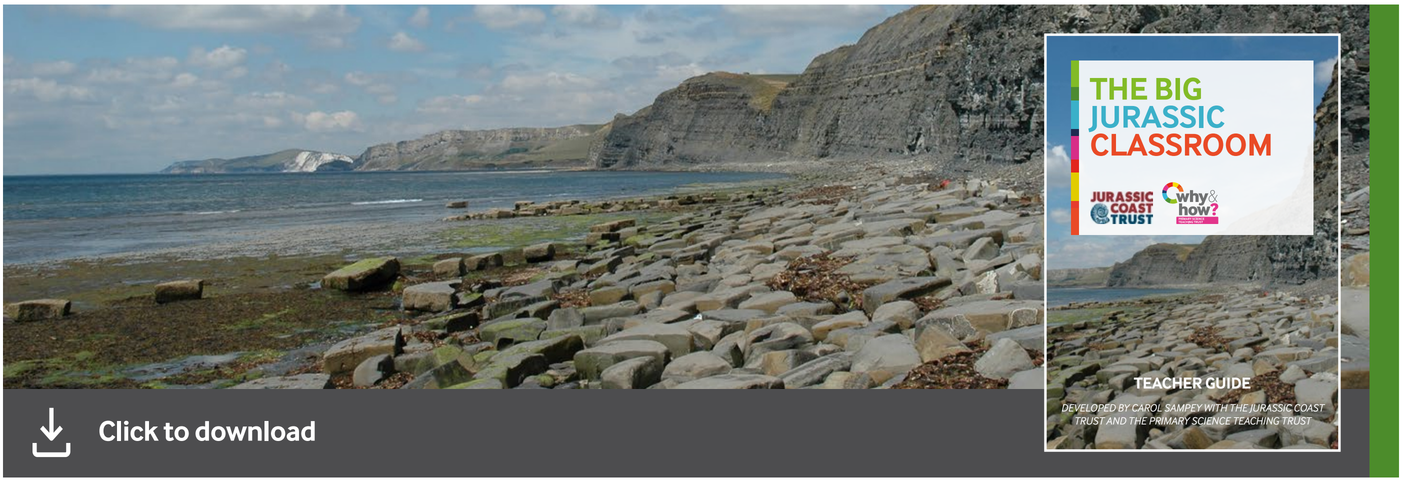
The following articles are taken from our archive. Therefore, some of the stats may be out of date and teachers should check the latest data.

Please do share this issue of Why & How? with anyone who would like to receive free resources, classroom guidance, and updates from PSTT and other organisations who support primary science.

Primary Science Teaching Trust

Free Resources

Big Jurassic Classroom



jurassiccoast_kimmeridge_2005_copyright_jurassiccoastteam.

The Primary Science Teaching Trust has worked with the Jurassic Coast Trust since 2014, culminating in the production of The Big Jurassic Classroom book.

This free to download book brings together resources and information to show teachers how they can use their local environments to inspire interest in the UK's geological history. Compiled by PSTT Fellow and Area Mentor Carol Sampey, the book includes exciting activities for learning about rocks, fossils and evolution.

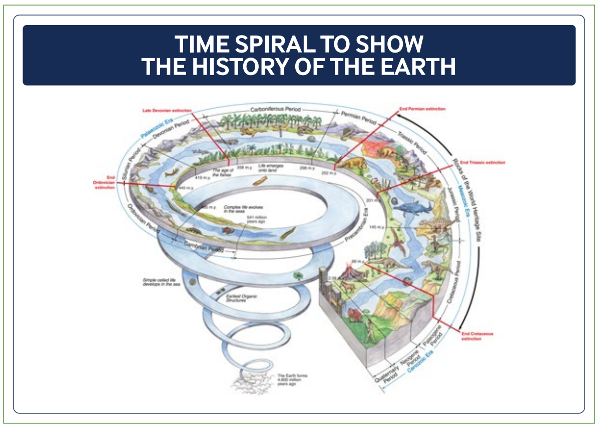
All the reproducible resources in the book are available at full size in a separate resource pack, also free to download **here**.

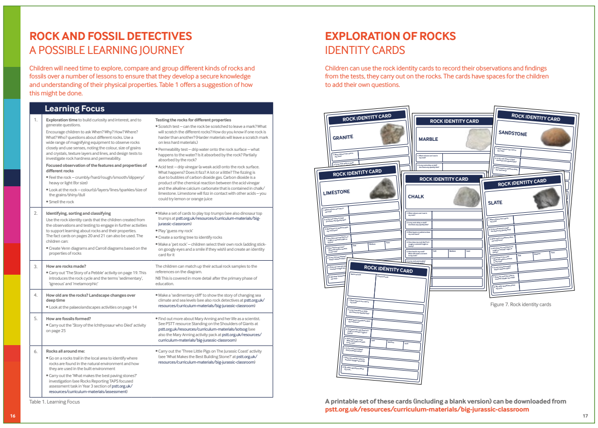
We provide Teacher Guides which explain:

- The appropriate age range for the activities
- Subjects and topics covered
- Resources needed
- What the activity is about

There are also Activity Packs which provide:

- Images
- Worksheets
- Instructions for carrying out the activities





Free Resources

Play, observe and ask (in EYFS)

Strategies, provision, activities and examples of young children learning science to support early years and foundation stage practitioners.

This resource focuses on the teaching and learning of science through play. It provides support for adults who are helping very young children (ages 3-5) to explore the world around them with a focus on learning science. Organised into comprehensive sections, the activities and strategies are suitable for use by educators in an Early Years setting or by parents or carers at home.

The **Effective Practice** section explains how you could develop science teaching and learning in your Early Years setting or at home. You will find strategies that you might like to use to develop children's science skills and science vocabulary, as well as their knowledge and understanding of the world around them.

The **Provision Maps** offer ideas for activities and science investigations suitable for Early Years children. These are one-page maps that focus on learning science in an Early Years classroom or outdoors and they are linked to different topics, nursery rhymes and storybooks that are commonly used with this age range.

The **Resources** section contains wildlife games and activities that introduce plants, animals and fungi commonly found in Britain. These are intended to develop children's knowledge of the names and features of living things and their habitats that might be found in their local environment. This will enable children to become familiar with the natural world around them, and through this develop an enjoyment of nature and a desire to care for it.

The **Frequently Asked Questions** cover some commonly asked questions about some of the challenges faced by Early Years practitioners and offer some ideas to overcome these.

Acknowledgements

This resource was created in 2021 by PSTT Fellows who have extensive experience teaching in the Early Years Foundation Stage: Jane Catto, Chris Lawson, Kathy Schofield, Claire Seeley and Alison Trew (in England), Elaine Stockdale (in Wales), Liz Branniff (In Northern Ireland) and Nicola Connor (in Scotland.

We are also extremely grateful to Susanna Ramsey, founder of **The Nature Collection**, who has freely shared her images and ideas that we have included in the Wildlife materials.

Click **here** to download the guide

Free Resources

UK Wildlife

NEW! Resources for learning about animals and plants in the context of UK wildlife.

We have been delighted to work with the **Nature Collection** to create these resources and we are extremely grateful to Susanna Ramsey for her generous donation of their original images to the PSTT.

Click Here to access the resources.

Our brand new wildlife resources are designed to:

- Raise children's awareness of the wide variety of animals, plants and fungi that can be found in the UK
- Support the development of children's observational skills
- Encourage children's use of correct scientific vocabulary
- Increase scientific literacy through promoting paired or group talk

There resources are suitable for using across the primary age range. They include games, card sorts, paired pictures for talk, annotated slideshows, and odd one out activities.

They can be used before taking children outside to explore their natural environment, as a follow-on activity after going outside, or as stand-alone activities. All the resources include supporting background knowledge for teachers and links to other related resources.

The resources are organised in three sections.

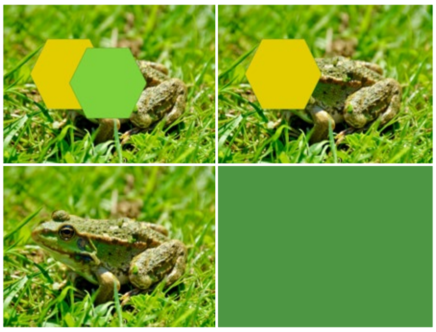
1. Animals

The animal resources are ideal for developing children's subject knowledge and learning the names and features of animals typically found in parks, gardens, fields and hedgerows in the United Kingdom. The activities are interactive, fun and varied, and include opportunities to guess the animal in the picture as parts of it are gradually revealed, or to match picture halves to make a 'wildlife face'.

Examples from the animal resources:

Who is hiding?

Which animal might be hiding behind these shapes?



The slides that follow take away a shape at a time to reveal the animal

Matching faces

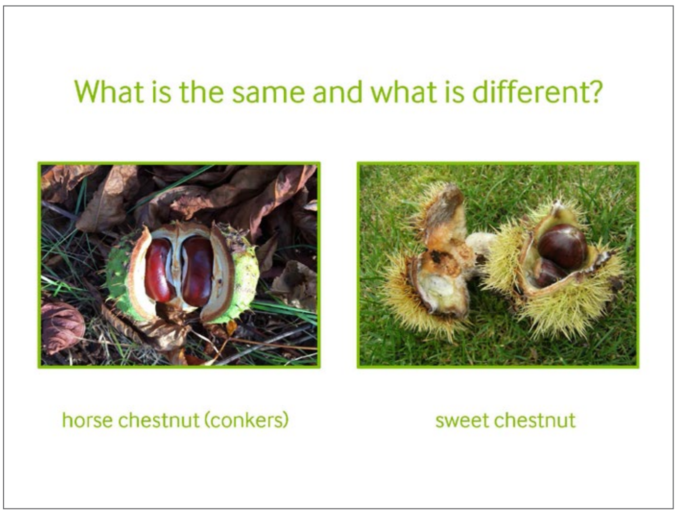
Can the children find the pair to each picture to make a complete animal face and then can they find out what the animal is called?

2. Plants and Fungi

The plant and fungi resources support children to learn the names and features of **plants and fungi** and encourage them to spot them when they are in the outdoors. Children are encouraged to observe closely to choose an odd one out and to explain how they made their choice. The paired picture activities also encourage focussed observation.

Examples from the plant and fungi resources:

Paired pictures



Questions to encourage children to observe closely and describe similarities and differences

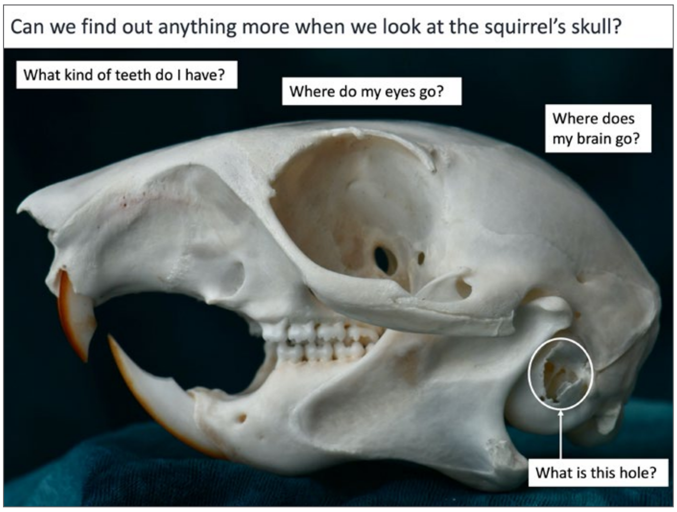
3. Mammal Skulls and Teeth

This set of six slideshows encourage children to **think** about the links between structure and function and how particular **features** of animals enable them to **survive**. Each slideshow features one mammal (badger, deer, fox, hedgehog, rabbit, squirrel). Each starts with a series of questions (answers are also included) about the external features of the animal before moving on to consider the animal's skull and teeth in more detail. The slideshows can be used flexibly and the discussions with the children can be pitched as appropriate for their developmental stage.

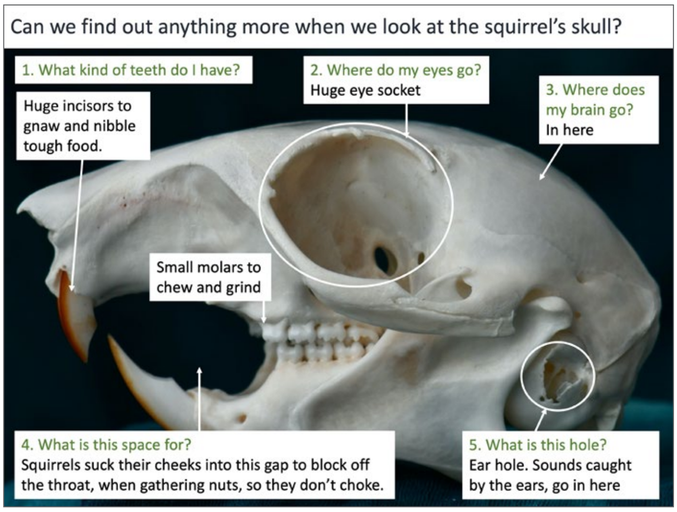
Examples from the mammal skulls and teeth resources:

Questions to encourage the children to observe closely and to link the animal's features with how it survives

Answers on the next slide support the development of children's scientific thinking and understanding



Questions to encourage the children to observe closely and think about the structure and function of the animal's skull and teeth



Answers on the next slide support the development of children's scientific thinking and understanding

Acknowledgements
the Nature Collection

Free Resources

Science and STEM Club resources – Eco Science

children's UNIVERSITY®

We have a set of club resources to add to our collection of ready-to-go packs that will get children engaged in practical investigations.

Eco Science is a series of eight activities related to recent research about the environment and climate. They are ideal for use in a weekly club with children aged 7-11 years. Each activity is based on one of PSTT's 'I bet you didn't know' articles. Teachers and adults interested in introducing primary children to cutting-edge research may be interested in these and other articles, all available **here**.

