Autumn 2019 *Issue 7*

Why & How?

The Primary Science Teaching Trust Newsletter

Supporting excellent teaching and learning in primary science

Free to access for all

Inside this issue:

Climate Science
A new section with resources to support climate science education for primary children

The Why and How? Challenge
Turn an 'O' ring flyer investigation into an exciting whole school challenge

CONTENTS

Click to jump to article

- **News** 4
- **PSEC News** 6
- **PSTT Children's conference** 8
- **Climate Science** 10
- **Resources**
  Selection of free, ready-to-go, downloadable resources.
  - *Pictures for talk in primary science* 17
  - *The Why & How Challenge* 18
- **I bet you didn't know...** 20
  PSTT College Fellow Dr Rebecca Ellis links cutting edge research with the principles of primary science
- **College Snapshot** 22
  Meet six of our College Fellows who share some quick thoughts and suggestions for teaching primary science
- **Project Update** 24
- **Research Update** 29
- **Key Dates** 31

Why & How? is the brand name of the Primary Science Teaching Trust
Tel 0117 325 0499 · Email info@pstt.org.uk · Web www.pstt.org.uk
Primary Science Teaching Trust · 12 Whiteladies Road · Clifton · Bristol · BS8 1PD

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Welcome

Welcome to Why and How? - the Primary Science Teaching Trust's termly newsletter. Why and How? is for anyone who has an interest in primary science. Our newsletter offers practical support, news and updates about PSTT and our projects and research. We value feedback from our readers so please do continue to keep us posted about what you find most useful and interesting in our newsletter, and please do keep sharing it with anyone else who would like to receive practical classroom support, news and PSTT updates.

In **News** we share the achievements of several of our Fellows. We are delighted to be extending the provision of our popular 'I bet you didn't know' articles that have appeared in each issue of Why & How. Additional articles are published monthly on the PSTT website and all articles now have accompanying PowerPoint presentations to support their use in the primary classroom.

The big event of PSTT's summer was our fantastically successful International Primary Science Education Conference. Our special **PSEC News** section picks out some of the highlights and shares a few of the raft of positive and appreciative comments we received after the event. PSEC news also includes a report about the enriching and lively **PSTT Children's conference at PSEC**, written by Hayley Sherrard from SSERC.

Following the success of the PSTT Children's Conference at PSEC at which children presented their climate change projects, PSTT is developing further initiatives to support climate science education for primary children. We will share the outputs, updates and ideas from these in the new **Climate Science** section of our newsletter. This issue's update is about the impact of microplastics on the environment. PSTT Fellow Dr Katharine Pemberton outlines the context and then offers four suggestions for practical science activities to develop children's awareness and understanding of this critical issue.

DOWNLOAD ALL ISSUES FOR FREE AT:
www.pstt.org.uk/what-we-do/why-how-newsletter

Click to go back to contents

This issue's **Picture as a stimulus for talk** is of a pile of cobra's eggs. The picture provides opportunities for the children to use evidence from what they can see to justify their ideas. The picture will encourage discussion about living things in their environments and the survival of animals, including top predators. Please do share this (and all our free resources) with your colleagues.

New section in this issue: Climate Science

The **Why and How Challenge** in this issue asks children to investigate how changing the features on an 'O' ring flyer affects how far it travels. It can be done as an open-ended exploration, which could lead to some fair testing, and it also makes a fantastic **whole school competition**.

In '**I bet you didn't know**' PSTT Fellow Dr Rebecca Ellis explains research carried out to explore the relationship between the air quality of a city and the happiness of its population. Rebecca outlines how this research can be used in the primary science classroom to develop children's scientific skills and understanding; the research also provides a fascinating context for some ethical and moral debate.

Our College **Snapshot** features six of our Primary Science Teacher College Fellows from across the UK. We hope you find their quick thoughts and suggestions useful for your own teaching of primary science.

This issue has a packed **Research Update** section. Isabel Hopwood-Stephens shares some of her PhD findings in a comprehensive article that offers valuable support to science subject leaders with making schoolwide improvements to using formative assessment in primary science. Two further articles focus on memory and learning, and sustainability education, and we also draw your attention to some key articles in the latest issue of the Journal of Emergent Science.

We are very pleased to be able to share details of our City Science Stars project in our **Project Update** pages. Working with Leicester City in the Community's STEM coach Dr Alex Evans, PSTT Fellow Sarah Eames has developed and trialled a set of lessons designed to complement the science curriculum and promote sport and exercise. All lessons are free to download from the PSTT website.

Finally, some **Key Dates** for your diary. Don't forget to book tickets for the ASE annual conference by 25th October to secure the early bird price. And don't miss nominating an outstanding teacher for a Primary Science Teacher Award – the nomination process opens again in January.

Prof. Dudley Shallcross
CEO

Ali Eley
Academic Director

Dr. Sophie Franklin
Cluster Director

Sue Martin
Programme Director

News

PSTT is delighted to offer many congratulations to:

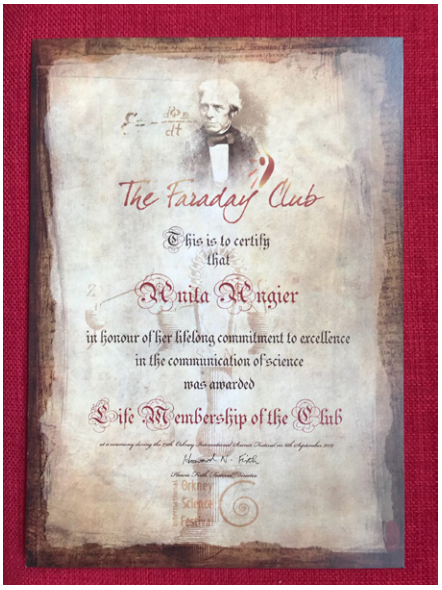
PSTT Fellow Sue Marks for gaining a distinction in her MA in Educational Leadership. Sue's dissertation included a focus on how children learn new things in science and the role of the short term memory in this (see research update on p**26**).

Angharad Pass – one of our newest PSTT Fellows. Angharad Pass from Tranmere Park Primary School in Leeds is one of this year's winners of the SHINE Trust 'Let Teachers Shine!' competition. Angahard will be using her prize funding to support disadvantaged children in primary school to develop awareness of the range of careers available to them in science, technology, engineering and mathematics (STEM). Angharad will develop resources and lesson plans for teachers to help them bring practical, real-life medical science into the classroom. The new resources and lesson plans will have a focus on the wide range of STEM focused careers, helping children to explore new possibilities at an earlier stage.

For more information about the Let Teachers Shine competition, please visit https://www.shinetrust.org.uk/what-we-do/let-teachers-shine/

Sarah Eames, who will be launching one of PSTT's latest free to download resources, City Science Stars, a collaboration with Leicester City Football Club's charitable trust 'Leicester City in the Community' and the National Space Centre, at Science on Stage in Portugal in October. Further details of this project are provided in the project update on p**30**.

Anita Angier, for additional recognition for her recent Primary Science Teacher Award by The Faraday Club. The Faraday Club was formed in 2010 in order to establish the highest standards for the communication of science 'in the way demonstrated so outstandingly by Michael Faraday himself'. Anita was awarded Life Membership of the club at the recent Orkney Science Festival.



