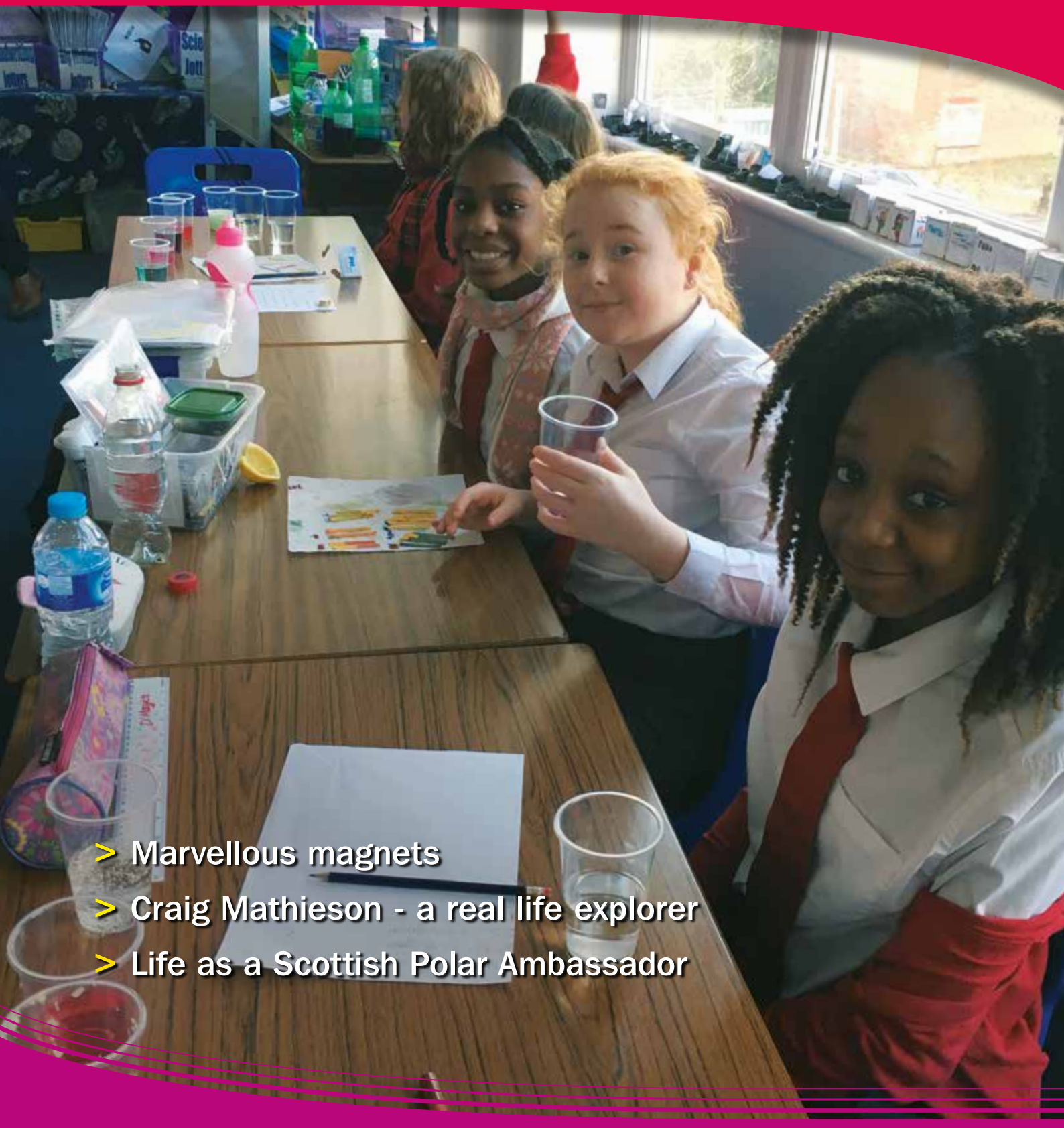
Primary Science & Technology *Bulletin*

Ideas and inspiration for teachers in Primary Schools and S1/S2



> Marvellous magnets
> Craig Mathieson - a real life explorer
> Life as a Scottish Polar Ambassador

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Figure 1 *- A variety of magnets.*

Marvellous magnets

Magnets come in lots of different shapes and sizes (Figure 1) and after some free play, observing and exploring their properties, learners will be ready to undertake more systematic investigations.