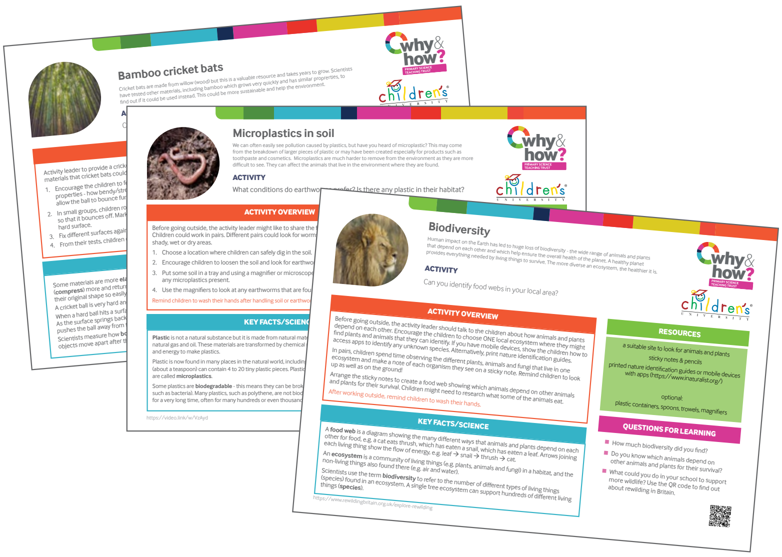
The Eco Science pack was created by PSTT College Fellow, Alison Trew, and the *I bet you didn't know* Team.

More about PSTT's Science and STEM Club resources

Each club pack includes:

- An overview of how to run the sessions with a list of simple, everyday materials needed
- An activity sheet giving the club leader guidance on organising the activities; including a practical challenge for the children, key facts, ideas for questions and further activities
- A fact sheet with some club packs for children to take home for further learning with family
- Validation by the **Children's University** that count towards accredited learning for any children taking part.

Explore our **Science Club Packs** to learn more about the benefits of running a science club



Sample activity sheets for microplastics in soil, biodiversity and bamboo cricket bats.

Sample fact sheets for termite tunnels and water harvesting.

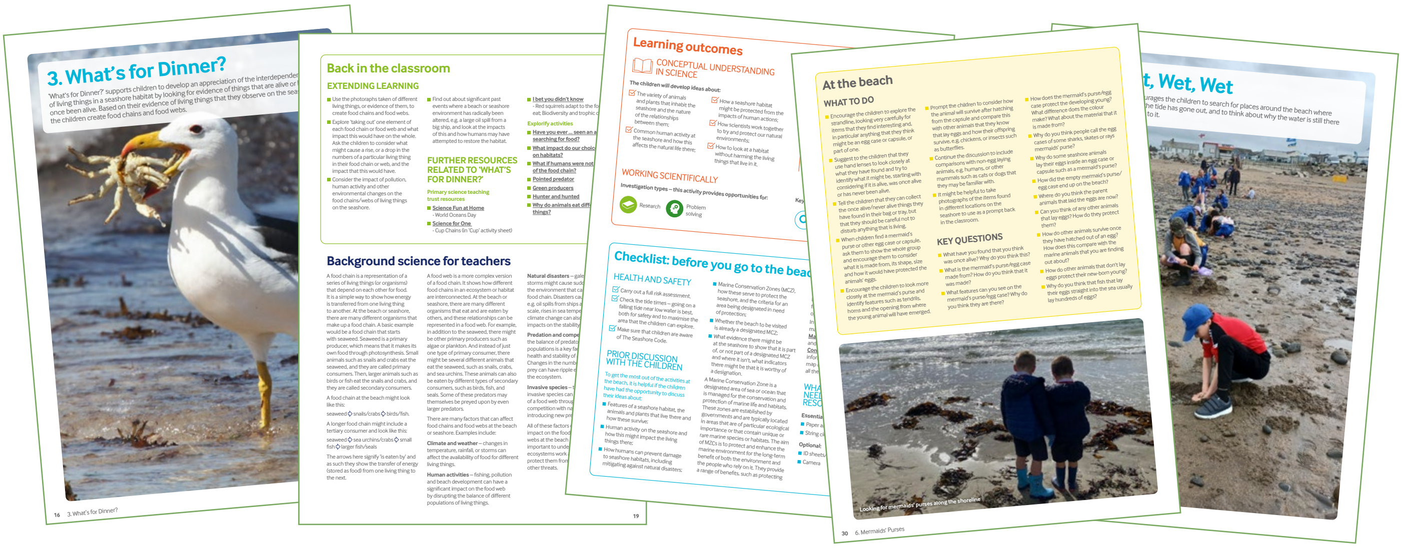
Free Resources

Seashore Science

Seashore Science – take science learning to the beach with our brand new free resource

Learning science at the beach offers all the benefits of outdoor learning as well as specific opportunities to encourage awareness of environmental issues such as plastic pollution and global warming. Exploring the impact that these have on marine and seashore ecosystems will help to cultivate a greater environmental awareness and a sense of stewardship, giving children a lifelong appreciation for the world around us.

Seashore Science is a 'pick up and go' set of 15 lessons to carry out at the beach, all with minimal requirements for equipment and preparation. The lessons cover substantive concepts relating to the biological, chemical and physical sciences, and they all offer opportunities to develop disciplinary knowledge and to learn and apply skills of working scientifically. The lessons are highly adaptable so they can be used with any primary age, and in a variety of coastal locations and types of shoreline.



Each Seashore Science lesson contains the following:

- Expected learning outcomes for children's conceptual development as well as skills of working scientifically that the children might learn and apply
- Key vocabulary
- Pre-visit checklist – what to do before you go to the beach
- At the beach – a step-by-step list of suggestions about what to do
- Key questions to support children's thinking and explaining
- Ideas for extending learning back in the classroom
- Suggestions for further resources related to the lesson
- Background science explanations to support teachers
- Links to UK science curricula

Download your free book **now**

"Seashore Science is simple and straightforward to use. Everything is included to enable teachers to deliver a fun and engaging practical session that challenges the children and meets requirements in the curriculum."

PROJECT TEACHER

"The key questions are brilliant, especially for supporting parent helpers, and for providing a challenge during the activities."

PROJECT TEACHER

"Seashore Science helps children think about what they already know. The Power of the Sea lesson was great as they made links with their prior learning about rocks and about forces."

PROJECT TEACHER

"Everything is incredibly user-friendly and clearly set out - it can be used by learning support assistants and teachers, and is great for anyone less confident in science."

PROJECT TEACHER

Free Resources

Pictures for Talk

A picture can be a very good stimulus for children to engage in effective talk in science.

Using pictures is an inclusive approach which facilitates high levels of participation. Pictures can also be used as a starting point for enquiry. The discussions the children have will generate questions that they want to investigate.

Asking the children carefully chosen questions about the picture will support them with learning to:

- Construct explanations and link their ideas with evidence
- Make confident challenges to the ideas of others
- Explore scientific terminology and use it with genuine understanding

Pictures for talk in science activities are designed to be very open ended and usable with children of any age. The activities can be done as a quick ten-minute starter, or extended into a longer and more in-depth lesson.

Click to download image

Figure 1: '"Last House on Holland Island", 23rd May 2010, online image, Flickr, 20th May 2019.

What to do

Download the image in figure 1 by following the link and either display on a whiteboard or give out printed copies. Ask the children to discuss, in groups of three, the following questions:

What do you think has happened to this house over time?

Why do you think this?

What do you think might happen next?

Other questions to generate and promote thinking and explaining:

- The picture is called 'Last House on Holland Island' (it was taken in May 2010 by an American photographer)
- Why do you think the photographer gave it this name? What further evidence might be useful to help you answer this question?
- What materials were chosen to make this building?
- Why do you think they were they chosen?
- What problems do you think the house has faced?
- Do you think that these problems could have been prevented? Why do you think this?
- Ask the children to look closely at the photograph. Is the house floating? Why do you think this?
- What type of birds are on the roof of the building? Why might they choose this place?

Follow-on discussion ideas:

- The house was built in 1888. What do you think the house would have looked like 100 years ago? What might it look like in 10 years' time? Why do you thinkthis?

Download and look at the two pictures below that follow on from the main image:

- Is the house floating in the first image?
- Why do you think the house was burned down after it collapsed? What does this tell you about the materials from which it was made?

Click to download image

Figure 1: "Duria Antiquior – A more ancient Dorset' is a watercolour painted in 1830 by the geologist Henry De la Beche based on fossils found by Mary Anning, and was the first pictorial representation of a scene from deep time based on fossil evidence.

What to do

Download the image in figure 1 by following the link and either display on a whiteboard or give out printed copies. Ask the children to discuss, in groups of three, the following questions:

The picture was painted in 1830, but what time in history do you think it represents?

Why do you think this?

The animals drawn here would have been alive hundreds of millions of years ago. What evidence do you think the artist must have seen to be able to draw them?

Where might the evidence have been found?

Other questions to generate and promote thinking and explaining:

- Ask the children to look closely at the animals.
- What similarities are there to animals you might see today? Are there any differences?
- How many different animals can you see? Can you sort them into groups?
- What other living things are in the picture?
- Can you create a possible food chain from animals in the picture?
- What do the animals need to stay alive?

Follow-on discussion ideas:

- Why might these animals (or their descendants) no longer be seen today?
- The artist used fossil evidence discovered by Mary Anning. What type of scientist was Mary Anning?
- Ask the children to find out more about her life and work.
- Why might her life be considered unusual at that time?

For more information and ideas for teaching about fossils and geology, visit The **Big Jurassic Classroom**.

Click to download image

Figure 1: Extatosoma tiaratum, Insect, female, after 4th molt.

What to do

Download the image in figure 1 by following the link and either display on a whiteboard or give out printed copies. Ask the children to discuss, in groups of three, the following questions:

Can you see an animal in this picture?

What does it look like? Why does it look like this?

This is a spiny leaf insect. They are native to Australia and can grow to be as long as 20 cm. Their body and leg segments resemble leaves and they also curve their bodies to accentuate their leaf-like appearance. Their bodies are covered in thorn-like spikes for defence and for camouflage. Spiny leaf insects can be green, like this one, but they can be a creamy colour and many are brown which gives the appearance of a dead leaf (see the picture below). They don't bite or sting but they can spray an odour which deters predators.

Other questions to generate and promote thinking and explaining:

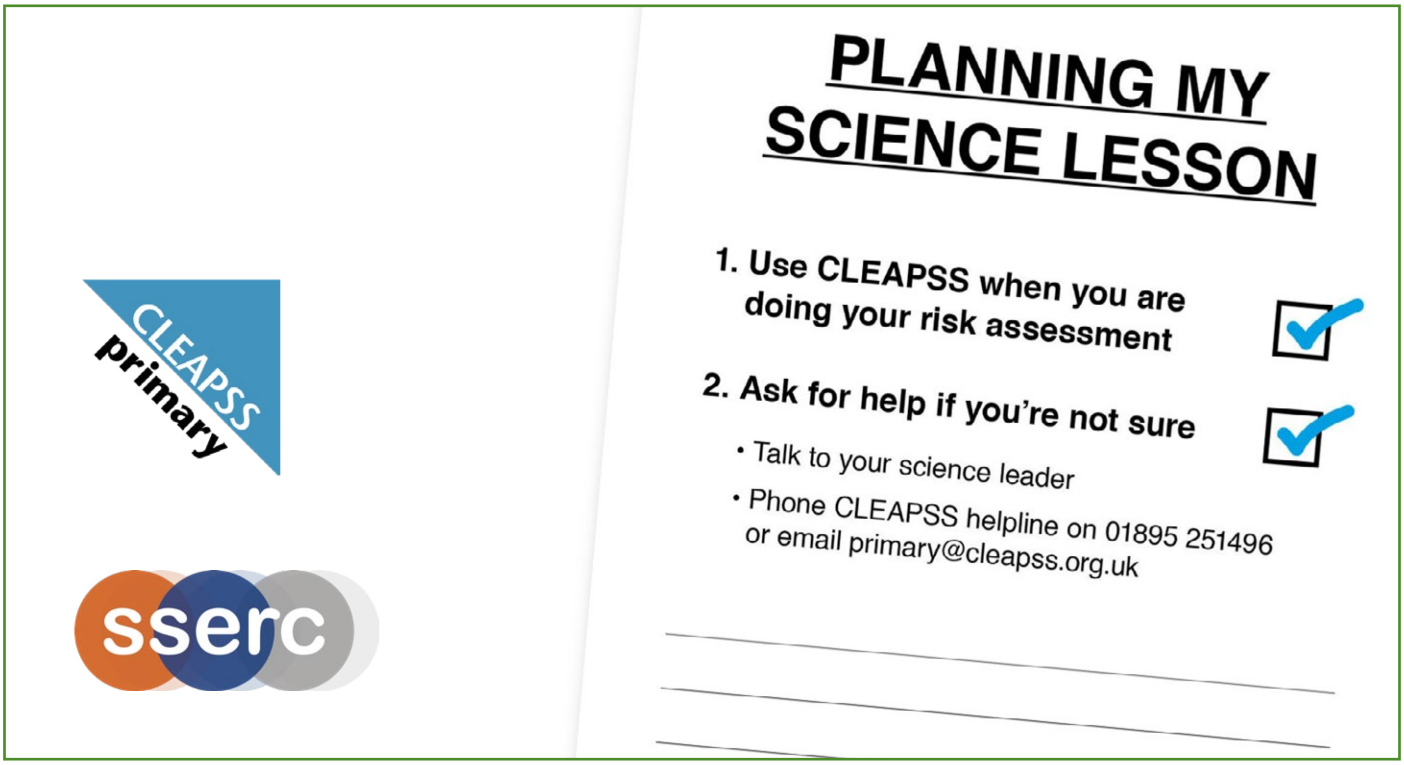
- What do the animal's legs and its body remind you of?
- What might want to eat this animal?
- How does the animal stop other animals eating it?
- How many legs does it have? What kind of animal do you think it is?
- What do you think it eats?

Follow-on discussion ideas:

Have a look at other pictures of insects that camouflage themselves by looking like leaves or twigs. Discuss the features of the insect, and the similarities and differences between them all. Use the questions above to prompt the discussion. Here are three pictures you might want to use. Large versions can be downloaded by clicking on the image.

Free Resources

Health and Safety in Primary Science



CLEAPSS checklist for planning a science lesson.

CLEAPSS and SSERC explain how to make the most of your membership with them.

CLEAPSS is the health and safety advisor for schools in England, Wales and Northern Ireland. SSERC does the same job for schools in Scotland. It's our job to provide member schools, and other educational organisations like PSTT, with safety advice including risk assessments for practical activities in science, DT, art and food.