Dr Isabel Hopwood-Stephens for gaining her PhD at Bath Spa University. Funded by the PSTT, Isabel's PhD explored how the TAPS pyramid had been used to change assessment practice at a schoolwide level (for further information, please see research update on p**24**)

STEM Learning's Primary Magazine

Don't miss the autumn 2019 issue of [STEM Learning's Primary magazine] for a raft of ideas about linking the sustainable development goals to classroom STEM activities, creating a 'creepy classroom', computing for girls, assessment, exploring space and much more...

Linking cutting-edge real science research to the primary science curriculum

Fellows of the PSTT's Primary Science Teacher College, who have backgrounds in science research and experience teaching in primary classrooms, are using their expertise to gather recent research papers (published within the last two years in peer-reviewed journals) and to write articles which explain cutting-edge science research in language that primary children can understand. These '[I bet you didn't know...]' articles explain what scientists have done and what they have discovered, suggest questions for children and teachers to consider in the classroom and describe activities that children can do to mirror the research.

We include an '[I bet you didn't know...]' article in each of our newsletters. These and [the whole collection] can be downloaded from our website. New articles will be added to the collection approximately once a month so do keep checking to see what is new.

PSTT Authors of 'I bet you didn't know....' articles are:

Professor Dudley E. Shallcross

Dr Alison Trew

Dr Craig Early

Dr Julia Nash

Dr Katharine Pemberton

Dr Rebecca Ellis

Dr Paul Tyler

Find out more about these authors and their scientific research [here]

PSEC NEWS

INTERNATIONAL PSEC Primary Science Education Conference

Outstanding Professional Development for all Primary Science Educators

From 6-8 June 2019 we welcomed well over 400 delegates to our second international Primary Science Education Conference (PSEC).

Over three packed and exciting days at the Edinburgh International Conference Centre, PSEC 2019 offered a varied and carefully chosen programme of the very best in professional development for primary science, all delivered by experts. Organised around a range of themes, our programme enabled every delegate to select sessions particular to their areas of interest and curriculum needs.

"The programme was superbly balanced - plenty for absolutely everyone."

"We had a wonderful time at PSEC: it was easily the best conference we have been to."

"There were so many enthusiastic practitioners talking and enthusing about science for three whole days - I loved it."

We are very grateful for all the outstanding contributions made to the conference programme from PSTT's Fellows of the Primary Science Teacher College, our academic collaborators and strategic partners, and many other world class experts in the field.

We are also delighted to have been able to welcome so many international delegates to PSEC; we had visitors from all around the globe, including New Zealand, Australia, Brazil, South Africa, Nigeria, USA and many European countries.

Thanks to the generosity of our bursary donors, over 70 teachers were able to come to PSEC through our bursary scheme. Many came knowing nobody and left feeling part of a supportive and inspiring primary science community.

"I am so impressed by all the work going on around PSTT and all the amazing research and resources being put into primary science. Huge thanks to the presenters and their incredible generosity in so freely sharing their time, ideas, expertise, opinions and resources. I have come away with so much to share and build on back at school, and further afield. My attendance would have been quite impossible without the very generous bursary I was awarded."

The exhibition hall at PSEC 2019

The exhibition hall was a dynamic and lively hub throughout the whole conference. We thank all our exhibitors for the considerable expertise, energy and enthusiasm they brought to the event as this was undoubtedly key to its success. Our exhibitor feedback tells us that they had a great time too, with many commenting that they engaged with significant numbers of teachers who had not previously known about them. Our exhibitors also reported that they learned a lot more about what is happening in primary science.

"One of the best conferences we have ever attended. Everything was spot on, exceptionally high level of delegate interaction, well organised, high quality venue and exhibition space. The social side of the conference was well thought out and also added to the experience as exhibitors."

PSEC was hosted by PSTT in partnership with SSERC

PSEC 2019 included some lively social events.

Working with School Outdoor Learning, PSTT hosted an engaging and thought-provoking evening at the end of the first day. Over a glass or two of fizz, delegates took part in activities that encouraged them to reflect on their own teaching and connect with like-minded colleagues.

We are very grateful to the Wellcome Trust for generously hosting a second social event where delegates enjoyed complimentary drinks while making new contacts and learning about teacher research and how they might make a bigger impact in their own schools.

"Loved the networking drinks and social events after each day's sessions. Lots of great conversations with people from lots of different backgrounds."

Conference Awards Dinner

The conference dinner was held at the prestigious Edinburgh science venue, Dynamic Earth. Guests enjoyed a tour of the galleries, welcome drinks and a three course meal with wine. During the dinner we held our Primary Science Teacher Awards where we celebrated outstanding teachers of science and welcomed them to the PSTT Primary Science Teacher College.

We ended day two of the conference with some Scottish dancing – guests joined Lewis Hou and his award-winning Science Ceilidh band for a night of traditional Scottish dances with a few science-themed versions thrown in!

"The ceilidh was a fantastic social evening experience that added to the conference immensely. I had a great time!"

THE PSTT CHILDREN'S CONFERENCE AT PSEC

By Hayley Sherrard,
Scottish Schools Education Research Centre (SSERC)

hayley.sherrard@sserc.scot

Hayley Sherrard from the Scottish Schools Education Research Centre (SSERC) shares the story of this exciting children's event.

Pupil voice forms an integral part of effective STEM education, so when planning the 2019 PSTT Primary Science Education Conference, finding a way to involve children directly was given high priority.

Climate change was chosen as the theme for the Children's Conference. This highly topical and pertinent issue provided a stimulus for a range of different projects that could be undertaken on a large or small scale – with either a local or international focus. Awareness of the problem posed by plastics in the oceans and the global issues arising due to human activity has risen sharply, especially among young people - due in part to the work of Sir David Attenborough and Greta Thunberg.

Children from West Jesmond Primary school share their deforestation project

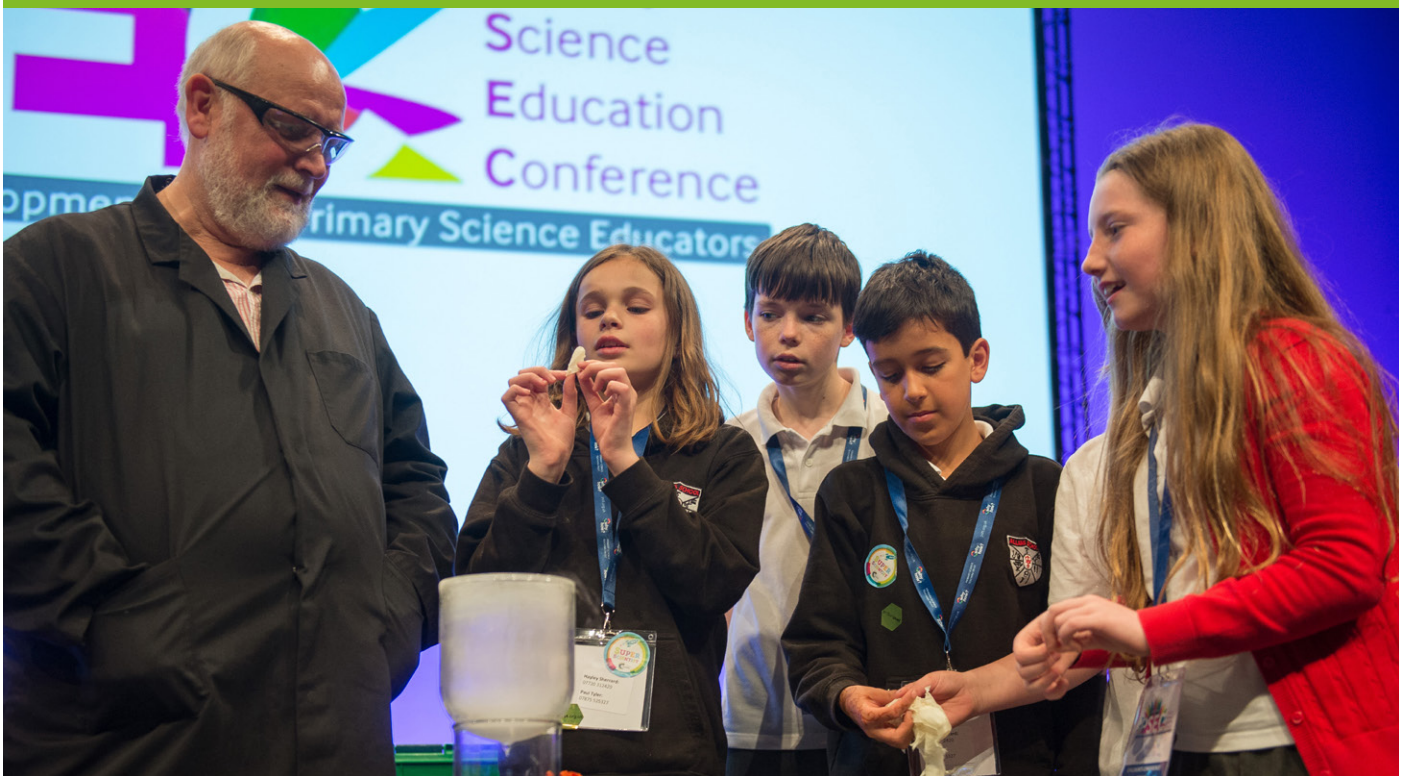
Children discuss the impact of urbanisation with PSEC delegates