Experience and Outcome
By exploring the forces exerted by magnets on other magnets and magnetic materials, I can contribute to the design of a game [1] - *SCN 1-08a*.

Key vocabulary: pole, south pole, north pole, attract, repel.

Which materials are attracted to the magnet?

Often learners will discover that only metal objects are attracted to a magnet and so, to avoid misconceptions, it is important to ensure that some metal objects which are not attracted to magnets e.g. gold, copper, aluminium etc. (Figure 2a) are available for testing. Figure 2b shows the objects which "are magnetic".

From this collection only the objects which are made from, or contain, iron are attracted to a magnet. The metals nickel and cobalt are also magnetic.

Magic? No, magnets

For a simple activity to demonstrate magnetic force, you will need the equipment shown in Figure 3.

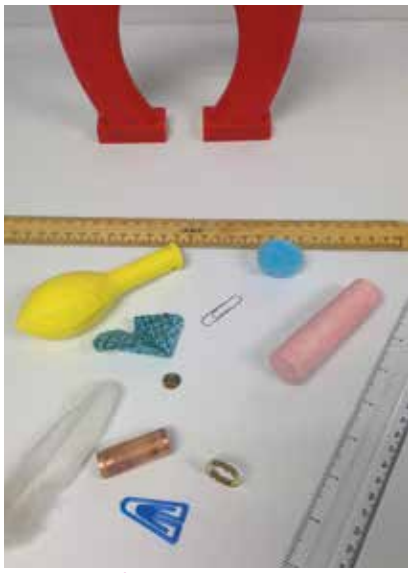


Figure 2a *- Objects to test.*

Figure 2b *- Magnetic objects separated from the collection.*

Secure the magnet to the base of one container using tape (Figure 4).

Tie a length of thread to one paperclip so that there is a length of thread on either side of the paperclip then secure the thread to the sides of one container with tape. Repeat this with the other container and then stand the containers side by side so they each clearly show a paperclip hanging in the container (Figure 5).

Predict what will happen if you turn both jars upside down. Gently turn both jars upside down. What did happen? Why did this happen? Our result can be seen in Figure 6.

Even though the magnet is not touching the paperclip, the magnetic field is strong enough to hold the paperclip in place when the container is turned upside down. The result is that the paper clip looks as though it is hanging 'up' in the container. Try placing the containers on their sides and observe the result. If you turn the containers upside down and shake them, what happens and why do you think this happens?

This activity is a great way to explore the topic of magnetism. Prepare the containers in advance and cover the base of both containers so that the magnet is not obviously seen but the hanging paperclips are still clearly visible. Encourage the children to gently turn the containers upside down and to observe and discuss what happens.

Figure 3 *- Equipment needed for magic? No, magnets.*

Figure 5 *- Paperclips hanging in both containers.*

Figure 6 *- Both containers turned upside down.*

How strong is the magnet?

One popular classroom investigation is to determine which magnet is the strongest. How can you test this? Examples of possible investigations may be:

How many paper clips can the magnet hold? See Figures 7a and 7b. Is this method a better test than the examples shown in Figures 8a and 8b?

Another way to test the strength of a magnet is to investigate through how many sheets of paper the magnet will attract a paperclip.

From what distance will the magnet attract an object? See Figures 8a and 8b for a suggestion as to how to investigate this.

The magnet's poles

If we look at the bar magnet in Figure 9 the ends are different colours. This is to allow us to easily recognise the different poles of the magnet. In some cases, magnets are labelled with "N" and "S" denoting the North Pole and South Pole respectively.