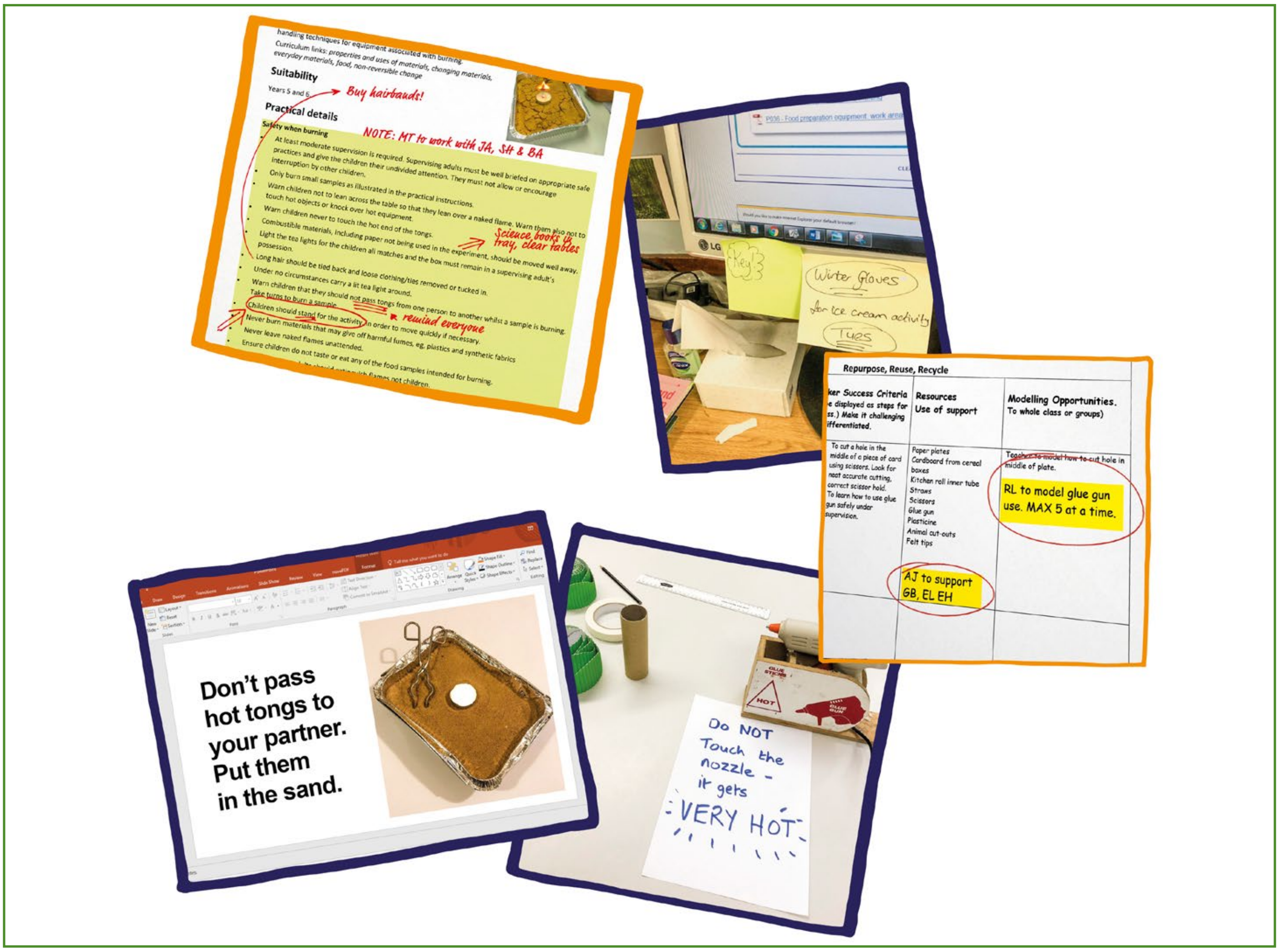
We've been doing this very specialised work since the 1960s. As a result, CLEAPSS and SSERC are a long way from a generic health and safety advisory service. All our staff used to work in schools and the advice we give is specifically developed for use by teachers with the children in their schools.

There are minor differences in the approaches taken by CLEAPSS and SSERC. If you are in Scotland make sure you read the sections on SSERC.

Do primary teachers need to risk assess activities?

Yes, but not in the way they might think. Often, when people think about 'doing a risk assessment' they imagine filling out a form listing the hazards including any substances or equipment being used, and then populating a grid with numbers that, allegedly, symbolise how dangerous each hazard is. Sadly, such procedures tend to be more about compliance than safety. Worse still, the forms may not keep anyone safe, and may even offer an undeserved sense of confidence.

CLEAPSS and SSERC do not believe in forms (at least not for forms' sake). At the heart of the risk assessment process is a simple question.



Examples of how teachers add risk assessment to their planning or give children instructions on how to stay safe.

"What are you going to DO to keep your children safe during the practical activity"?

Tragically, teachers often spend far too much time and effort assessing risks. Under the law, they're not expected to do this, are usually not qualified to do it, and in many cases, it has already been done.

The law says that it is the **employer's** responsibility to provide its employees (you) with risk assessments and safety advice. This is sensible - after all why would you know technical information about the safety of say: tadpoles, kitchen cupboard chemicals, voltage, compost or anything else you might do or use while teaching practical lessons?

Employers e.g. Local Authorities, Governing Bodies and MATs devolve the task of providing safety advice, including risk assessments, to us, CLEAPSS and SSERC. In return they expect you to use our resources to support you in keeping the children, yourself and others safe.

Does this mean that getting a risk assessment from CLEAPSS or SSERC is all I need do?

Nearly...but not quite. CLEAPSS and SSERC provide model risk assessments. You need to consider what we say about the activity/ substance/equipment you are intending to use in relation to what you know about your children and the environment in which you work. In most cases this will simply mean doing what CLEAPSS/SSERC says needs to be done. However, you may, having read CLEAPSS/SSERC advice, decide your children need extra support in order to remain safe. This is fine and exemplifies how the process is, first and foremost, about thinking. If, having looked at the guidance, you are unsure about how to make an activity safe for your class, then help is available, either by email or telephone, in the form of the CLEAPSS or SSERC Helplines.

Free Resources

Did you know?

Topic: Biodiversity & Habitats/Energy/Sound

Dr Alison Trew, PSTT College Fellow, links cutting-edge research with primary science

alison.trew@pstt.org.uk

Have you ever wondered what sounds there might be deep in the oceans?

Nature films are often soundtracked with meditative music so you may not have thought about this. Scientists have been monitoring the oceanic acoustic environment for many years and have shown that abiotic processes (earthquakes and volcanic activities), human activities (shipping, seismic exploration of subsurface deposits of crude oil, natural gas and minerals) and biotic sources (animal sounds) all contribute to this. Whales dominate the low-frequency range (low pitch) of many recordings.

Scientists know that whales use a variety of sounds to communicate verbally: clicks, whistles and pulses (which sound like squeaks to the human ear). Whales also use their tails and fins to make loud slapping noises on the surface of the water to communicate nonverbally. Discussing types of whale communication with children could be an interesting way to explore and learn about sound and environmental change.

Figure 1. An adult blue whale (Balaenoptera musculus), up to 29.9 m in length and a maximum recorded weight of 173 tonnes, it is the largest animal known to have ever existed.

Figure 2: A pygmy blue whale. Calls from Antarctic and pygmy blue whales, and fin whales, were analysed at sites across the Indian Ocean.

Questions children might like to consider:

How do whales communicate?

How is this different from how humans communicate?

Consider both verbal and body languages.

What about other animals?

What is happening when we make sound?

Children could explore many types of sound to develop an understanding that sound originates with a vibration.

Do you know what is meant by high and low pitch (the frequency of sound)?

Children could be asked to demonstrate their understanding by making appropriate sounds!

A 'sound' background

Sound is a pressure wave vibration of molecules. Whenever molecules vibrate, they will lose some energy to heat. Because of this, sound is lost to heating of the molecules in the medium it is propagating through. Consequently, a sound wave can only propagate through a limited distance. The attenuation of sound waves is frequency dependent in most materials. In general, low frequency waves travel further than high frequency waves because there is less energy transferred to the medium.

Sound research

Scientists have known for some years that whales emit low frequency calls (<100 Hz) which travel up to several hundreds of kilometres. They have also known that the frequency (pitch) of blue whale calls is decreasing worldwide but the reasons are unknown.

Recently, researchers have analysed acoustic data from six sites in the Indian Ocean over 7 years. They have shown a long-term frequency decrease (reduced pitch) for the call of the Antarctic blue whale, pygmy blue whales and the fin whale. To help children understand what this means, they could investigate how the pitch of a sound can be changed by tapping or blowing over bottles containing different amounts of water, or twanging rulers (details of investigations can be found in the Teacher Guide).

The researchers suggest that the long-term decrease in call frequency must have a long-term cause and describe two possibilities. The population density of the whales may have increased since the International Whaling Commission (IWC) banned commercial whaling because of the extreme depletion of most of the whale stocks. If whale numbers have increased, the interindividual distance is reduced and the need for whales to raise their call intensity (loudness) is reduced. Scientists believe that the intensity of the whale's call and its frequency are linked: low-level (quieter) calls have lower peak frequencies (lower pitch) than high-level (louder) calls. Thus, the lower frequencies of calls observed might be a result of an increase in the whale population. Alternatively, the acidification of the oceans since the industrial age has resulted in decreased sound absorption and therefore an increase in the distance the sound can travel. This means that for a given distance, the whales could lower their intensity of call and this might facilitate the lower-frequency calls.

In addition, the researchers have shown short-term cyclical call-frequency changes in Antarctic blue whales, fin whales and the Madagascan pygmy blue whales which follow the seasonal changes in ambient noise levels at similar frequencies. For example, the Antarctic blue whale low frequency noise level increased during the austral summer (January to February), which is when most iceberg cracking noises are heard, and decreased in the autumn (April to May) and winter. Because ship traffic (another potential source of noise) is limited in the southern Indian Ocean, the scientists suggest that the seasonal changes in whale calls could be due to the whales adapting to the seasonal changes in the ambient noise level. This adaptation to maintain the signal-to-noise ratio of vocalizations is known as the Lombard effect and has been demonstrated for birds, primates and for other species of whales.

Although noise levels are rising in other parts of the world ocean, there seems to be no effect on the worldwide frequency decline in whale calls. This presents a paradox: changes in environmental noise correlate with a short term seasonal effect on the frequency of whale calls, but not a long-term effect. Scientists will need to investigate acoustic behaviour of other whale species in other parts of the world, along with monitoring the pH and acoustic properties of the ocean to find answers to this.

How can children investigate sound in their local environment in a similar way to the scientists who carried out this research?

Using data loggers or sound apps, children could investigate ambient noise levels in different locations, at different times of the day, in different weather conditions, or how sound intensity (loudness) varies with distance from the noise source. They may also consider how different materials might reduce the distance sound travels. Apps for measuring sound frequency (pitch) are also available. Using an electronic sound source (a keyboard or computer) with fixed volume, children could investigate how far different frequencies of sound can travel and what effect different background noises have on this. Details of these investigations are included in the Teacher Guide (see figure 3).

Figure 3: Example pages from the accompanying Teacher Guide PowerPoint presentation.

Glossary

sound intensity – relates to the loudness of the sound (measured in decibels) which depends on the energy or power of the sound wave and how far the sound wave travels from its source.

sound frequency – the number of vibrations per second (measured in Hertz) which determines the pitch ('higher' and 'lower' sounds associated with music).

The paper that inspired this work was:

Long-Term and Seasonal Changes of Large Whale Call Frequency in the Southern Indian Ocean

By Emmanuelle C. Leroy[1], Jean-Yves Royer[1], Julien Bonnel[2], and Flore Samaran[3].

Journal of Geophysical Research: Oceans, **123**, 8568–8580. Accessed Oct 2019

[1]University of Brest and CNRS Laboratoire Géosciences Océan, IUEM, Plouzané, France.

[2]Woods Hole OceanographicInstitution, Woods Hole, Falmouth, MA, USA.

[3]UMR CNRS 6285 Lab-STICC, ENSTA Bretagne, Brest, France.

Investigations for children are described in the Teacher Guide which can be accessed **here**.

Free Resources

Did you know?

Topic: Food chains and webs

Paul Tyler, PSTT College Fellow, links cutting-edge research with primary science

topicalscienceupdates@gmail.com

About biodiversity and trophic cascades

Populations of some of the world's largest carnivores are declining to such an extent that it is having a damaging effect on biodiversity in their ecosystems (Figure1).

Figure 1. Nearly all wild lions live in Africa below the Sahara Desert. Lions eat birds, hares, turtles, mice and much larger animals such as antelopes, cheetahs, baby elephants and even tall giraffes.

Large carnivores such as lions, leopards, hyenas and wild dogs are the apex predators in their ecosystems. If they were removed, then the populations of herbivores that they hunted would have nothing to control their numbers, they would become less fearful and start to occupy new habitats. This can lead to potentially damaging changes in biodiversity in ecosystems.

Research scientists were interested in studying the effects of removing the apex predators in an ecosystem on the behaviour of the herbivores that would normally have been their prey. They were also interested in the knock-on effect on plant life in the ecosystem and whether they could reverse the effect through targeted rewilding.

The Mozambique Case Study

Opportunities to study whole ecosystem changes do not come around very often; the researchers in a recent study focused on what happened in Mozambique's Gorongosa National Park following the Mozambican Civil War (1977–1992). During the civil war, large mammal populations declined by more than 90% with leopards, hyenas and wild dogs being wiped out and the lion population being severely reduced.

The research team took advantage of the carnivore-depleted system to study the behaviour of the bushbuck antelope (Figure 2). The bushbuck is normally a closed habitat feeder, which means it likes areas with lots of plant cover to help it hide from predators. It is not normally found in the open floodplains where there is very little plant cover to hide it. Following the removal of the apex predators, the bushbucks were observed feeding freely in open landscapes on the Urema floodplains – this behaviour had not been observed prewar (Figure 3).

Figure 2. A bushbuck antelope.

Map data © 2020 Google Maps.

Figure 3. Aerial view of the Urema flood plain.