To provide support for educators and learners PSTT produced a climate change pack. This pack is still available to download free from **PSTT**. The pack contains background information about a range of different climate change themes to engage and inspire young people as they plan their own climate change projects. During the last year over 200 schools across the UK and beyond have used the pack to engage with a project.

At PSEC 2019, PSTT were delighted to welcome 13 groups of young people from schools and educational settings to Edinburgh to showcase their climate change projects. All the children talked confidently and enthusiastically to each other and to the PSEC delegates who took a wealth of ideas back to their own settings. During the Children's Conference Members of the Scottish Parliament - Clare Adamson, Iain Gray and Oliver Mundell - visited the exhibition and spent time talking to the children and the passion they felt about their projects was very evident.

The Children's Conference at PSEC was enhanced by a range of talks and workshops provided for the children. A careers zone featured selected STEM Educators, including representatives from St Andrew's University, University of Edinburgh, Royal Society of Chemistry, Royal Observatory Edinburgh, RAF 100, Skylab and the Children's University.

The children's day ended with an exciting and interactive science demonstration, "Gases in the Air" presented by Tim Harrison from Chemlabs at the University of Bristol



What teachers said about the impact for the children of attending PSEC

"It allowed the pupils to showcase their work to peers and adult guests. They also benefited from visiting other stall to get ideas that we could use at school."

"They learned even more about climate change - there were areas of impact they hadn't known about before and were enthusiastic about finding out more as a result of what they had seen. They were truly inspired."

"It reinforced their interest in STEM, gave them ideas about resources... It gave them confidence in their own knowledge and understanding."

"It will make them more confident to speak in public and to share their views."

The PSTT children's conference at PSEC

CLIMATE SCIENCE

Microplastics in our seas

By Dr Katharine Pemberton,
Modbury Primary School, Devon
katharine.pemberton@gmail.com

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.

Why study microplastics?

Plastic is a very useful material because it can be produced in many colours and melted, rolled or squashed into a huge range of shapes. Plastic products are often lightweight, strong, durable, resistant to corrosion and low-cost (Thompson et al., 2009). This has led to their huge popularity and to the annual production of more than 380 million tonnes worldwide (Plastics Europe, 2018). The production of single-use, disposable plastic containers and packaging has created a huge waste problem in the UK. One of the downsides of its durability is that plastic takes hundreds, if not thousands of years to degrade.

Large pieces of plastic rubbish are easy to spot and are a real eyesore on our streets, in our countryside and on our beaches. Many of us have seen horrific images of marine animals caught up and injured in large pieces of plastic waste. However, in recent years, it has become clear that the marine environment is under huge threat from smaller, microscopic pieces of the material. The sea is contaminated with much smaller particles, called microplastics. These are defined as plastic particles that are less than 5mm in diameter and have been found on seashores, in the water and inside a wide range of marine creatures. They are small enough to pass down our drains, through sewerage processing plants and into our rivers, estuaries and oceans. Microplastics may be tiny beads (microbeads), used in the personal care and cosmetic industries, or can be formed when larger pieces of plastic degrade and are broken down by exposure to the sun, weathering and daily wear and tear.

A feeding barnacle in a colony of anemones extends its tentacles to grab any suspended plankton floating by as the current flows'

Many marine creatures have been shown to ingest, or eat, microplastics, including barnacles (suspension feeders), crustaceans, fish, mammals and seabirds. Scientists do not yet know the extent to which microplastics will cause harm to the marine environment and the creatures within it, but current evidence suggests microplastics will have a negative impact on the animals that eat them. Zooplankton, the smallest animals in the sea, are eaten by small fish. If a small fish eats 100 zooplankton and each zooplankter has eaten 1 piece of microplastic, the small fish would contain 100 pieces of microplastic. In turn, a larger fish eating 100 small fish would end up ingesting 10,000 pieces of microplastic.

Acknowledgements

Dr. Penelope Lindeque and Dr. Matthew Cole of Plymouth Marine Laboratory provided the ideas and original instructions for the investigations. They have been adapted into their current form for primary school teachers by Dr. Katharine Pemberton.

PML | Plymouth Marine Laboratory

References

Plastics Europe, 2014. The Facts 2014. An Analysis of European Plastics Production, Demand and Waste Data [WWW Document]. www.plasticseurope.org

Thompson, R.C., Swan, S.H., Moore, C.J., vom Saal, F.S., 2009. Our plastic age. Philos. Trans. R. Soc. Lond. B. Biol. Sci. 364, 1973–1976. http://dx.doi.org/10.1098/ rstb.2009.0054.

Classroom resources

The following four investigations have been specifically designed to help children understand the sources of microplastics and how they persist in the marine environment and affect the creatures living there. The investigations are all suitable for carrying out in a primary school classroom and the resources you will need are listed at the beginning of each enquiry. Each section also includes ways in which you could adapt the investigation to allow for time constraints or to differentiate for children working at different levels. A science context is included in each investigation to help you link the work to your curriculum aims. The activities support the development of understanding across several science topics, including humans, other animals, plants, living things in their habitats, materials and forces.

Plastic waste washed up on the beach

Depending on how you choose to guide and implement each activity, they can be used to support and teach the skills of working scientifically. You could choose any from a range that includes asking questions; planning an enquiry; setting up an enquiry; making observations; taking measurements and recording, presenting, interpreting and evaluating results.

In our school, we combined these activities with some practical attempts to address the problem of plastic in the marine environment. Amongst other activities, we carried out a beach clean and launched a project to try and quantify and then reduce the amount of disposable plastic we used in our packed lunches. Note that the investigations will generate a small collection of microbeads and microfibres. To avoid flushing these down the drain, use a filter to collect all the bits and put them in the bin. Alternatively, you may be able to incorporate them into a poster raising awareness about microplastics.

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 (www.gov.uk/government/news/world-leading-microbeads-ban-comes-into-force). 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)*

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?