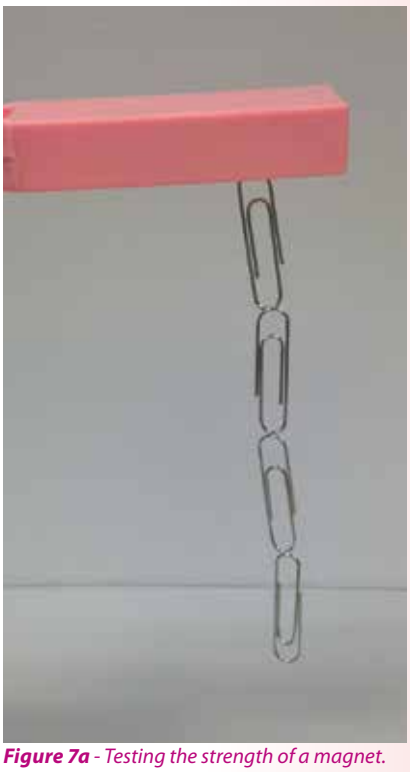


Figure 7a *- Testing the strength of a magnet.*

Figure 7b *- Testing the strength of a magnet.*

Figure 4 *- Magnet secured to underside of one container using tape.*

If you look closely at the horseshoe magnet in Figure 8b you may notice the label for the north pole.

What happens when you bring 2 different poles (colours) together? The magnets move towards each other i.e. they attract each other (Figure 10a). 2 similar poles? The magnets move away from each other i.e. they repel each other (Figure 10b). You will also observe that these pulling and pushing forces of attraction and repulsion ▶

Figure 8a *- Testing the strength of a magnet.*

Figure 8b *- Testing the strength of a magnet.*

are evident without the need for the magnets to come into contact - they are forces which act over a distance or non-contact forces.

Using encased iron filings it is possible to see the magnetic field (Figure 11a). This is the area around the magnet(s) where the force can be felt. Note the area between the 2 like poles (Figure 11c).

Health and safety considerations

Avoid using very small magnets especially with young children as they could pose a choking hazard.

Children should be warned about the possibility of strong magnets moving together and pinching the skin. This is particularly important if you have the very powerful rare earth metal magnets (e.g.neodymium).

The use of loose iron filings should be avoided. They can cause irritation and possibly damage if they get into the eyes and they may irritate the skin of young children. Iron filings can be purchased in sealed containers from many school suppliers.

Strong magnets should not be used near anyone who has a pacemaker.

Coins

You or your learners may have noticed an anomaly with 1p, 2p, 5p and 10p coins in that some are magnetic whilst others are not.

This is because the metal used to produce coins was changed by the Royal Mint and it is possible to work out the years this happened.

Since 1992 1p and 2p coins have been made from copper plated steel rather than bronze (a copper alloy) and from 2011 5p and 10p coins have been made from nickel plated steel rather than cupronickel [2]. It should be noted that the alloy cupronickel, although it contains some nickel is mostly copper and is not magnetic.

In the collection of coins needed to do such a study you will need a number of the older, non-magnetic coins and you will need to collect them before they are withdrawn from circulation.

The main reason for these changes is the cost of raw materials.

Practical uses of magnets

Recycling centres need to separate metals by their type so that each type can be melted down and used again. The first step is to use a magnet to sort metals into 2 groups (ferrous and non-ferrous) [3]. This is a very important step in the recycling process and magnets provide the quickest way to separate types of metal. Try this in class by collecting aluminium drink cans and steel food tins. Place them all in a box and see if you can use a magnet to sort the metal recycling.

Maglev (Magnetic Levitation) trains use magnetic repulsion to lift the train up from the ground and reduce friction [4]. The Japanese bullet trains use this technology and one maglev train that is still in development has documented a record-breaking maximum speed of 603 km/h.