Data was collected using the satellite-based global positioning system (GPS) to monitor the bushbucks' movements, wildlife counts in specific areas, and DNA analysis of their diets to see what they had been eating. This data allowed the researchers to build up a picture of the bushbucks' changing habits in response to the lack of predators.

Clear evidence was found showing that, once the threat of predation was removed, the bushbucks were moving into the open floodplain areas to feed on the more abundant, and nutritious, plant growth found there. One consequence of the change in diet was that the floodplain bushbucks were in better condition and consistently larger than their woodland feeding counterparts.

The researchers studied the effect on plant growth caused by the change in bushbuck behaviour. They caged off some of the plants in the floodplains so the bushbuck could not eat them and they monitored the size of various plants against the control ones. They observed an increase in 'browsed stems' (stems which have been eaten) in the uncaged plants and a decrease in the number of flowers and leaves as well as a lower average height of the plants. The study showed that even in a relatively short amount of time, the bushbucks were having a significant effect on an ecosystem that they usually did not inhabit.

The final part of the study involved observing how the bushbucks would react to the reintroduction of predators into the ecosystem. This was done by simulating predator presence and monitoring the bushbucks using GPS trackers. The research team used recordings of the predator calls, sprayed areas with their scent, put down artificial lion scat (animal droppings) and carnivore urine to mimic the presence of predators in the area. They also set up a control experiment using generic white noise and herbivore urine and dung. The results from the two different areas were able to be directly compared.

The bushbucks strongly avoided all the predator signs but ignored the herbivore signs and the white noise. Scientists also monitored the plants in both areas and found that plants in the areas the bushbucks avoided showed rapid regrowth compared to in the areas where the bushbuck continued to feed.

This evidence shows that the bushbucks retain their natural instincts and fear of predators. They revert to their pre-war behaviour whenever the threat of predation is present. The next phase of the research is to reintroduce wild dogs into the National Park and monitor the bushbucks' behaviour. The hypothesis is that they will vacate the floodplains and return to feeding in the more densely covered woodland areas.

Why are trophic cascades important?

It was always thought that if apex predator numbers in an ecosystem were reduced, then the numbers of the organisms in the trophic levels below would increase and there would be a net benefit to the biodiversity of the system. This was part of the reasoning behind hunting wolves to extinction in Yellowstone National Park in the USA, culling magpies in the UK, and hunting whales in the Pacific Ocean to increase fish stocks.

What American zoologist Robert Paine found in his research, culminating in the 1980s, was the opposite. Eradicating the apex predators led to a decrease in the number of species thriving in the ecosystem and in many cases caused irreparable damage. He coined the term 'trophic cascade' to describe the changes in ecosystems when populations of apex predators are changed, most often by human interference; for example, the wolves in Yellowstone National Park (Figure 4). The Teacher Guide that accompanies this article explain how the biodiversity of their ecosystems was changed.

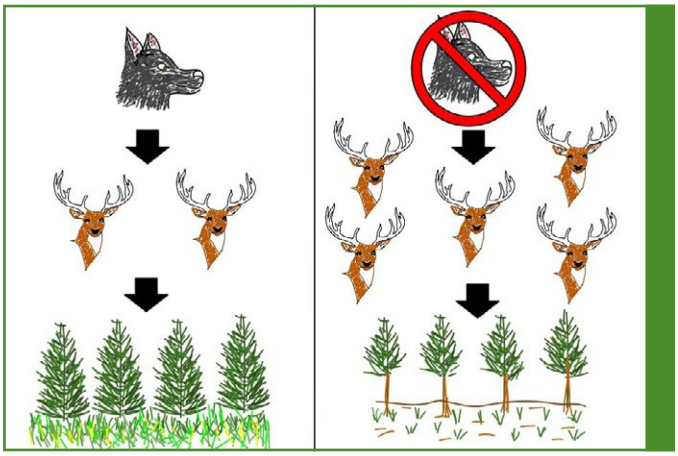


Figure 4. Trophic cascades describe more complex relationships than a simple food chain, or web. They describe the importance of every trophic level in the ecosystem to the success of it.

Top-down trophic cascades explain the importance of apex predators in ecosystems for ensuring that every organism, at every trophic level, thrives.

So why does rewilding matter?

In the 200,000 years since human beings have existed, they have had a greater impact on Earth's ecosystems than any other species; they are the 'ultimate ecosystem engineers'. This impact has accelerated rapidly in the last 200 years since the industrial revolution and it has mostly been negative (Figure 5).

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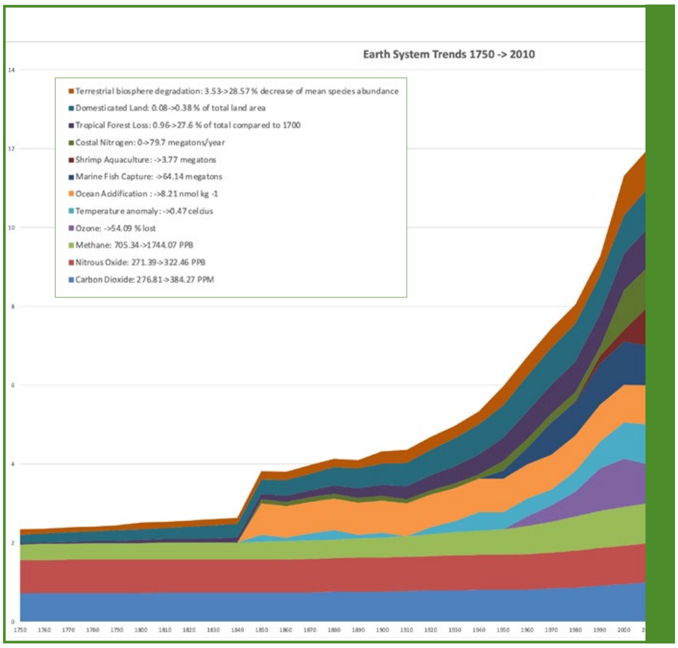

Figure 5. The graph shows the change in global temperature (observed by NASA) against the 1850-1900 average as a preindustrial baseline. The red line shows that the main driver for the temperature rise over the last 150 years is human activity.

Deforestation, species extinctions, natural resource exploitation and fossil fuel use have all increased almost dramatically. Unfortunately, most of this has happened without a real understanding of the impact. Ecosystems are very finely balanced, and the slightest human interaction can be the trigger for the rapid decline of biodiversity and functional species interactions.

Rewilding is simply a way of trying to return ecosystems to their pre-human interaction states by letting nature find the right balance at each trophic level. Each ecosystem is different, and cases need to be considered on their own merits but, so far, rewilding projects round the world have shown great potential in increasing biodiversity that had been adversely affected.

Glossary

apex predator – top predator in an ecosystem

biodiversity – the number of different species found in an ecosystem

ecosystem – a community of living things (e.g. animals and plants) in a habitat, together with the non-living parts of the environment (e.g. air and water)

ecosystem engineer – animal that alters the ecosystem in a specific way to create habitats for other species

habitat – the place that an animal or plant lives, providing all essentials for life

rewilding – the act of introducing specific species back into an ecosystem that they once inhabited

trophic cascade – the indirect effect of changes to apex predator and herbivore populations on levels of plant life

trophic levels – the stages in a food chain

The paper that inspired this work was:
Cascading impacts of large-carnivore extirpation in an African ecosystem.

By Justine L. Atkins[1], Ryan A. Long[2], Johan Pansu[1,3,4], Joshua H. Daskin[1], Arjun B. Potter[1], Marc E. Stalmans[5], Corina E. Tarnita[1], Robert M. Pringle[1].

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Investigations for children are described in the Teacher Guide which can be accessed **here**.

Common Misconceptions

Seeing the Light

Ruth Shallcross tells us how she helps children understand the Principles of Light.

What children need to know:

- That light travels in straight lines
- That objects are seen because they emit light (sources) or reflect light into the eye
- That we see things because light travels from light sources to our eyes or from light sources to objects and then (is reflected) to our eyes

Common misconceptions – often children will think that:

- Sight is purely an active human process (I am looking at something, which is why I can see it) or that eyes give out a form of light to enable us to see
- Reflective surfaces emit light
- Only shiny surfaces or water reflect light
- Opaque objects do not reflect light
- Opaque surfaces give out colour or 'darkness'

When teaching children about principles of light and how we see, I am guilty of holding back the full truth as a stepping stone to clear scientific understanding. Before you judge me, let me explain!

The principle here is seeing learning as a sequential jigsaw, where each new concept that is learnt is tagged on to prior learning. As the sequence progresses, children will need to 'rethink/redefine' some of their earlier understanding.

For children first learning about the principles of light, understanding that both reflective surfaces and opaque surfaces reflect light can be confusing. In an everyday context, children are familiar with reflection being a sense of mirroring connected with the reflections they see of themselves (or other people/objects). This understanding of reflection as mirroring is then further embedded when learning about reflection in maths. So, and here comes the fib, when first teaching children about principles of light, I have found it useful to create a distinction between the verbs I use. For light reflecting off any reflective surface, I use '**reflect**'; for light reflecting off any opaque surface, I use the term '**bounce**'.

At this stage, I am most concerned with getting on with the business of understanding the abstract concept of how we see, so I wish to avoid confusion.

Exploring how light interacts with different materials: transparent, translucent, reflective, opaque.

Primary school children's initial explorations of materials (typically Years 1 and 2) are from their perceptions of and experiences of materials. A transparent material will be 'a material which I can see through'; an opaque material will be 'a material which I cannot see through'. In Year 6, children need not only to build on their earlier understanding but also redefine it in terms of how the materials interact with light. This is best done through exploration of materials, to see how light interacts with them.

As a result of these explorations, children create new definitions: a transparent material becomes 'a material which lets most/all light through'; an opaque material becomes or 'a material which most light does not pass through' (and translucent materials allow some light to pass through).

Through their own life experiences and the results of their explorations, reflective surfaces and opaque surfaces appear to interact differently with light (Figure 1). I work with this understanding.

Before moving on, children need to experience and understand that:

- Light sources emit light
- Light travels in straight lines
- Without light, we cannot see

Figure 1: Children explore how different surfaces interact with light.

Understanding how we see objects

For this learning, I like children to work as a group to create a dynamic model which demonstrates how we see objects. A bouncy ball is used to represent how light travels (Figure 2). Using their model, the children role play and explain the process of how we see objects by breaking it into a sequence.

1. The light source emits light.
2. (Some of) the light travels in a straight line towards the opaque object.
3. Once the light reaches the opaque object, some of the light **bounces** off and travels in a straight line towards the human eye.
4. Some of the light enters the human eye; as a result, the object can be seen by the human.

To use reflect instead of bounce here can potentially confuse children because it may conflict with their own exploration/experience of materials.

"But there's no reflection, so why are you using reflect?"

"But light interacts differently with reflective surfaces and opaque surfaces – we saw that!"

After group work, I will move them on to demonstrating their understanding individually e.g. through the use of a scientific diagram (Figure 3).

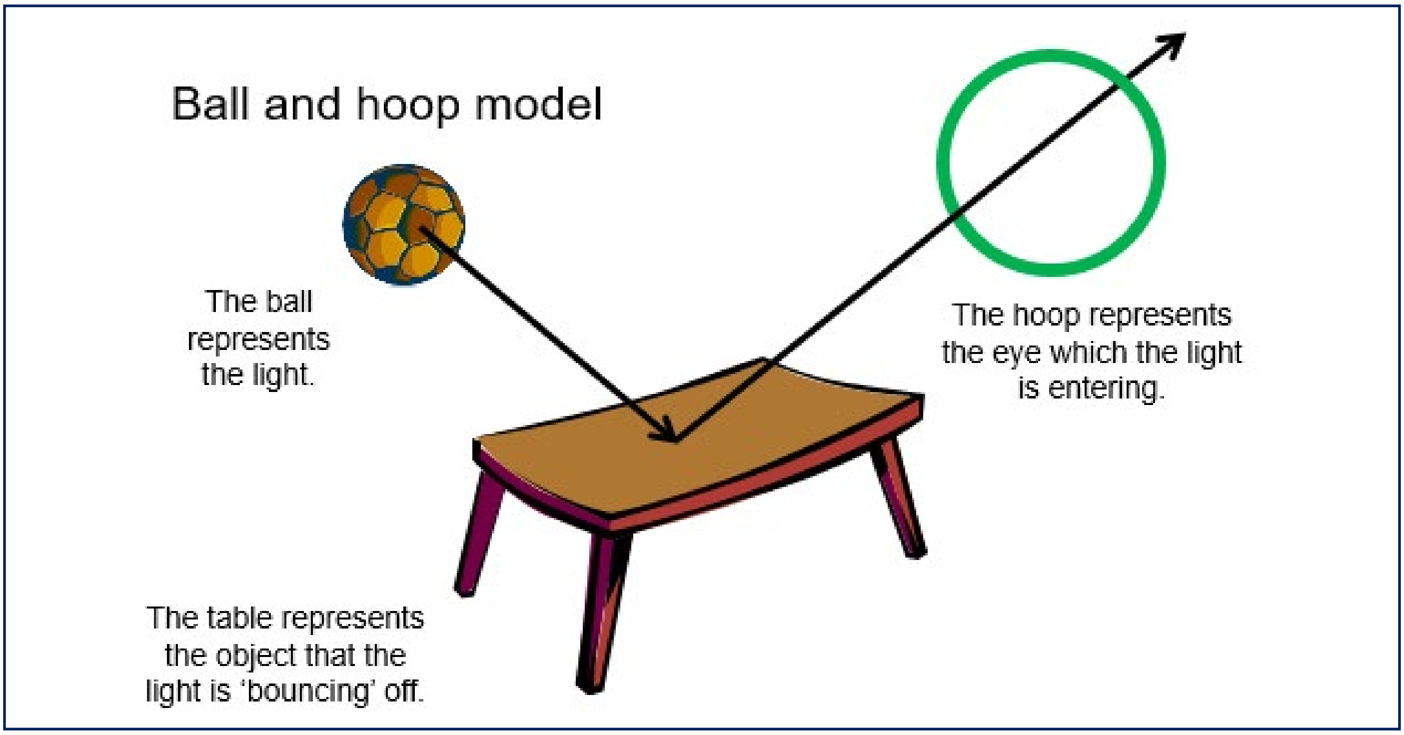


Figure 2: Dynamic models used to role play how light enables us to see objects.