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 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.

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.

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.*

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 produce per square metre of the fabric. Alternatively, you could estimate how many one 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.

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.

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 pieces of plastic you found? How big was it?*

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.*

HOW TO ADAPT OR EXTEND THE ACTIVITY

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

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?

chopsticks mimic crawfish claws

STEM Learning is the largest provider of education and careers support in science, technology, engineering and mathematics (STEM). We work with schools, colleges and others working with young people across the UK. Supported by a unique partnership of Government, charitable trusts and employers, we are dedicated to raising young people's engagement and achievement in STEM subjects and careers.

We never lose sight of the fact that it's the teachers in schools who have the greatest impact on developing the skills and knowledge of the next generation. Offering a range of support and guidance to enhance teaching, from courses and resources to STEM Ambassadors and STEM Clubs; all of our programmes are designed to have a positive impact on education.

RESOURCES

If you're looking for ideas for science lessons, then our primary resource pages provide a treasure trove of ideas which aim to save you time, whilst being quality assured by teachers.

As well as science for each year group, we have collections of resources to support teachers teaching science through **cross-curricular** topics and popular **children's stories**. Whether your topic is Romans, WWII, Charlie and the Chocolate Factory or the Gruffalo, there is something for everyone, you can find them all **here**.

October brings Halloween, which of course conjures up myriad opportunities to spookify your lessons. There are four whole pages in our latest primary magazine, with activities and resources to make the most of pumpkins, trick or treating, ghosts and more in each of science, technology, engineering and maths. **Read more**

Free Online Courses

Our flexible approach will help you progress your teaching and your pupils' learning in STEM subjects. We run a collection of teaching primary science CPD, of which we have a 'Getting started' course starting this autumn. **Join now for free**.

Face-to-face Courses

- ***Primary science curriculum design: working with the new Ofsted framework*** *- starting 12th November in York*
- ***Leading and developing primary science expertise*** *- starting 2 December in York*

Visit our website to find out more

www.stem.org.uk

FREE RESOURCES

Pictures for talk in primary science

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

Using pictures is an inclusive approach that facilitates high levels of participation. Pictures can also be used as a starting point for inquiry. The discussions the children have will generate questions that they want to investigate. **A picture can be a very good stimulus for children to engage in effective talk in science.**

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 any age of children. The activities can be done as a quick ten minute starter, or extended into a longer and more in-depth lesson.

WHAT TO DO

Download the image overleaf 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 laid these eggs?

Why do you think this?

Other questions to generate and promote thinking and explaining

The eggs were laid by a cobra. The most common type of female cobra lays between ten and thirty eggs at once. They lay them on the ground, usually in a dip or hole. The shells of the eggs are softer than a chicken's. The cobra guards the eggs from predators (e.g. the mongoose or wild boar) until they hatch, which takes around two months. The biggest type of cobra is a King Cobra which can be up to six metres long and can swim and climb trees as well as move extremely fast along the ground.

Download here:

What do you notice about the shells of the eggs? (focus on size, colour, texture, hardness)

Where are the eggs?

What kind of animals lay eggs?

Why did the animal lay so many eggs?

Follow-on discussion ideas

Find pictures of cobras guarding their eggs and of the hatchlings emerging from their eggs. Discuss what threats there are to the eggs and to the hatchlings (predators, weather) and how the parent cobra protects their eggs, and how the hatchlings protect themselves (they are independent and fully venomous from birth).

Pictures for talk in primary science

Why & How *Autumn 2019*

FREE RESOURCES

The Why and How Challenge

The 'Why and How' Challenge is intended to be something for the staffroom table that lots of teachers will try.
It is specifically designed to encourage the children to work scientifically to design and make something or to solve a problem.

This issue's Why and How Challenge is based on a simple 'O' ring flyer. You may have tried versions of this before, but have you used it as a whole school competition?

'O' ring flyer whose goes the furthest?

RESOURCES

Children need strips of card, drinking straws (please re-use where possible), scissors and sticky tape. They may also need a ruler and paper clips.

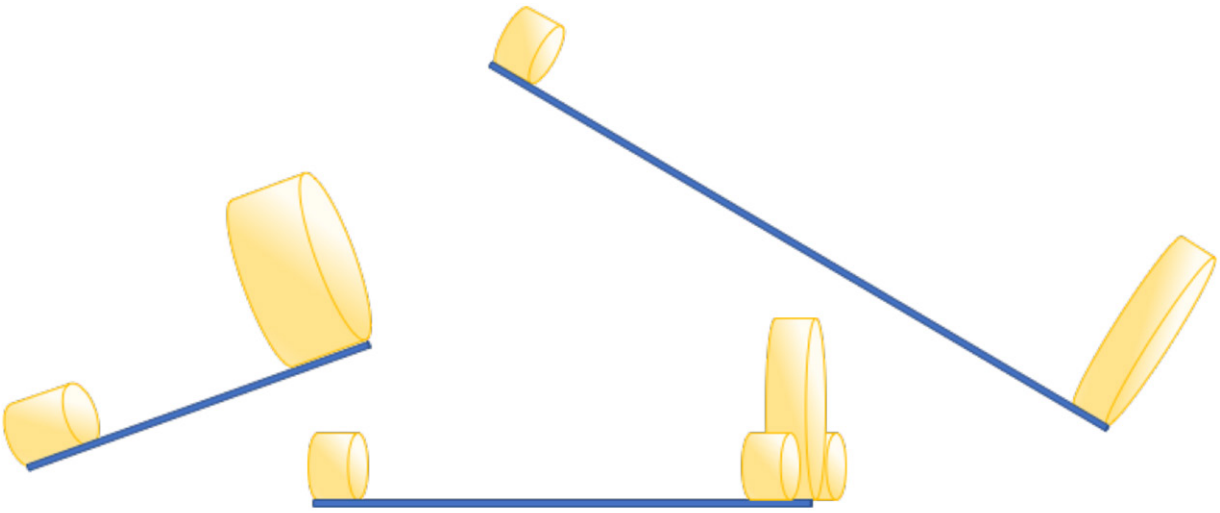
WHAT TO DO

Cut two strips of card: one 15cm long and the other 8cm long, each 2cm wide. Form each strip into a loop and secure with a piece of sticky tape. Now attach the loops to either end of a drinking straw, again securing with a piece of sticky tape, as shown in fig.1.

Holding the straw around the mid-point, with the small ring at the front and larger ring at the air, try throwing the flyer as you would a paper aeroplane. It should fly well.

Now give the children an opportunity to make and test their own. They can vary the sizes of the loops, front and back, or adjust the length of the straw (shorten by cutting or lengthen by inserting the end of one straw into another and securing them together), to explore how this affects the way the flyer travels. They may also wish to add additional loops or try adding some form of ballast (paper clips) to the front of the flyer.

Flyer fig.1 – simple 'O' ring flyer construction



Flyer fig.2 – varying 'O'ring size, straw length or overall design

Once the children have had an opportunity to make changes to their flyers, compare the results as a class.

Tell the children about the whole school competition and that, as a class, they are going to produce **one flyer,** that **goes as far as possible**. This will then be their **class entry** to the competition.

Rules for a whole school competition:

- *all flyers must be made from the same type of card/ thick paper*
- *all straws should be the same type*
- *length, width and arrangement of card and straws may be altered*

HERE'S HOW YOU COULD STRUCTURE A WHOLE SCHOOL SCIENCE CHALLENGE DAY:

Morning

Quick assembly to introduce the competition.