Using a compass

When a compass is held flat in the palm of a hand or placed flat on the ground the needle of the compass will always settle on a north-south line. In most compasses this needle is colour-coded with the black half of the needle being the side that points south and the red half of the needle being the side that points north (Figure 12).

Figure 9

Figure 10a *- Opposite poles attract.*

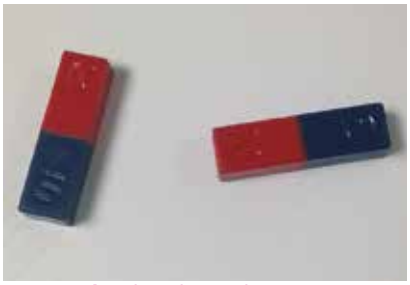


Figure 10b *- Like poles repel.*

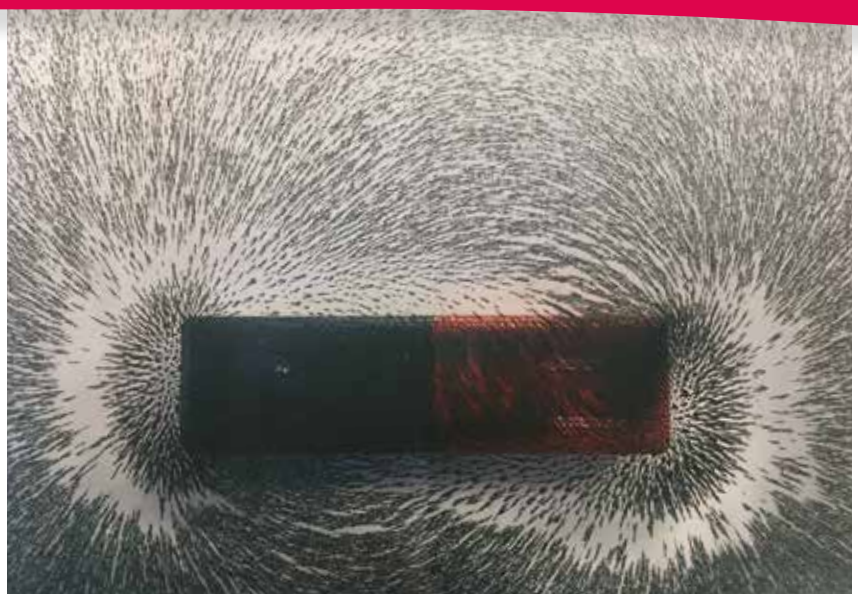


Figure 11a *- Iron filings show field line around a magnet.*

Figure 11b *- Iron filings show field line around 2 magnets with opposite poles facing.*

Figure 11c *- Iron filings show field line around 2 magnets with like poles facing.*

This happens because the Earth is a huge magnet and has two magnetic poles that are located in the Arctic and the Antarctic. Your compass needle is a little magnet which can swing around [5] so the needle settles on a north-south line because it lines up with the magnetic field of the earth.

Can another magnet interfere with a compass? Hold your compass flat in the palm of your hand and then gently move your hand over a magnet on the jar used in the previous activity.

What do you notice?
How close did you have to get to the magnet to see this?
Do you think you would need to be this close if you used a stronger magnet?

Fun with Magnets

Playing with magnetic trains sets such as Brio trains [6] is a good way for children to explore the properties of magnets and experience the effects of magnetic attraction and repulsion in relation to building or moving a train set.

A fishing game is always a fun way to use magnets and can be used to support literacy and numeracy outcomes by setting up the game so that the children 'fish' for specific letters to make up a word, specific words in order to make up a story, specific numbers relating to counting exercises or as answers to maths problems.

Magnet painting is another engaging way to use magnets. Simply fix a sheet of paper to a sheet of cardboard or a table then place a few 'blobs' of coloured paint on the paper. Place a paperclip in one 'blob' of paint then place the magnet under the sheet. As the paperclip is attracted to the magnet, it will move when the magnet moves and thus spread the paint across the paper.