Understanding how we see objects (or organisms) in mirrors

Once children have fully grasped how we see objects, it is time to introduce a mirror! I will ask children to return to their earlier human model and ask – how do we see using a mirror? Children are challenged to add the mirror into the role play.

After establishing the process, they explain.

- The light source emits light.
- (Some of) the light travels in a straight line towards the opaque object.
- Once the light reaches the opaque object, some of the light **bounces** off and travels in a straight line towards the mirror.
- The light hits the mirror and reflects off travelling in a straight line towards the human eye.
- Some of the light enters the human eye; as a result, the object can be seen by the human.

Moving learning on

If children understand how we see an object and how we see using mirrors or other reflective surfaces, then they are able to apply their knowledge to a range of different contexts e.g. how we see using a periscope. Once their understanding is totally secure, it is time for the truth!

Both reflective surfaces and opaque surfaces reflect light but why does it appear to be different?

If a surface is flat and very shiny, almost all of the light will be reflected, which produces clear images of objects (my face reflected in a mirror). Light will strike and reflect off at an equal angle.

Opaque surfaces are 'bumpy' in comparison to reflective surfaces. Light does reflect off such surfaces but it scatters in many directions and cannot create clear images.

The difference can be demonstrated using a bouncy ball and a flat tray (to represent the reflective surface) and an upside down muffin tray (to represent the dull surface). There will be a consistency to the direction in which the bouncy ball bounces off the tray but unpredictable scattering when using the muffin tray.

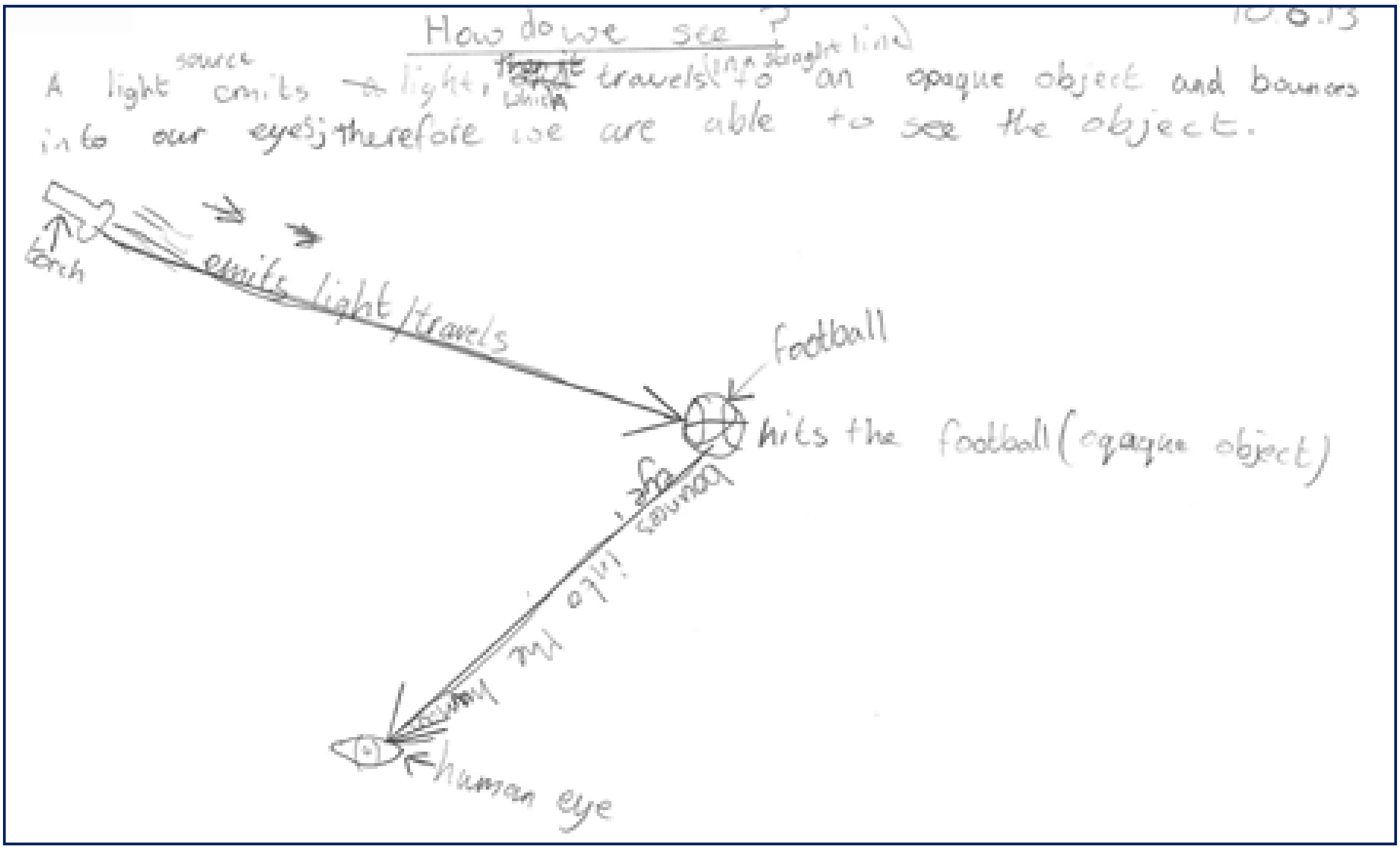


Figure 3: Children need to demonstrate their own understanding.

Common Misconceptions

Electricity

Kate Redhead, PSTT Regional Mentor, tells us how she helps children understand the Principles of Electricity.

What children need to know:

- A simple circuit consists of a series of conductors
- Some materials, such as metals, are conductors and others, such as plastic, are insulators
- A circuit needs to be complete to work
- The number and voltage of cells in a circuit affect the brightness of the bulb or loudness of the buzzer
- The reasons for differences in how components behave in a circuit
- The different symbols that represent a simple circuit

Common misconceptions – often children will think that:

- Different coloured wires affect how the circuit works
- Wire is made of plastic
- If a circuit is broken, energy goes off into the air
- Electricity comes out of both sides of the battery and leads to both sides of the component
- Current, voltage and electricity are all the same thing
- Current gets less as it passes through components
- Electricity is an object that can be seen

As teachers, if we're honest, there is always an area of the curriculum that we find 'challenging' to cover; the one we need to go over more thoroughly before we can facilitate it with full aplomb in the classroom. In science, for me, it has always been electricity.

Why electricity?

The abstract nature of energy being passed around a circuit seems to be the root of the cause; children can see the result (a buzzer sounding for example) but not what is making it happen; it is invisible. Research suggests that with abstract concepts like these, if we are not adequately able to encourage children to recognise what is happening, then they may leave the lesson having said all the right things and seemingly taken on board the learning, but actually still hold onto their own ideas about 'what is really happening' (Harlen and Qualter, 2006).

As with all science topics, the common use of words or phrases can also lead to misconceptions. We often refer to a single cell as a battery and speak of 'turning a light on' rather than making a bulb light up.

My own revision!

The fear of passing on my own possible misconceptions to the children, drives me to go back to basics before teaching the topic. Key terms and definitions, appropriate for primary level, are my starting point (see Table 1).

Whilst the curriculum may not dictate that children are clear on all of these formal terms when electricity is first introduced, I always use them in context as a way of slowly introducing science vocabulary that can be built on at key stage 3. However, I do exclude the use of the term 'electron' as this is not included in the curriculum until key stage 4.

Electricity	A form of energy.
Charge (electron)	An electric current flows when electric charges move through a wire. Just as in a flowing water system, the charge is analogous to the amount of water in the system.
Current	The movement or flow of electrical charges. This is measured in amps (A). The greater the charge that flows, the bigger the current. Just as in a flowing water system, the current is analogous to the flow of water.
Voltage	The voltage provides the force that pushes the current around the circuit. A voltmeter measures voltage in volts (V). The higher the voltage, the more current is passing through the component and if this is too high, a bulb could blow. Just as in a flowing water system, the voltage is analogous to water pressure.
Cell (electrical)	This generates the electrical energy (e.g. through chemical reactions that occur within the cell). When a cell is connected to a complete circuit, it provides a flow of electrical current to the components.
Battery	One or more cells joined together.
Components	The different parts of a circuit, for example: bulb, buzzer etc.

Table 1: Key terms and definitions.

Where to start in the classroom

Give children a set of circuit equipment and usually, they can make a component work without much difficulty. However, I prefer to start with a 'wow' and for this I use an 'energy ball', 'energy stick' (Figure 1) or 'circuit maker breaker', which literally provides a hands-on approach to exploring circuits. Each contains an open circuit that produces light and/or sound when completed – the children should offer explanations as to how this works.

Figure 1: Energy stick.

These devices are cheap to source, and work when the metal strips are touched on both sides and a connection is made across the surface of the skin (impurities in the sweat on our skin carry the current). In a class situation, they are an excellent tool to involve every child by forming a 'magic circle' (slowly increasing the number of children holding hands in a circle whilst keeping the connection on the metal strips). There are numerous possibilities for extending the learning in this: exploring whether different materials are electrical conductors and considering how switches work are just two examples.

Exploration and taking ownership

Next steps for me are to give the children chance to explore; baskets of equipment on each table (including bulbs and cells that are separate from their holders) and a variety of prompts at the ready for those that need it (Can you make a bulb light? Can you change the direction of the motor? Does it matter which way around the cell is? Etc.). As the children explore and make their own discoveries, I prompt them for predictions and explanations (see Figure 2). The aim is for the children to take ownership and begin to pose their own questions to investigate.

Post-It notes of the children's discoveries placed on a learning wall are a useful tool for identifying misconceptions and if time permits, I encourage the children to investigate further; often they will then reassess their findings as their explorations progress.

I also use this time to encourage children to recognise what is inside a wire, ensuring they know that the plastic is the coating and not the conductor.

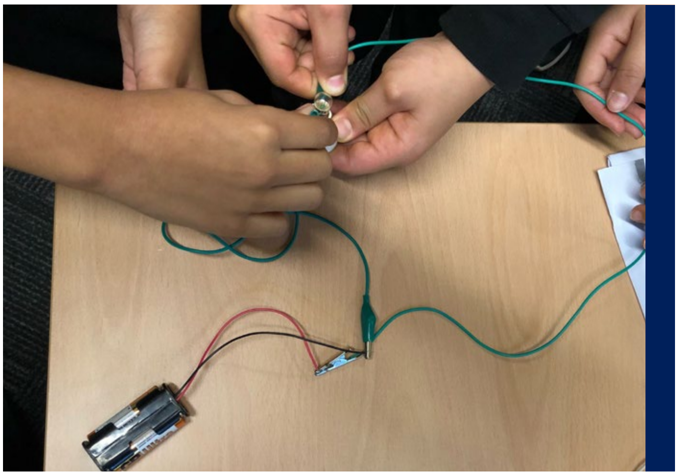


Figure 2: Children exploring with electrical equipment.

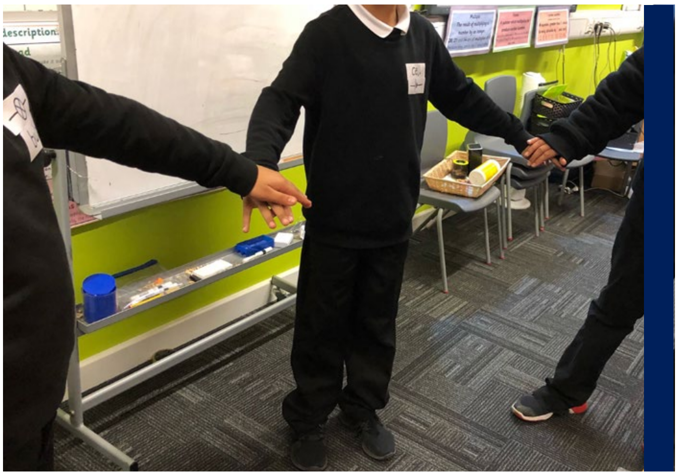


Figure 3: Children holding hands in a circle.

Assessing findings and using models to address misconceptions

Children are usually able to say what they think happens in a circuit and how they can change its results, but less clear on what is making it happen. Practical activities and models are excellent tools to address misconceptions, and if all children can be physically involved in a demonstration, they are much more likely to develop a thorough understanding. Whilst we all have our favourites, there is no perfect model, all having limitations and the children should be encouraged to identify these.

The first model I share is controversial! Some might say, it deepens a child's misconception that there is only one charge travelling around the circuit and that the charge takes time to travel from the cell to the bulb. I would argue that it allows this misconception to be addressed head on.

I start with the '**whole-class circuit**' and have a 'two stages' approach:

1. 'Passing the squeeze' around the circle first introduces the movement of charge in the circuit. A child wears a 'cell' hat and another a 'bulb' hat (Figure 3). The cell calls, "Go!" as they start the squeeze and the bulb, "On!" as the squeeze reaches them. Children could decide how they can show the effects of adding extra components into the circuit.

I then encourage children to recognise that the bulb was calling, "On!" only when the squeeze reached them and pose the question, "Did the bulb go on and off in the circuits we made?" This is where the misconception is addressed, as children see the difference between the model (with a bulb lighting intermittently, whenever the squeeze passed through it) to the actual circuit they created (where the bulb was lit whenever the circuit was complete). By demonstrating and underlining these differences, children see that there is not just one charge.

2. The 'Paper Game' helps the children understand that the charges are in the wires and all components. Each child in the circle is given a piece of scrunched up paper (or similar item) on which each child writes 'charge' and told they cannot not pass it to their neighbour until their other neighbour is ready to give them theirs. The cell and component hats are still used, but now have 'On' written on the reverse sides. Children determine when to turn them, depending on the movement in the circle.

In moving the model forward, I want children to recognise the following:

- Electricity does not travel by a single charge to the component and then away again, but that there are many charges that all move simultaneously when the cell introduces the push force, and all stop when the circuit is broken.
- Current flows through components and is the same when it exits as when it enters (it is not 'used up').