Children in their own classes, working individually or in pairs to make the best flyer they can, ready to race them against the other flyers in their class.

After break

Each class holds their own races to decide on their competition entry – only one per class.

Afternoon

Whole school to hall for the grand competition. This is best done as a knock out. Two classes at a time race their flyers against each other in a best of three. The winner is the flyer that goes the furthest and this one goes through to the next round and so on.

I BET YOU DIDN'T KNOW...

that computers can measure the happiness of a city.

PSTT College Fellow **Dr Rebecca Ellis** links **cutting edge research** with the **principles of primary science**

rebecca.ellis@pstt.org.uk

Happiness is not an easy parameter to put a number to. Do we measure smiles? How can we differentiate between a grimace, a polite smile and true pleasure? Emotion measurement does not seem like a natural area for a computer to be more effective than a human. However, Chinese researchers[1] have found them very useful to measure how air pollution affects the happiness of their population.

Children will know what makes them happy. From eating chocolate to scoring a goal, there are many things that can bring a smile to their faces. Try measuring what makes the class happiest by identifying reasons to be happy. Then give every child two votes to cast anonymously. Produce a pictogram to show which activity makes the class happiest.

But how can scientists measure happiness?

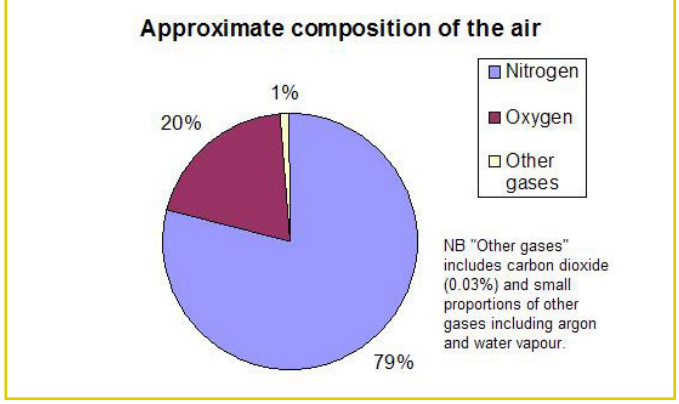
Their method was to construct a daily city-level happiness measurement, based on the feelings in the contents of 210 million geotagged tweets on the Chinese largest microblog platform, Sina Weibo. This is a government-monitored social media platform, often just called Weibo (pronounced 'way-bo'). It is very popular in China, despite the government control, and combines features of YouTube, Facebook and Twitter. Users tend to post more frequently than those on Twitter and the posts are more personal[2]. The researchers applied a machine-trained analysis tool and the people were unaware that their happiness was being measure in this way, which may make the results more convincing.

The scientists were comparing happiness of the population to the quality of the air in the cities.
To understand air pollution, children may need to explore what air is. The Science Museum's rocket mice[3] demonstration is a fun way to demonstrate that the bottles are filled with air rather than 'nothing'. If there is time, children could investigate the relationship between bottle size and height of 'mouse'.

Do the children know what air is made from? You could demonstrate the presence of oxygen in air by burning a candle (Figure 1). Safety guidance for using candles in the classroom is available from CLEAPSS[4]. Most of the rest of air is a gas called Nitrogen (Figure 2). Use the analogy that if air was their hand, four fingers would be Nitrogen; the thumb Oxygen and half the nail of their forefinger other substances.

*Figure 1: An experiment to show that a lit candle uses oxygen from the air in order to continue burning. If you limit the amount of air available, the candle's flame eventually goes out when there is insufficient oxygen to sustain it. ©Suzette, licenced through Creative Commons and accessed **here***

*Figure 2: Composition of air. ©Charlie123, licenced through Creative Commons and accessed **here***



What are the other gases making up the final 1% of air? We need careful observations and tests to work out which gases are there. On 'Explorify'[5], show Fantastic Flicker (or try to demonstrate this yourself). This shows that candle smoke is made up of vaporised wax which can cause the flame to 'jump' and reignite the candle without touching it!

There are invisible solids in the air too. Hold a tile just above a burning flame for a few seconds and show the children the black soot marks. Wipe them away to show that the tile has not burnt. The tile collects the tiny unburnt soot which is produced when most things burn.

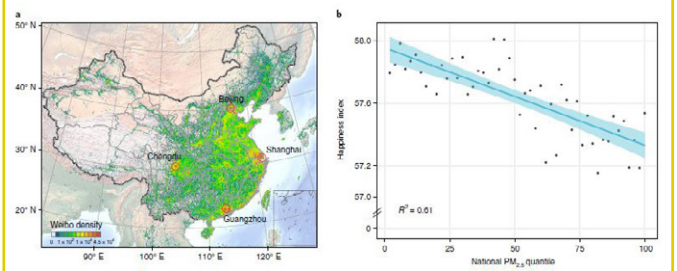
In this research, small particulate pollution (called $PM_{2.5}$ concentration) was recorded and compared to the daily happiness index. $PM_{2.5}$ measures fine particulate matter with diameters equal or smaller than 2.5 µm, which is the most prominent air pollutant in Chinese cities (Figure 3). Particles this size (ten times smaller than the width of a hair[6]) can hang in air for a long time and are so tiny they can enter deep into the lungs. This increases cardiovascular and respiratory disease, and cancers. In 2016, the Word Health Organisation estimated that exposure to $PM_{2.5}$ air pollution caused 4.2 million premature deaths worldwide[7].

*Figure 3: Air pollution in Beijing. © Kentaro IEMOTO, licenced through Creative Commons and accessed **here***

To find out whether this type of pollution changed people's happiness, the scientists plotted a graph with 'happiness index' on the y-axis, against $PM_{2.5}$ levels across the x-axis (Figure 4).

We could ask children to draw a 'predictive graph' to show what they think the scientists' results were. How does their prediction compare to the actual results? The trend is for happiness to decrease as the PM2.5 increases. All the points aren't exactly on the line. What other factors might be involved? **The paper[1] reports that happiness was higher at the weekends and when there was national 'good news'. Increased cloud cover decreased happiness, as did extreme temperatures (17.5ºC was the 'ideal'). They also found that women were slightly more sensitive to the pollution levels than men.**

*Figure 4: **a**. The four Chinese cities where happiness and pollution were compared. **b**. the relationship between PM25 concentration and the happiness index. (The happiness index ranges from 0 to 100 where larger values indicate a more positive mood).*



Reprinted by permission from Springer Nature: Nature Human Behaviour, Volume 3 Issue 3; Air pollution lowers Chinese urbanites' expressed happiness on social media; Siqi Zheng, Jianghao Wang, Cong Sun, Xiaonan Zhang, Matthew E. Kahn. © 21 Jan 2019

The results from this research could help Chinese scientists to continue to campaign for improvements in $PM_{2.5}$ levels, which is good for the Chinese people and for the environment. The use of social media combined with a computer to measure happiness is new and very clever. However, the scientists identified weaknesses with the method; the views of the elderly may not be fully represented because they do not use social media as much.

How do the children feel about the government monitoring social media? What are the positives and negatives? Currently, the governments in other countries, including the UK, are trying to improve the way that social media sites regulate their content to prevent violent or inappropriate content. YouTube, Facebook and other social media companies have defended their self-regulation records[8]. Government intervention might lead to people feeling that they have less freedom of speech; they might be unable to disagree with the government. Considering how dangerous $PM_{2.5}$ levels are, does this work justify government monitoring social media in other countries as the Chinese government has?