Designing a magnet maze is a great way for children to get creative and show their understanding of magnets. Drawing out the route options for the maze and choosing the material for the object that will travel through the maze all illustrate their understanding of magnets and how easy or difficult it can be to use magnets to guide an object around tight corners.

Figure 12 *- Compass with red needle pointing north and black needle pointing south.*

References

[1] https://www.education.gov.scot/Documents/sciences-eo.pdf (accessed January 2018).
[2] http://www.royalmintmuseum.org.uk/FAQRetrieve.aspx?ID=49896 (accessed January 2018).
[3] https://sciencing.com/about-6398727-magnets-used-recycling-.html (accessed January 2018).
[4] https://science.howstuffworks.com/transport/engines-equipment/maglev-train.htm (accessed January 2018).
[5] http://www.iop.org/activity/outreach/resources/pips/topics/forces_magnets/index.html (accessed January 2018).
[6] http://www.brio.uk/products/by-age/12-months/magnetic-train (accessed January 2018).

Craig Mathieson - a real life explorer

Polar Ambassador Craig Mathieson is a real life professional explorer. He has been spending time in primary schools involved in the Polar Explorer Programme [1] sharing his knowledge and experiences.

Craig's talks have included his close encounters with polar animals and descriptions of how their bodies are adapted to cope with the harsh environments. He has also shared with pupils his methods of coping with such extreme conditions. In preparation for expeditions Craig spends many hours towing tyres through woods and up hills to build his strength for sledge pulling. He also takes on a very high calorie diet that includes a breakfast consisting of huge bowls of porridge and banana followed by 6 boiled eggs followed by 6 raw eggs. Pupils were surprised to hear that he does not actually like the taste of chocolate but, as it is a high energy fuel, he manages to eat it by wrapping it in slices of salami.

Craig is the first man to have successfully reached each of the poles in his first attempt. He described how during these expeditions he has experienced temperatures as low as -70°C, a temperature at which the enamel shattered off his teeth and the liquid in his eyeballs froze. His dream of conquering the South Pole came after 21 years of hard work and meticulous dedication and he shared with pupils how he had to snap the frozen tears of emotion off his cheeks when he finally reached the Pole. ◀

***Figure 1** - Pupils from Carmodean Primary School modelling some of Craig's expedition clothing.*

Reference

[1] https://www.stem.org.uk/welcome-polar-explorer-programme.

Polar Explorer Programme

The Polar Explorer Programme encourages and supports schools who are keen to raise aspirations and attainment in science, technology, engineering and mathematics (STEM) and aims to inspire the next generation of scientists and engineers.

Polar Ambassadors across Scotland have already begun their work and are helping schools to take part in a range of activities, including:

- in-school professional development for teachers;
- free access to resources and activities, which have been curated to link with the commissioning and operation of the ship, the Sir David Attenborough;
- ideas and suggestions to support schools' outreach activities.

Through their work with schools Polar Ambassadors help to increase:

- enjoyment and engagement in STEM subjects and extra-curricular activities;
- confidence in learning science and in scientific enquiry skills;
- awareness of the importance and relevance of science to society, and the role this plays in relation to helping people live with and adapt to climate change;
- knowledge of career opportunities available to pupils who study STEM subjects. ◀

Free resources, further information about the programme and how to get involved are available here: **https://www.stem.org.uk/welcome-polar-explorer-programme.**

Life as a Scottish Polar Ambassador

When SSERC invited me, Heather Reid, to get involved with the STEM Learning Centre's Polar Explorer Programme I wasn't sure quite what to expect. But having forecast my fair share of wintry weather over the years, and even a few 'polar lows' - I was sufficiently intrigued to attend a training day and find out more!

Figure 1 *- Pupils at Corpus Christi Primary school.*

I, along with my fellow Scottish Polar Ambassadors, learned all about this creative primary STEM programme inspired by the UK's new polar research ship, the Sir David Attenborough - not forgetting it's state-of-the-art robotic subsea vehicle, Boaty McBoatface!