Taking it further: a reason to investigate

I then give children a reason to investigate further and apply their understanding. Electricity lends itself brilliantly to construction-based projects and wherever possible I link this to their Design Technology topic. A prompt based on a problem (e.g. "Adam is struggling to do his homework because his light isn't bright enough…") or a story ("The Lighthouse Keeper's Son" in 'Science Through Stories' by Jules Pottle and Chris Smith) are possible approaches. Children can then plan and carry out their own construction based on their new knowledge and go on to discover how changes to cell voltage and numbers of components affect how these behave.

Common Misconceptions

Evolution

Beth Budden, PSTT College Fellow, shares some of her experiences of teaching evolution.

What children need to know:

- There are similarities and differences between living things and they can be grouped according to specific characteristics
- Animals and plants live in habitats to which they are suited
- Living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents
- Living things have changed over time and fossils provide information about living things that inhabited the Earth millions of years ago
- Animals and plants are adapted to suit their environment in different ways and adaptation may lead to evolution

Common misconceptions – often children will think that:

- Environmental change can be inherited, e.g. if a sheep loses its tail, its lambs will be born without a tail
- Humans used to be monkeys
- An individual can evolve during its own lifespan
- Evolution produces living things perfectly adapted to their environment
- Natural selection is an active process, ie an individual or a species can try to adapt
- Natural selection is always good for the species
- Evolution and religion are incompatible

Last year I attended an excellent lecture at the Institute of Education by Professor Martie Sanders on teaching evolution to young children, which provided me with ideas to share.

As evolution now has to be taught in Key Stage 2, I think it's really important for teachers to think carefully about how to do this, and do it well. In this article, I bring together resources that teachers may find helpful when tackling this topic.

To begin with I'm going to use a quote Martie used:

> Nothing in biology makes sense except in the light of evolution.
>
> **DOBZHANSKY, 1973:125**

You could also watch a quick YouTube clip about why evolution is important explaining this in a snappy set of clips, but in essence, life processes and living things begin and end with evolution. If children understand the basic concept of evolution it will mean they have a fundamental foundation for understanding all other biological concepts. Even if children don't become scientists, understanding evolution brings the individual a clearer sense of the relationship between living things and the environment and this helps them become an informed citizen. For example, take the over-use of antibiotics causing bacteria to become resistant to common drugs, then developing into 'super bugs'. This is evolution!

Worries about teaching evolution

Martie shared her studies carried out in South Africa and found that when confronted with teaching evolution, teachers were most worried about their own subject knowledge and also about conflicts with their own or children's religious ideas. However, her quote 'knowledge is power' really made sense here. The best thing to do then is not to shy away from teaching it but jump right in and try to understand what's going on.

It is important to make a distinction between scientific explanations and religious beliefs and not to set them against each other, even if they seem contradictory. For me, it's a mistake to present both religious and scientific ideas as theories because we are then using 'theory' in a very causal way and not a scientific way. A theory comes about when a hypothesis has been tested using evidence. A theory is not a belief; a theory is a viewpoint arrived at using all the evidence presented so far; theories themselves can also evolve and change depending on the evidential base. So – I would say, please don't call beliefs theories; you need evidence to have a theory.

So, once you're comfortable with presenting these scientific explanations, and have not set these against any 'beliefs' in the room, then it's all about getting to grips with the subject knowledge and how best to teach it.

Subject knowledge

Let's start with **variation in a population** (a group of the same species living in a particular area). A farmer wants to breed sheep with thick curly brown fleeces. They have a herd of sheep with different kinds of fleeces: grey, brown, black etc. What do they do? They select two sheep with the thickest, curliest, brown fleeces and breeds them. This is selective breeding. The two

curly, brown sheep have a few lambs. Of these the farmer only allows the ones with the curliest brown coats to breed. The farmer continues like this so that over the generations, more and more offspring have the thick, curly brown feature and any other colour or texture is bred out.

Now, what Darwin thought was, 'maybe this happens in nature too?' Maybe somehow, there is a process of natural selection so that certain attributes become more prevalent? He was right, but here comes a problem and a potential misconception for children!

Anthropomorphism and evolution on demand

The trouble is that the way we talk about living things often sends the wrong message and forms the basis of misconceptions for young children. When we say things like 'some plants **prefer** more light' or 'roots **try to find** water' we are implying that these living things possess decision making abilities. They don't. So as teachers we need to be really careful how we say things. Most of biology is process driven and not decision driven, and we need to use language to indicate this.

The point here is that living things do not **choose to evolve** – that's why Darwin used the word 'natural selection'. A polar bear did not at one time choose to grow thicker hair in order to live way up North, just as a tiger did not choose to grow a stripy coat so it could hide in the leafy jungle and hunt. Instead, these were naturally selected attributes that became more prevalent over generations. In fact, let's use Martie Sanders' definitions to make the three key areas clear:

- **Evolution:** "Changes in a population, resulting from the increase of certain features in the population over many generations."
- **Natural selection:** "The mechanism by which evolution occurs."
- **Adaptations:** "Evolutionary results of natural selection in a population."

Let's take the tiger and its stripes. We take a population of big cats with plain coloured fur. A genetic variation means that some of the cats are born with a stripe or two. It turns out that when they are hunting the stripes give them a slight advantage over the plain coloured cats. They are better camouflaged and as a result they are better at catching food and so have a better diet. This gives them more energy to breed and to reproduce. Their offspring are born with the same kind of stripes because they share the same genes. These tigers also have an advantage over the less stripy cats, and they hunt more and reproduce more.

So now there are more stripy cats and fewer non-stripy cats. The stronger stripy cats are more likely to mate with another stripy cat. Eventually, this goes on over many generations and each generation includes more stripy cats because the adaptation of 'stripy fur' has been naturally selected. Remember, the tiger didn't decide to get more stripes, or decide to choose a stripy mate even, but they might reproduce with the fittest mate, who was stronger because he had stripes and was more successful at hunting – see 'survival of the fittest'. Even this term can be misinterpreted, like living things having some big kind of fight and the strongest one winning – as you can see, it's not quite like that. It simply means that the living being with attributes best suited the environment is more likely to survive and reproduce than one that doesn't. Remember, no decision making – just process.

Children rightly love stories with animals, but this can sometimes create or reinforce misconceptions about them and about evolution. Please don't stop reading wonderful stories to children but do choose carefully which ones you use to support and enrich your science lessons!

Evolution is learnt mostly through observation

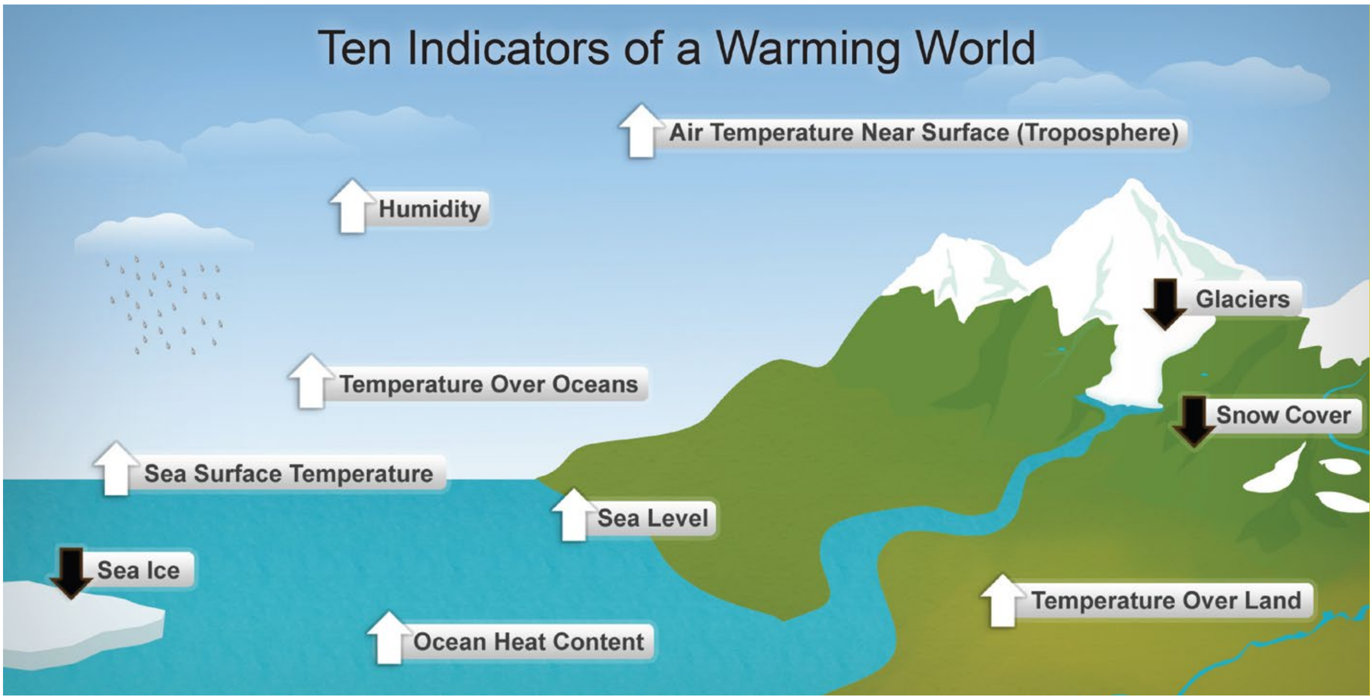
Just as Darwin arrived at his theory of evolution through observing living things and recording evidence, children's understanding of evolution can be developed in the same way. They need to be provided with lots of opportunities to 'play at evolution' themselves. Martie Sanders suggested using the attributes of insects to investigate camouflage and survival. For example, on a leafy green plant, which beetle is more likely to be spotted by a predator? And what are the consequences for this beetle?

There are lots of games children can play like this. You could darken the room, like a deep jungle, cut the beetles out, lie them on a green leafy background and give the children ten seconds to pick up as many as they can (playing the role of predator). Because they will naturally find it easier to pick out the black and then yellow beetles against the green, they will see how more of the green beetles will be left to survive and reproduce with other green beetles. What I find fascinating here is that this shows the localised nature of evolution. Children often think all polar bears came at once or all tigers, or green beetles suddenly appeared. The point is that if evolution begins with variation in a population, this is referring to groups of living things living nearby each other. In this way, the adaptations are local to the population, which of course might be so well adapted to where they are that they get bigger and bigger leading to migration and larger, more global populations. All this is at the heart of the great 'tree of life' and the huge variety of life on earth. Amazing!!!

Spring 2020 Issue

Climate Science

Supporting Resources for the Primary Classroom



Ten indicators of global warming.

PSTT is working hard to support climate science education for primary children. In this Climate Science section, we share the outputs, updates and ideas from some of the initiatives we are developing.

What is Climate Change?

Climate is an average measure of the weather conditions for an area over a long period of time, typically 30 years. Scientists have been closely monitoring the Earth's climate for the last 150 years and in that time they have observed significant changes in the global climate. As well as immediate measurements, scientists are able to study Earth's climate changes over 1000s of years using ice core samples, ocean sediment analysis and fossil records. They have measured that global temperatures are increasing faster than at any other time in Earth's history and they conclude that the increases are directly linked to a variety of human activities.

Why does Climate Change Matter?

But why does climate change matter? Surely if the Earth is getting a bit warmer, we can just enjoy nicer summers and more ice cream? Unfortunately changes in global climate don't just mean it's going to be a bit warmer. Melting ice caps, rising sea temperatures, ocean acidification and increased natural disasters are just some of the effects of long term climate change. The global population continues to rise - 7.6 billion on 16th July 2018 – and all these people need food, water, accommodation, transport and energy, all of which draw on the Earth's natural resources and affect climate change.

Wind and solar power – examples of renewable energy.

Why do people talk about it as the Climate Change Debate?

Science tells us we have a problem that affects all of us, so surely we can all pull together to solve it? That'd be great, wouldn't it? Unfortunately it's not quite that simple. Science is often influenced by politics and economics; global leaders hold the power to make real change - most of them agree, but not all of them, hence the word debate which is unhelpful.

The Energy Issue

Seven and a half billion people use a lot of energy! In the last 50 years, global energy consumption has more than tripled and shows no signs of slowing down. More concerning is the fact that, even with advances in renewable technology, we still get about 75% of our energy from non-renewable fossil fuel sources: gas, coal and oil. Energy scientists and engineers are constantly working on new solutions and improving current technologies to meet the growing needs of an energy-hungry global population.

Learn more about:

- Non-Renewable Energy
- Renewable Energy
- Energy Sources

Power from burning fossil fuels – an example of non-renewable energy

Pollution Problems

Pollution is closely linked to society's increasing demands for energy. Burning fossil fuels produces carbon dioxide which is a greenhouse gas. The build up of CO2 in the atmosphere traps more heat from the Earth that is trying to escape to space, with some of that trapped heat being redirected to the Earth's surface, causing warming. Other significant contributors to the global pollution crisis are deforestation, concrete production and agriculture. Pollution is also linked to a number of serious health issues, such as asthma, which are on the rise globally.

Other large scale agricultural pollutants are fertilisers and pesticides, which are sprayed on crops and often run off into streams and rivers polluting water supplies.

Learn more about:
- The Greenhouse Effect
- Carbon

Australian Bushfires

Bushfires are common throughout Australia, but since September 2019 they have been raging out of control across South Eastern regions of the country, leading to thousands of people having to abandon their homes to escape not just the fire itself, but the polluted air caused by the fires. Bushfires are most likely to start when the weather is very dry and very hot. The hotter it is, the more likely a fire will start, or carry on burning and if it is windy, this can spread the fire very quickly. Sometimes they are started by human activity which may be deliberate or accidental, but they can also start naturally, e.g. because of lightning.

- How did the fires start in Australia?
- What is it like in Australia for kids right now?

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Trophic Cascades

Until the 1960s it was thought that ecosystems were always controlled by the primary producers: green plants. It was then discovered that top predators can also play a significant role in determining the success of ecosystems. These predators not only affect their own specific ecosystems, they can have a significant effect on keeping the global ecosystem balanced.

Learn more about:
- How Wolves Change Rivers
- How Whales Change Climate

Questions to support children's discussions and research

- What can we do in our school to reduce the amount of energy we use?
- What can we do as individuals or families to reduce the amount of energy we use?
- Can we find out which human activities contribute most to climate change?
- Why might some countries and companies not want us to worry about climate change?
- Can we find out how climate change could affect our lives in the future?