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3. Science museum web resource: Accessed Aug 2019
4. CLEAPSS website: Accessed Aug 2019
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PSTT COLLEGE SNAPSHOT

Meet six of our **College Fellows** who share some quick thoughts and suggestions for teaching primary science.

Pauline Rodger

Wiltshire

Year 6 teacher

Year of award: 2015

Most used piece of equipment in your science cupboard?

Currently - pipettes. Great for increasing precision in eg: measuring out 'oil spills' onto 'sea-water', controlling drops into different liquids and cheap enough to hand out for a homework task on counting drops of liquid on a coin. Quite good for 'squirty' forces too!

Most recommended book/website for supporting teaching in science?

'Misconceptions in Primary Science' by Michael Allen. This book helps interpret children's ideas and work out 'next steps' for their learning.... using the right words isn't the same as understanding.

Best strategy for helping children develop independence in their science learning?

One strategy I use is creative homework tasks where children engage with open-ended research and practical investigation questions. The contexts are relevant and meaningful to the children, which creates vested interest in the outcomes. This up-skills and broadens understanding so they feel more equipped to contribute to lessons and prior learning increases confidence and autonomy. A recent favourite was a picking up ice-cubes with string (and salt) challenge.

Judy Beer

Leicester

Teaching School Director

Year of award: 2017

Most used piece of equipment in your science cupboard?

Probably the magnifying glasses. They help children to look really closely at their experiments and the world around them. It's great to let the children loose with them at playtime too so they can explore a familiar environment in a different way.

Most enriching off-site science trip?

You can't beat a trip to a zoo or safari park. With so many links to the curriculum and the chance to see animals that they would otherwise never see, it can be an experience that children never forget.

Best idea for an observing over time investigation?

It has to be growing mould on a variety of foodstuffs - guaranteed to get the children rushing in every morning to see how it has grown and close observations happen without any encouragement!

Claire Loizos

Isle of Wight

Year 6 teacher and Volunteer Science Support Adviser across the Isle of Wight

Year of award: 2017

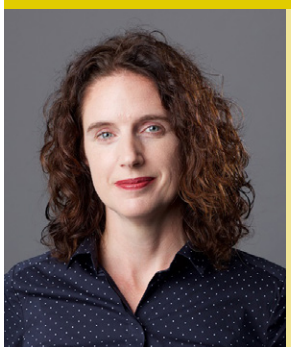
Most enriching off-site science trip?

The beach - useful for looking at ecosystems, classification, materials, rock cycle, plastics and pollution, the water cycle, chemical reactions, salt water evaporation.

Best idea for an observing over time investigation?

The night sky or the Moon. Children love keeping 'Moon diaries' logging what they see through the naked eye. They often make links to the weather, cloud cover & visibility and show a real depth in understanding of Moon cycles. When observing changes in the night sky over a year, they start to justify other things, including earth's rotation and its position relative to other planets and stars.

Fran Long



Oxfordshire

Education and Training Co-ordinator at the Faraday Institution

Year of award: 2017

Most used piece of equipment in your science cupboard?

My energy cosmic ball (from Amazon) as I am busy teaching about electric circuits and how batteries work. It is fantastic for demonstrating a human circuit! So simple yet promotes deeper thinking and fascinating discussion. I also make a lot of lemon batteries!

Most recommended book/website for supporting teaching in science?

Hard to pick one but am a big fan of Nicky Waller's 'A Creative Approach to Teaching Science'. Packed full of creative ideas this is a great support for planning exciting science lessons. Wind socks and material munchers have been a huge hit with Year 1 and 2 children!

Debbie Jones

Sutton Coldfield

PSTT Area Mentor - Midlands

Year of award: 2012

Most enriching off-site science trip?

A visit to a local stream or small river tributary. We plotted the depth of a stream and used ping pong balls to measure the speed of flow. This was great for cross-curricular work with maths in a context which the children loved – apart from a few leaking wellies!

Best idea for an observing over time investigation?

Plant an Amaryllis bulb in the classroom with a long piece of dowel in the pot. Water, measure and record the daily growth – sometimes a couple of centimetres a day!
The results can be plotted on a line graph with lots of discussion to interpret the results and the flower is perfect for exploring and identifying the different parts. This is a great one for January when little else grows!

Paul Tyler

Glasgow

Principal teacher and STEM co-ordinator

Year of award: 2013

Most enriching off-site science trip?

The beach: we started with a beach clean in the morning, did a microplastics survey and then finished with some waterways engineering, digging trenches to divert streams into pools rather than the sea.

Best idea for an observing over time investigation?

I love using time-lapse photography with my classes – anything from ice cubes melting, candles burning to daisies or dandelions opening as the sun rises. It's an amazing way to open children's minds to how amazing science is.

PROJECT UPDATE

City Science Stars

The Primary Science Teaching Trust was initially approached by Leicester City Football Club Community Trust (now Leicester City in the Community) in 2017 with a proposal for PSTT to partner with them (supported by the Premier League Charitable Fund and the National Space Centre) on the development of an innovative, high quality educational resource to support science teaching in Leicester.

The City Science Stars project was an extension of LCitC's Premier League Primary Stars offer, consisting of a 10-week programme of exciting and engaging science interventions for upper KS2 primary school children. In partnership with the Primary Science Teaching Trust, the City Science Stars workshops have been produced to complement the KS2 science curriculum with links to sport and exercise while also helping to strengthen maths, literacy and teamwork skills. LCitC's pre-programme survey identified that 87% of children participating in City Science Stars enjoyed sport, demonstrating a valuable opportunity to reach disengaged children by linking STEM activities with sport. The programme delivers hands-on curriculum-linked activities in classroom sessions but has also offered extra science-themed events at the King Power Stadium and National Space Centre. Following a successful pilot period in late December 2018, the City Science Stars programme had been delivered to over 300 children across Leicester and the surrounding county by September 2019.

PSTT's initial support was delivered through the secondment of PSTT College Fellow, Sarah Eames, during 2017-18 to develop and trial lesson plans within schools and to create the associated resources for others to deliver the programme moving forward. During the second phase of the programme, PSTT supported an appointed STEM Coach, Dr Alex Evans, based at LCitC to deliver, refine and extend the initial programme in additional Leicester schools.

Feedback on the programme has been very positive. Post-programme surveys found that **96% of participants enjoyed the sessions**, with 76% saying that they "loved them", **85% of participants reported learning a substantial amount** (rated as "a lot" or loads") with 45% saying that they "learned loads" and **99% of participants would recommend the sessions to other pupils**. Furthermore, survey results were further broken down to look at the differences between boys and girls to help identify any girl-specific needs for engagement in STEM (see below). While fewer girls responded positively to their enjoyment and education during regular science lessons than boys prior to the programme, **the number of girls responding positively to their enjoyment and learning not only increased approximately by 27% post-programme**, but also reached a similar level as boys

post-programme. Girl and boy responses to interest and knowledge of science jobs were comparably similar with both improving post-programme.

In addition to providing support for Leicester schools, it had always been the intention to create resources that could be used by other schools. Together, Sarah and Alex have worked to create lesson plans, classroom PowerPoint resources and additional supporting materials for wider dissemination to children at upper primary school level (UKS2, 9-11 year olds). These were first demonstrated at PSEC and in October, we are delighted that Sarah will be sharing the project outcomes at the Science on Stage Festival in Cascais, Portugal.