The Polar Explorer Programme includes a fantastic collection of resources and teaching notes which are freely available on the STEM Learning website to anyone who wishes to use them for STEM activities using the context of the design, construction, and subsequent role of the research vessel and its long range submersible.

I am now thoroughly enjoying life as a Polar Ambassador working with Corpus Christi (Figure 1 and 2) and St. Pauls Primary schools in Glasgow, and Todholm Primary in my home town of Paisley. We have investigated floating and sinking at second level using the programme's 'Design a Boat' activity. This was followed up by an Ice Breaker experiment which allowed pupils to research forces and different hull shapes. Of course ship-building also lends itself to an excellent historical context in Scotland, as well as the potential for reading and discussing the adventures of Ernest Shackleton and Scott of the Antarctic.

Figure 2 *- Polar Ambassador Heather Reid at Corpus Christi Primary school.*

My schools are all developing their Polar Explorer Programmes in slightly different ways and that's one of the beauties of this very flexible resource. It offers a wide range of easy to follow experiments and activities, complete with teaching notes and ideas for extension work. So whether you want to focus on engineering and forces, polar region wildlife, polar exploration or climate change and the oceans - there is something for everyone. And because this is such an appealing context for learning, it's the pupils who are leading the way with excellent project work and creative ideas.

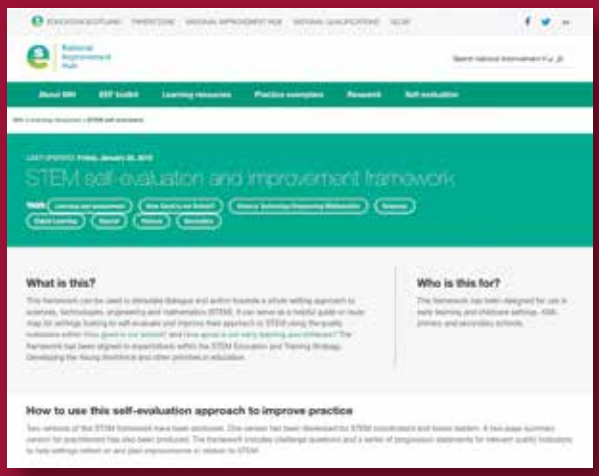
We're currently working on a series of ocean acidification workshops along with a great little experiment entitled, 'How do you like your Oceans - Still or Sparkling'. It's wonderful to see pupils understand the consequences of increased CO_2 levels on our oceans, and then designing their own experiments to investigate the impact of increased acidity on shell-fish. Some P7 pupils are even leading science workshops in P1 classes (see Figure 3).

As well as creating memorable primary science experiences, the Programme also aims to increase young people's knowledge of the many and varied career opportunities available to those who study STEM subjects. We definitely have some budding polar scientists of the future in Glasgow and Paisley who can't wait to meet a few polar bears, penguins or arctic foxes while conducting cutting edge science in the world's most extreme climate. I wish them well. ◀

Figure 3 *- P7 leading P1 workshop.*

STEM self-evaluation and improvement framework

Education Scotland's new STEM self-evaluation and improvement framework is available to download from the National Improvement Hub [1].



This STEM framework can serve as a helpful guide or route map for early learning and childcare establishments, primary, additional support needs and secondary schools looking to evaluate and improve their approach to STEM using the quality indicators within *How good is our school?* and *How good is our early learning and childcare?* The framework has been developed in partnership with 50 early-learning and childcare settings and schools that participated in Education Scotland's National STEM Project.

The framework is also aligned with national priorities and policies including the STEM Education and Training Strategy for Scotland, Developing the Young Workforce and the Scottish Attainment Challenge. Two versions of this STEM framework are available: one for STEM coordinators and senior leaders and a two-page summary version for practitioners. ◀

Reference

[1] The framework can be accessed at https://education.gov.scot/improvement/learning-resources/STEM-self-evaluation.

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