Useful websites:
- Climate change guide
- World Population Counter
- The 2° Problem
- Effects of Climate Change
- The Paris Agreement

Climate Science

Spot the Difference

These activities are designed to encourage the use of observation and visual literacy skills using images that show either the effects of climate change or a related solution.

Our approach is that it is important to be honest with children about what is happening to our world in an age-appropriate manner, and to focus on sharing solutions with them as well as talking about problems.

In the activities, the teacher guides the children to compare the two images and spot the differences between them. Through scaffolded questioning, the teacher can support the children to explore and discuss what is happening, why it is happening and the possible impact.

How to run the activity:

1. Display the pairs of images to the children.
2. Provide any brief context that is required. The teacher notes will be useful for this. Take care not to explain what has happened between image 1 and image 2 as this is the focus for the children.
3. Invite the children to describe what they can see in image 1, what they can see in image 2 and what the differences between the two images are. Partner talk is effective here.
4. Use the suggested questions (or your own) to prompt children's reasoning and deeper thinking.

Additional resources and information:

GLACIERS:

- **Glaciers then and now**
- **Effect of melting glaciers in Alaska**

POLAR BEARS:

- **World Wildlife Fund resources**
- **Polar bears and climate change**
- **Polar Bear International Resources**

REFORESTATION:

- **Trees for Life Charity**
- **Woodland Trust education resources**
- **Practical Action Regreen the desert**
- **Alan Watson Featherstone**

ECO-ANXIETY:

- **Climate Psychology Alliance**

Activity 1

Melting glaciers – The Pedersen Glacier

Teacher notes to set the context:
A glacier is a large area of thick ice formed on land by many years of snowfall which has not melted and instead forms ice. Glaciers remain frozen from one year to the next and they flow slowly over the land due to their weight. If they reach the sea, pieces can break off and become Icebergs. The images below show the Pedersen Glacier that sits on the western side of Alaska in Kenai Fjords National Park. The glacier was formed in the little ice-age (1350 - 1850), a geological period when mountain glaciers in a number of locations expanded into streams and rivers polluting water supplies.

Click to download image

Click to download image

Images courtesy of NASA: 1917 photo captured by Louis H. Pedersen; 2005 photo taken by Bruce F. Molnia

Questions to support the children to make comparisons:

- How do you know this is the same view? What features can you see that identify it as the same view?
- What are the differences that you notice in the pictures of Pedersen Glacier in 1917 and 2005?
- What causes ice to melt?
- What conditions does grass need to grow?
- What do you think caused the change in the glacier and the surrounding landscape over this time?
- What could the effects of this be?
- What problems might melting glaciers cause?

Further background information for teachers:

Glaciers are melting due to climate change leading to global heating. Sometimes melting ice forms a glacial lake. If melting increases and these lakes overflow, they can release huge volumes of water and cause catastrophic flooding. Glaciers store around three quarters of the world's fresh water. When a glacier disappears completely this can mean a loss of freshwater supplies to communities. From 1951 to 1986 the Pederson Glacier retreated steadily but slowly at 20 metres per annum (m/a) (706 m in total) and from 1986 to 2005 at a speed of 23 m/a (434 m in total). By 2015 the glacier had retreated 2600 m since 1994. This is a speed of 125 m/a which is much faster than before.

Activity 2

Melting sea ice: why is this a problem? – Polar bears

Please note: these images may cause children to feel distressed and teachers should exercise their own judgment about whether or not it is appropriate to show them to the children they are teaching.

Teacher notes to set the context:

Polar bears mainly inhabit the Arctic Circle, subsisting on a diet of seals and other prey. Polar bears spend most of their time on sea ice and it is from the ice that they hunt for seals. When seals come to the surface at holes in the ice, they become prey to the polar bears. With their sensitive sense of smell, polar bears are able to detect the smell of a seal's breath when they exhale. This enables them to catch the seals. Polar bears also stalk seals that are resting on the sea ice. Both methods involve sea ice.

Click to download image

Click to download image

Image from Wikimedia Commons, courtesy of Andreas Weith

Questions to support the children to make comparisons:

- What are the differences you can see between the two polar bears?
- What do polar bears need to be healthy?
- Which polar bear do you think looks healthy and why?
- What do you think the unhealthy polar bear is missing?
- What might have caused this?
- Is there a solution for the unhealthy polar bear?
- How is the health of polar bears related to the melting of polar ice?
- What are ways that polar bears could adapt to the melting of sea ice to survive?

Further background information for teachers:

Arctic sea ice keeps the polar regions cool. The ice melts and forms with the seasons; however, global heating has upset this balance and the thickness and extent of the sea ice is decreasing. Polar bears depend on ice to hunt for their food. As a result of habitat loss caused by climate change, polar bears are unable to find enough food and are now classified as a vulnerable species. To date, the impact of global heating has been seen in the Arctic most. Polar bears' dependency on sea ice makes them highly vulnerable and we are yet to see how they adapt to their changing environment. Some studies suggest that the Arctic could be ice free in the summer by 2050.

Activity 3

What can we do to help the planet? – Reforesting

Teacher notes to set the context:

The images that follow show the same view at Coille Ruigh, Glen Affric in Scotland. This was home to red deer who were overgrazing the Scottish Pine seedlings (95% of the seedlings had grazing damage) which was preventing them from reaching mature growth. In both images, Scots Pine snags are visible. Snags are standing dead or dying trees. For example, 9 year old trees were on average just 8.5 m high. By building a fence around the area to prevent red deer from entering, the Scottish Pines were allowed to naturally regenerate. This project is a partnership between the charity Trees for Life and Forestry Commission Scotland.

Click to download image

Click to download image

Photos with kind permission of Alan Watson Featherstone ***alanwatsonfeatherstone.com***

Questions to support the children to make comparisons:

- How do you know this is the same view? What features can you see that identify it as the same view?
- What are the differences that you can see between Coille Ruigh in 1989 and 2020?
- Why do you think there are so few trees in the photograph from 1989?
- What do you think has happened in the years in between?
- What impact do you think the differences have on wildlife?

Further background information for teachers:

Much of Scotland, like most of Britain, was once densely forested. Caledonian Forest was the temperate rainforest which once covered much of Scotland. The mission of the charity Trees for Life is to rewild the Scottish Highlands by enabling the restoration of the Caledonian Forest. Some of this work involves planting trees or, as in the case of Coille Ruigh, allowing an area to naturally regenerate. Amongst other aspects of their work is the introduction of red squirrels to new forests and studying the feasibility or reintroducing lynx to the Scotland Highlands.

Climate Science

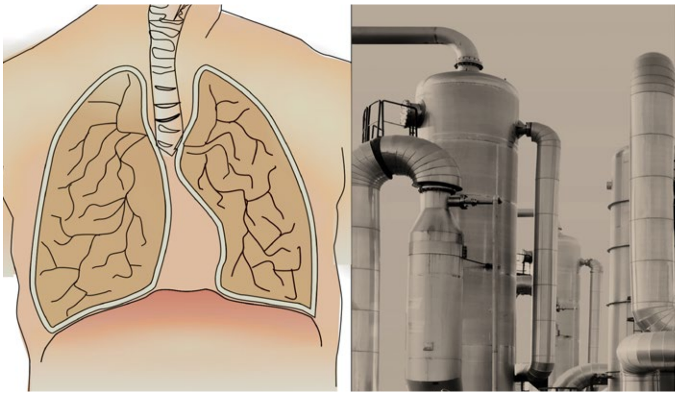
Turning to nature as our teacher

PSTT Trustee and civil engineer, Jyoti Sehdev, describes how biomimicry – using ideas from nature as models for the design of new structures and systems – can be part of the solution to some of the global challenges we are facing.

Engineers are problem solvers. We evolve our designs over and over to meet the changing needs of society. The last issue of the Why & How magazine focused on society's greatest challenge of the moment: human-induced climate change which is leading to a mass extinction of species.

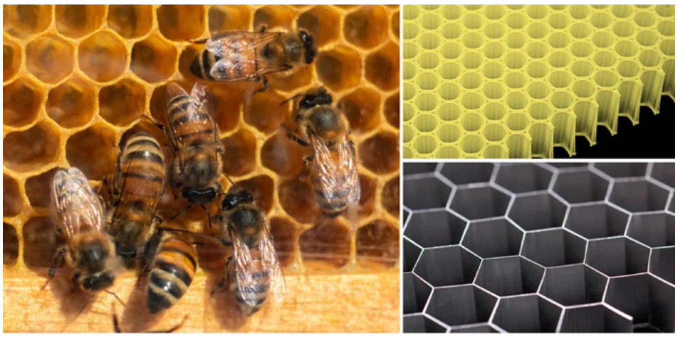
Consequently, engineers are looking for ways to reduce our use of fossil fuels whilst evolving infrastructure to be resilient to the impacts of changing weather events. Perhaps we need to turn to the very species we are trying to protect, the beings that have been evolving for 3.8 billion years, to develop truly sustainable answers to these challenges.

Biomimicry is the conscious emulation of life's genius to create sustainable designs. Biomimetic design in engineering has led to the development of more efficient and lower carbon solutions. The following examples illustrate some of the recent biomimetic approaches that have been used by engineers.



Biological processes in chemical engineering

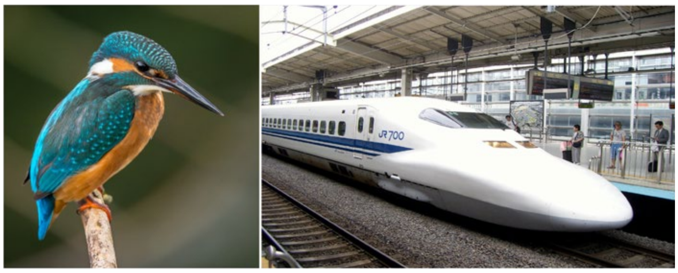
Recent climate change regulations require industrial factories to capture CO_2 as a resource instead of allowing it to enter the atmosphere. The company Saipem has taken learning from an enzyme found in red blood cells, carbonic anhydrase, which converts carbon dioxide to carbonic acid to be transported in and out of the lungs. They have developed an 'Industrial Lung', which is a carbon capture solution that uses a synthetic carbonic anhydrase enzyme to dramatically accelerate CO_2 capture.



Structural and materials engineering

Honeybees build hexagonal honeycombs as the tessellating shape provides the most area with the least perimeter for honey storage. The honeycomb pattern also provides a high strength-to-weight ratio, enabling scientists and engineers to incorporate hexagonal designs into building applications, such as flexible panels for bridge construction, sound absorption and even building better surfboards.

Find out more here.



Mathematical form in automotive engineering

Japanese engineers turned to the kingfisher when tasked to reduce the noise from drag on the Shinkansen (Japanese bullet train). The new trains are designed on the beak of the kingfishers, which has evolved to aerodynamic perfection to avoid disturbing the water's surface, increasing the bird's chances of catching fish.

Physics in mechanical engineering

Buildings in hot countries need to keep their inhabitants cool all day long. So do termite mounds, often found in desert conditions. Engineers have built the Eastgate Centre in Zimbabwe to cool itself like a termite mound, with porous walls with opening and closing vents, without needing to use expensive and energy-intensive air conditioning.

Find out more here.

Inspiring children to look to nature for solutions

Biomimicry and nature-based learning is a great way to engage children with different engineering challenges whilst encouraging interest in the natural world around them. "Why?" and "How?" are exactly the questions we should be encouraging children to ask about their local ecosystems. Why does that look like that? How does it grow like that? By incorporating bio-inspired learning into the classroom, we have an opportunity to inspire children to have a reverence for the life around them and a personal sense of environmental stewardship as part of their education, preparing our next generation of engineers to find truly sustainable solutions.

Research

Creativity in Science

Prof. Deb McGregor has some suggestions about using drama

I passionately believe that if students in classrooms are not engaged in meaningful activities requiring both cognitive and actional participation, learning is less likely to be effective.

I recognise that capturing what learners 'know' in some kind of textual form (written by hand or electronically processed) has become a school and national requirement so that progress in learning can be assessed and measured. However, I strongly believe that in the current political climate, too often, we 'value what we measure' rather than attempt to 'measure what we value'. Having worked with 5-year olds to 50-year olds, it seems to me that that this simple Chinese proverb still holds true for most people, whatever you are trying to teach:

> Tell me and I forget
> Show me and I remember
> Involve me and I understand

This has underpinned my practice for years. Introducing new ideas or concepts for learners is much more exciting, fun and meaningful if there is interactional activity involved. However, not just any practical work will do, as research has shown. Activity needs to be focused, relevant for the learners and provide opportunities for them to succeed at a variety of levels. This is exactly what my research in using creative approaches like drama and stories illustrates. Since my responsibility for the MA History of Science module over 10 years ago, my interest in the lives of Leonardo da Vinci, Edward Jenner, Marie Curie, Florence Nightingale, Isaac Newton, Robert Boyle, Dmitri Mendeleev, Rachel Carson, Marianne North etc. have re-ignited my enthusiasm for, and fascination with, the ingenious ways they used materials that were available to them, solved problems of their era and developed methods that 'pushed the envelope' during their life-time. My research into the ways that the design of learning tasks (McGregor 2008) also provides a context and purpose for learners is key. From the outcomes of my studies and reflections on practice, it became explicit that the challenges learners are invited to consider influence the kinds of dialogue and action they engage in. Combining the evidence from these studies suggests how the use of drama could be used to 'transport' children back in time, or to a different place, and enable them to consider what it was like to live in a different country at a different time. An example provided below is that of Joseph Shivers (the creator of Lycra). Children can be invited to listen to him (as read out by a teacher or child in-role) talking about his interests in football and his role as an important senior scientist who experimented for years (for the company DuPont) before he found the correct formula for the elasticised material. Listening with eyes closed and then discussing what they deduce about the scientist from the mini speech, imagining his everyday life as well as his work, provides context and background for an enquiry here the children work in-role. In the case of Shivers, they are asked which material is the best for an athlete to wear (in wet, dry, cool or warm weather). Carrying out a dramatic enquiry can take up to a couple of hours.

However, you don't need hours to use the other basic drama techniques. If you have fifteen minutes, an hour or half a day you could try the following suggestions.

If you have fifteen minutes, you could try...