Current 'fixtures' included within the City Science Stars programme:

- *'Pitch Perfect' – Planning and running long-term scientific experiments with grass-seeds to investigate how football pitches might be grown on Mars.*
- *'Be a Sport' – Classifying different sports by shared characteristics, building decision trees and then designing and testing their own table-top sports.*
- *'Space Olympics' – Designing spacesuits that are adapted for sports and exploring how sports might be different on other planets with different environments.*
- *'Kick-Off to Lift-Off' – Learning about the physics of launching rockets (Newton's Laws of Motion) and how it links to football by launching their own paper rockets.*
- *'Feel the Pressure' - Investigating by collecting data on football bounciness under different pressures and by seeing how air pressure can be used to make fizzy film-canister mini-rockets.*
- *'Match Fit' – Learning about the skills that both astronauts and footballers share, then collecting data as they perform skill-linked activities and using mathematical statistics to analyse their results.*
- *'Get a Grip' – Investigating the friction generated between footwear and surfaces and learning about the applications of friction in sport, as well of ways to reduce friction to make their own hovercraft.*
- *'On the Wing' – Learning about the aerodynamic forces involved in flight and learning how engineers take inspiration from nature by making and flying paper planes based on different birds.*
- *'Survival of the Fittest' – Leaning about how footballers could adapt to play football better in different habitats and participating in a "Wild Cup" tournament where they will adapt their own players.*

These materials are now completely free to download from the PSTT website.

PSTT continues to support Alex in this academic year. He also aims to increase the opportunities for family engagement in science education, allowing children to engage in science activities and learning at home with family and friends, as well as in the classroom and he is continuing to develop further resources.

RESEARCH UPDATE

Assessment

Isabel Hopwood-Stephens

Isabel completed her PhD (funded by PSTT) at Bath Spa University. She is now a researcher on the Transforming the Experience of Students Through Assessment (TESTA) project TESTA at the Bristol Institute for Learning and Teaching

isabel.hopwood-stephens@bristol.ac.uk

How can we make schoolwide improvements to using formative assessment in primary science?

Let's start this article with a mental imaging exercise. Does the word "workplace" conjure up images of corridors and classrooms, or colleagues and conversations? And does the phrase "staff meeting" summon thoughts of working together to discuss and solve an issue, or being lectured in a stuffy room that contains no decent biscuits? By the end of this piece, I hope to have persuaded you that our workplaces and staff meetings both play a role in schoolwide efforts to improve assessment practice in primary science, but I'm afraid I can't help with the biscuits.

As a primary practitioner, formative assessment was the key that unlocked my teaching. It helped me to understand the range of ability in my class, plan better lessons and teach more responsively. My PhD study, funded by the PSTT, evaluated the impact of the TAPS (Teacher Assessment in Primary Science) pyramid on the use of formative assessment in the teaching of primary science (see Fig. 1).

The TAPS pyramid, for those who have not yet encountered it, is a downloadable tool (see link https://pstt.org.uk/resources/curriculum-materials/assessment) which helps you evaluate your use of formative assessment strategies in the teaching of primary science while also providing exemplars of the other strategies. It also provides a framework to show how the formative assessment data which you generate from all of this activity can be used towards reporting purposes.

One of the advantages of this tool is that it can be used by individual teachers wishing to improve their practice, but also by Science Subject Leads or school leaders to evaluate the assessment practice of the entire staffing body. (This could be done by giving all teachers a paper copy of the TAPS pyramid and asking them to indicate where they think they are on the classroom-based assessment activities in the blue layers; this kind of feedback could be provided anonymously to encourage an honest appraisal, and taken into account when planning any interventions).

But how easy is it to change teachers' assessment practice in primary science across the whole school? A useful tool isn't enough on its own; we need to provide support to help our colleagues develop their practice. My research encompassed an online survey of 100 primary practitioners up and down the country and two case study schools where the TAPS pyramid had been used to change assessment practice at a schoolwide level. The key findings, and how they relate to the support we offer our colleagues, are explained below.

Firstly, I found a wide range in reported assessment practice. Some participants were confident and experienced practitioners of formative assessment, using the TAPS pyramid to expand their repertoire; others were using it to teach themselves the basics. The implication of this finding is that, if we want to develop our colleagues' assessment practice, we need to formatively assess what they are currently capable of. We don't expect all thirty children in our class to understand a new concept in exactly the same way; anticipating a range of understanding, we elicit their existing ideas before planning appropriate learning opportunities. When it comes to evaluating and developing our colleagues' assessment literacy, we need to take the same approach.

Secondly, we need to provide teachers with the opportunity to discuss what they are doing. My findings showed that staff meetings were linked to schoolwide improvements to assessment practice – but not the kind of staff meeting where Mrs. Briggs is explaining how she teaches Rocks and Soils while everyone else sits in silence. I'm talking about interactive staff meetings with a clear focus on an aspect of assessment practice, where people can share ideas, raise concerns and work collaboratively with others. (Some of us are lucky enough to work in schools where staff meetings already have a collegiate atmosphere and problem-solving focus, but for those of us looking for ways to develop interactivity and encourage participation from a wider range of speakers, Littleton and Mercer's guidelines for Exploratory Talk are really helpful – see References).

But perhaps the most surprising finding of my study was the extent to which professional learning between teachers takes place outside of staff meetings. Discussion between colleagues was significantly linked to reports of schoolwide changes to assessment practice in primary science, but this discussion often took place within informal interactions between colleagues. Those quick conversations in the corridor, that question over a cuppa in the staff room, or popping into someone's classroom at the end of the day were just as important. These connections don't just provide an immediate answer to a burning question, they also let us to check in with each other about what we are doing, seek support and offer encouragement. By considering schools as workplaces which can enable or inhibit a teacher's attempts to improve their practice, my study showed that workplaces where collaboration, innovation and professional development were encouraged were linked to reports of schoolwide changes to assessment practice. These kinds of workplaces might also be the ones where teachers freely approach each other with questions and ideas during the working week.

So, what can we do to facilitate schoolwide improvements to assessment practice in primary science teaching? Formatively assess colleagues' assessment literacy before deciding how to best support them; use the staff meeting as a forum for focused and interactive discussions of an aspect of assessment practice; and, if you're in a leadership role, consider the extent to which your workplace encourages collaborative working and innovation. Oh, and sort out the biscuits.

REFERENCES

Littleton, K.; and Mercer, N. (2013) Interthinking: putting talk to work. Oxford: Routledge.

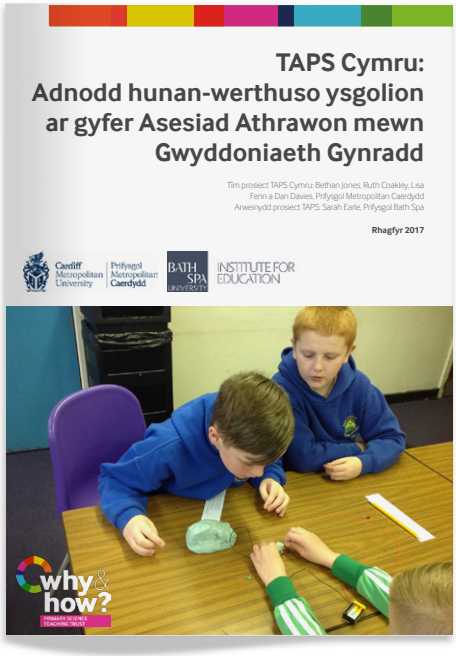
In summer 2020 TAPS will be launching its new interactive website and we look forward to sharing this and some brand new associated resources with you. In the meantime, please visit our current TAPS website and take a look at these useful and free to download TAPS resources.