1. Teaching a new topic

- Ask the children to create a statue or group picture of something you haven't yet taught them (this can provide insights into what they know before you teach them).
- All the class can do it around the room.
- 'Tap the shoulder' of groups in turn, for them to explain what their statue or group picture (tableau) represents.
- You can ask 'others' in the class to interpret what they think the statue/tableau represents.
- You can ask them to produce the statue or group picture again after you have taught the topic to compare how their understanding has developed.

2. Teaching how something works

Miming movement and freeze frame are very simple techniques to use and at varying levels.

- Ask the children to work in groups to move and show how something works or changes (this could be to demonstrate different forces or illustrate seed gemination).
- This is adaptable for virtually any science topic or concept.
- Interestingly once the children have grasped the strategy, when you then teach them something tricky, they may request 'acting it out' to help them make sense of it.

If you have an hour, you could try...

Hot seating, which takes longer than miming movement or freeze frame because it works best after the children have engaged in an experience they all have some familiarity with.

- It can improve the quality of questioning and developing explanations (answers).
- Within the topic of materials and their properties, invite children in small groups to choose a sport that they mimic (or mime) playing (this approach can work well if connected to an Olympics theme or big sporting event).
- Each group rehearses their mimes.
- Invite them to choose a card (each one with the name of a material written on it, e.g. paper, wood, metal, ice, foil).
- The children then practise miming playing in clothes made of that material.
- Make sure they do not say out loud what they are doing (some team huddling may be required).
- Once each group feels confident, in turn they can each perform their sport wearing normal clothes and then the clothes made of a different material.
- The rest of the class observe carefully how their actions change and what does that mean about the features (or properties) of that material.
- This can be huge fun.... working out what sport is being played and then interpreting how the material affects movement can engage the children in thinking both critically and creatively.
- If you have a little more time, you can ask them to mime how playing their sport is affected if the world is made of sponge or stone or everything becomes magnetic. This elicits some really interesting scientific understandings about properties of materials.

If you have half a day, you could try...

A dramatic enquiry (McGregor and Precious 2015: 103-125).

- Explain the children will listen to a mystery scientist talking (they can later guess who they think it might be).

Have the children close their eyes and listen to a monologue (through a teacher or child in-role reading the script from McGregor and Precious 2015 p. 207).

- In this monologue the mystery scientist is musing over the football scores and muttering about about the wealthy or well-known having access to a 'new' stretchy material, Lycra, that he has developed.

Reflective discussion, 'What do you know about the scientist?'; 'What do you imagine about the scientist?' enables the children to develop a 'feel' for the scientist as a real person.

- Explain the scientist is Joseph Shivers who experimented with materials to create Lycra.

Give them cotton, rubber, bubble wrap, space blanket, foil (plastic bowl, spoon, jug of water, pegs, string).

- Ask them to solve, as Shivers might, two questions,
  1. What can you tell me about the material?
  2. How could you find out which material is best for an athlete to wear in the Olympics?
- Remind them that field and track events will continue no matter what the weather.
- Invite them to work in-role as Shivers to answer the open enquiry questions.
- Invite them to work collaboratively in groups to extend the likelihood of success.
- Celebrate the wide variety of solutions to the two questions.

Key References

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Ten practical suggestions for using drama in science

In-role as Montgolfier brothers who invented hot-air balloon.

1. Spontaneous Role Play

In small groups children develop arguments about science in everyday life. By working 'in role' they can explore views and ideas which may be different from their own.

Hot seating used to question others' experiences of wearing 'paper', 'foil', 'stone' and 'rubber' clothing.

2. Hot Seating

Where teachers or children are placed 'in role' as experts to answer questions from their peers.

Miming movement to illustrate 'forces' applied to a toy (jack-in-the-box) and 'rubber' clothing.

3. Miming Movement

Pairs/groups/individuals mime movement, allowing them to explore different types/ways of moving and how this might be affected by different circumstances.

Freezing a moment in germination.

4. Freeze Frames

A freeze-frame is a frozen moment. Groups act out a phenomenon, on hearing a cue e.g. freeze, clap the group/individual stops and holds their position. This allows the group to examine and reflect on what is happening at that moment. The teacher may well ask 'why have you done it this way? What are you trying to show?'

Modelling changes in movement as ground becomes frozen.

5. Modelling

Modelling is a way of physically creating a mimic or illustration of an object or organism and exploring how it works/acts.

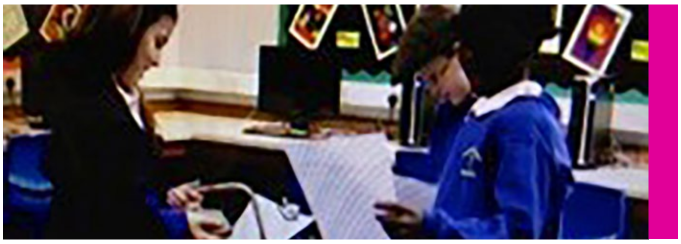
Preparing to travel to another place on the 'magic carpet'.

6. Mind Movies

Using audio and/or visual stimuli to support the children to imagine themselves in different places/situations. Group/s listen to a description/sounds (and may have images too) of a location. Whilst their eyes are shut the group/s can be asked questions about what they can hear/see so they can build up their own picture in their mind.

The magic carpet can also be used for this – to add to the imaginative picture of a different location or time.

Ten practical suggestions for using drama in science



Engaging in an historical play as Mary Anning and Edwardian visitors to Lyme Regis.

7. Mini-historical Plays (MHP)

The teacher tells the group a story – which could be scripted. During the story members of the group become the characters in the story – they could be given a prop/costume item to signify who they are or a simple line to say. There might be moments in the story when whole groups are engaged or moments when they could offer their thoughts on the events of the story e.g. a meeting. Through this enactment the narrative of a scientist's work is brought to life.

Introducing a mystery scientists (like Joseph Shivers who created lycra) through reading a monologue (McGregor and Precious 2015 : 207).

9. Monologue

Learners listen to a teacher (or child) speaking in-role as a scientist.

The 24 monologues produced so far provide an initial focus on a scientist's life and a particular aspect of their work. They can be used to introduce an enquiry.

On-the-table examples of equipment George Washington Carver might have used to investigate plant part uses.

8. On the Table

Examining objects (often unfamiliar or to be used in an unusual way). The objects to be studied can be related to the topic being taught or the scientists' work or inquiry to be engaged in.

10. Dramatised Inquiry

This builds on Mini Historical Plays or a Monologue (see 7 above) to introduce a scientist and then engage the children in a related investigation. Developing an enquiry from the Joseph Shivers story might include: soaking different material squares for different times, timing how long they take to dry when hung out (with pegs) on a string, and even comparing different places where the material square might be dried.

Professor Deb McGregor taught in schools in the Midlands and held posts of responsibility in Biology, Science and ICT. She worked as an advisory teacher for Staffordshire and the Stoke-on-Trent area before moving to Keele University where she led the Science PGCE program and studied for her doctorate.

After 10 years at Keele, an opportunity arose to work in the USA providing in-service training for would-be primary and secondary science teachers. Returning for family reasons, she took up a post at Wolverhampton University as Assistant Head of the Research Centre before moving to Oxford Brookes University to lead research and teach on the Masters and Doctoral-level programmes. Her research interests focus on teaching and learning processes, particularly those that involve creativity, stir the imagination of learners and inspire them to want to become scientists!

Deb has written books and articles related to thinking skills, creativity, metacognition, reflective practice, science teaching, learning and leadership.

Activities

1. Are there microplastics in cosmetics?

Background

Microplastics are used as exfoliants in scrubs and shower gels and are also present in cosmetics. In 2018, the manufacture and sale of such products containing microbeads was banned. Unfortunately, the ban only applies to those products that can be described as "rinse off". In other words those that are used briefly then washed down the drain. However, microplastics can still be found in many other products such as sunscreen and "leave on" make-up so the risk of them continuing to enter the marine environment continues.

Discussion questions

- Can you see any microplastics in the cosmetics to begin with (by eye, with a hand lens or with a microscope)?
- Why do you think warm water is mixed with the cosmetics and not cold water? Have you noticed a difference in how foamy the soap is if you use hot water or cold water?
- What shapes are the microplastics?
- How many microplastics were in 5 ml of cosmetics?
- Which product contained the most microplastics?

Resources needed

- Selection of face scrubs and make-up (look online for an up to date list of those most likely to contain microplastics)
- Petri dish
- Hand lens/microscope
- Filter paper and funnel (you could use the type of filter and funnel used in coffee percolators if you do not have access to laboratory filters and funnels)
- Beakers (500ml)

What to do

1. Use a teaspoon to measure 5ml of the cosmetic and transfer it to a petri dish. Study it with a hand-lens (or microscope if possible). Can you see any microplastics?
2. Rinse the cosmetics into a 500ml beaker using warm tap-water. Keep adding warm tap-water up to 250ml.
3. Stir the cosmetics thoroughly until it is well mixed with the water. Remove any foam by hand.
4. Carefully place your filter into the filter funnel so that water must pass through the filter, not around it.
5. Slowly, pour the cosmetics mix through the filter, making sure to hold the filter over the sink.
6. Rinse the filter with cold tap-water to remove foam.
7. Unfold your filter and see if you have any microplastics.

How to adapt or extend the activity

i) Simpler version – identify the presence or absence and the shape of the microplastics.

ii) More complex version – Calculate or estimate the total number of beads in the 5ml sample. How many microbeads do you think there are in the whole bottle (use the estimate that 1 bead has a volume of 0.0001ml)? How many people do you think use 5ml a day? How many microbeads do you think are washed into the drain each day?

How many of the myriad facial products available on our shelves contain microplastics?

2. Do my clothes contain microplastics?

Background

Lots of our fabrics and clothes contain synthetic materials such as polyester fleeces. When these fabrics are washed, thousands of tiny fibres of plastic can be released into the water. They are too small to be caught in the filter of the washing machine and end up going down the drain. They are even too small to be filtered out at the sewage plant so they end up in the ocean. In this investigation, you will try to make microplastics from clothes and larger plastic litter.

Discussion questions

- Did you manage to make any microplastic fibres? If not, why do you think it did not happen?
- What shape are the microplastics?
- How much did you make?
- Which item gave you the most microplastics? Why do you think this was?
- Did you treat all your samples in the same way? How could this have affected the results.

Resources needed

- Synthetic clothing or length of rope
- Large bucket (10l)
- Bowl
- Rubber gloves
- Large filter paper and funnel (you could use the type of filter and funnel used in coffee percolators if you do not have access to laboratory filters and funnels)

What to do

1. Take an item of synthetic clothing or a length of rope and place it in the bucket.
2. Fill the bowl with a small amount of warm water.
3. Using the rubber gloves, wash the clothing and rope. Remember you're the washing machine, the wind and the waves!!
4. When you have all had a turn remove the clothing or rope and put it back in the bucket.
5. Carefully place your filter into the filter funnel so that water must pass through the filter (not around it).
6. Now slowly pour the washing water through the filter, making sure to hold the filter over the sink.
7. Unfold your filter and look for microplastics.
8. Try repeating with the rope or clothes that you haven't yet used.

How to adapt or extend the activity

More complex – quantify the investigation by using a measured piece of cloth and trying to estimate how many fibres would be produced per square metre of the fabric. Alternatively, you could estimate how many of these items are washed each day by families in your school and estimate how much microplastic would be produced.

Polyester clothing

3. How much of the beach is plastic?

Background

Have you been to a beach recently? Did it look like it was full of microplastics? Maybe you could not see much evidence with your naked eye but, with closer inspection, we can often find lots of microplastics hiding amongst the grains of sand on our beaches.

Discussion questions

- Can you see the texture of the particles?
- What colour and shape are these items?
- How can you tell they are plastic?
- What is the most common shape and colour?
- What was the smallest piece of plastic you found? How big was it?

Resources needed

- Bucket of sand from a beach
- Big spoon
- Funnel
- 100ml measuring cylinder
- Large dinner plate or similar container
- Forceps
- Hand lenses or microscopes

What to do

1. Look at the beach sample. Can you see anything that doesn't belong there?
2. Using a spoon and funnel, carefully transfer 50 ml of the sand to a measuring cylinder: put the funnel into the measuring cylinder and spoon in sand until it reaches the 50ml level.
3. Now empty the 50ml sample onto the large dinner plate and use the forceps to spread out the sample.
4. Use the forceps to pick out any items that look like plastic and place these on the small Petri dish.
5. Now view these plastic particles under the microscope or with a magnifying glass.
6. Use the ruler to try and gauge how big these plastics are.
7. Write a list of all the plastic bits you can find in your beach sample or create a tally chart of different shapes, sizes or colours.

How to adapt or extend the activity

i) Simpler version – you could count how many different colours of plastic could be found in your sample.

ii) More complex version - if you have microscopes you may be able to make more detailed analysis of the types and sizes of plastic particles in your beach sample.

Can you work out what percentage of your beach sample was plastic? You might need to put all the plastic you found back in the measuring cylinder.

Microplastics on the beach

4. What eats microplastics in our oceans?

Background

Finding your food in water presents different challenges to the ones we face on land.

Scientists are interested in finding out whether marine animals inadvertently eat plastic when they try to eat their natural prey. Different animals have different ways to feed and this gives them different abilities to select exactly what they're eating. This activity mimics this by using different implements to collect "food".

A fork is used to mimic filter feeding by organisms like mussels and zooplankton;

Chopsticks act like crabs' pincers;

Hairclips mimic the beaks of seabirds.

Discussion questions

- Can you make a food chain with the three animals included in the investigation?
- Could you include other plants and animals to make a web?
- Can you use this investigation to help explain how trophic transfer (whereby animals that eat animals that have eaten plastics end up ingesting plastics themselves) could work in these organisms?

Resources needed

- Small polystyrene balls to represent plastics mixed in with natural food such as lentils or dried peas
- Hinged hairclips (where you pinch one end to make the other open like a beak)
- A fork
- Big plastic tweezers or chopsticks

What to do

1. Prepare three tubs / buckets containing "food" and microplastics.
2. Invite three children to use one of the different feeding tools.
3. Time the children for 30 seconds. During that time, they need to collect as much food as they can.
4. Count the number of food items and the number of microplastics.
5. Which animals collected the most food? Which collected the most plastic?

How to adapt or extend the activity

More complex: calculate the % of food "eaten" that was plastic.

Chopsticks mimic crawfish claws

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