TAPS special issue of Primary Science

Download here

TAPS Teachers' booklet

Download here



TAPS Teachers' booklet in Welsh

Download here

RESEARCH UPDATE

Evaluation of the impact of the Scottish Universities Science School

In the latest issue of ASE Futures, Colleagues at one of PSTT's Strategic Partners - the Scottish Schools Education Research Centre (SSERC) - describe the impact of one of their programmes, the Scottish Universities Science School (SUSS). The authors believe that this model for professional development for secondary science education students.

FUTURES

Student and probationer teachers

• Kate Andrews • Paul Beaumont • Emma Bissett • Kath Crawford

The Scottish Schools Education Research Centre (SSERC) organises and delivers the Scottish Universities Science School (SUSS), which is a residential professional development event for secondary science/education students across Scotland, routinely attended by more than 95% of the eligible cohort. SUSS has a positive impact on student teacher subject knowledge, confidence and motivation, but also provides a unique opportunity to explore the value of career-long professional learning and identify sources of effective, high quality support for student teachers as they enter the profession. This article focuses on the structure and effectiveness of the follow-on programmes for probationer teachers that SSERC offers in the year following their involvement in SUSS. The article also demonstrates how SUSS is an effective starting point in an ongoing relationship between SSERC and student/probationer teachers as they progress in their careers.

Introduction

Donaldson, in his influential report about teacher education in Scotland, summarised the available evidence and noted that *'…perhaps unsurprisingly, the foundations of successful education lie in the quality of teachers and their leadership. High quality people achieve high quality outcomes for children'* (Donaldson, 2010, p.2).

The Scottish Government, in its review of Education Governance (Scottish Government, 2017a), emphasised that *'Initial teacher education is the gateway to the profession, and we want to continue to attract aspiring and highly motivated individuals who are attracted to teaching because it makes a difference. We also want to inspire an ongoing commitment to learning throughout a teacher's career'.* The STEM Education and Training Strategy for Scotland (Scottish Government, 2017b) emphasises that effective career-long professional learning (CLPL) is vital to allow teachers and other practitioners to develop their STEM knowledge and skills. Such a conclusion accords with the views of several groups (see, for example, Jordan, 2019; Cordingley *et al*, 2018) that effective continuing professional development (CPD) environments have the potential to reduce staff turnover and this seems critical in an era when staff retention is high on the agenda.

In Scotland, there has been a shift in emphasis from 'one-off' professional development events to those that support CLPL. The Scottish Schools Education Research Centre (SSERC), with support from a number of agencies (including the Scottish Government, the National STEM Learning Centre, the Wellcome Trust and the Primary Science Teaching Trust), provides a national programme of professional development in support of science and technology education. One aspect of our provision is the organisation and delivery of the Scottish Universities Science School (SUSS). This event is seen as *'an important and enjoyable part of PGDE science courses across Scotland'* (Findlay, 2017) and we have previously described how SUSS has become an integral part of the educational landscape for Professional Graduate Diploma in Education (PGDE) student teachers or graduating science/education students in one of the secondary sciences (Andrews *et al*, 2018).

In this brief article, we wish to extend our previous observations about SUSS, its immediate impact, and explore how we maintain links with attendees as they continue their journey in the profession.

For further information please contact Paul Beaumont at SSERC on paul.beaumont@sserc.scot

The role of short term memory in children's learning

PSTT Fellow Sue Marks offers a summary piece from her MA dissertation. As research enlightens us further about the processes of learning, making memories, learning engagement, short term to long term memory transfer, memory recall and much else, as professionals we are challenged to reflect upon our classroom approaches to teaching and learning.

Learning comes naturally to us and so does teaching, as we show and tell others constantly in our personal interactions. Research suggests that it is helpful to distinguish knowledge and ability that are "biologically primary and emerge instinctively by virtue of our evolved cognitive structures," and knowledge and ability that are, "biologically secondary and exclusively cultural, acquired through formal or informal instruction or training" (Didau and Rose, 2016). These primary biological forms of knowledge can be further divided into our interest in people, our interest in living things and our interest in inanimate objects, with our natural preference for learning lying with peer and environmental interaction. However, although the short-term working memory functions well when processing primary knowledge, it is not entirely fit for purpose for acquiring secondary biological (or cultural) knowledge, which means that we find can this type of learning and thinking difficult: this includes much of the formal learning that takes place at school.

The importance of linking new learning to prior learning continues to be a focus of research. UCL's Science Capital's teaching approach (Godec, S., King, H. and Archer, L., 2017) encourages us to focus on what our pupils already know and what is relevant to them and their lives, and to recognise and acknowledge their experiences to date. The use of stories which have, "a privileged place in memory" (Didau and Rose, 2016), is another effective teaching strategy already well used in primary science teaching. The story provides a chronology and context to which new learning can be 'attached' and more easily embedded and retained.

REFERENCES AND FURTHER READING

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GODEC, S., KING, H. & ARCHER, L. (2017) The Science Capital Approach: engaging students with science, promoting social justice. London: University College London.

Sue Marks has been a PSTT Fellow since winning her award in 2012. Having been science subject leader in a variety of schools over her 30 year career, Sue is currently the headteacher of Grundisburgh Primary School, Suffolk.

marks1family@aol.com

RESEARCH UPDATE

ESERA 2019

'Recoupling Nature and Culture'

North-east fellow Debbie Myers used her fellows' CPD allowance to travel to Bologna, Italy, to deliver a poster presentation: '*Recoupling Nature and Culture*' at the European Science Education Research Conference (ESERA, 2019) as part of the Nature, Ecology and Environment Special Interest Group, in August.

At ESERA 2019 Debbie outlined an aspect of a whole school project on sustainability and its subsequent development with student teachers in recognition that the development of initiatives to transform societal attitudes towards more sustainable lifestyles, consumption and productivity must '*prioritise the education of educators – building their understanding of sustainability as well as their ability to transform curriculum and wider opportunities,*' (Mula and Tilbury et al., 2017, p1).

In the original project, undertaken during a Rolls-Royce Science Prize (2007) finalist project, Debbie combined dramatic inquiry with woodland fieldwork, habitat mapping and scientific inquiries to bring to life the story of 'The Tin Forest' by Helen Ward and Wayne Anderson. Such a holistic approach enabled children to develop actions to mitigate damage to the environment due to over-consumption of materials: Eg sorting, classifying and re-cycling/ up-cycling packaging and rubbish, composting, testing and purifying water using OPAL surveys and designing and growing gardens for learning, resulting in plants for scientific inquiries that were also used to yield art materials. The creation of habitats-in-boxes and predator-prey puppets enabled children to develop play-scripts to examine the relationships and inter-dependence of plants and animals and to consider the impact of human activities on eco-systems. Poetry, drama and dance were used to examine the central role of seed dispersal mechanisms in ensuring the continuation of eco-systems around the planet. In a lively debate, within their own climate change conference, children researched, reported and dramatised the fictitious perspectives of a range of passionate creatures who believed themselves to be either threatened with extinction (Mrs Sea Snail representing her angry colony) or given opportunities to thrive (the squadron leader of a crew of pandemic-causing mosquitos) by a warming climate.

The original project enabled children to become agents of change – who recognised their responsibilities to protect the environment by actively changing human attitudes and behaviours towards consumption. The development of this work involved research with student teachers to identify the ways in which sustainable development is currently taught within the primary curriculum and to evaluate how the suggested approaches could be adapted within classrooms.

Part of this work contributed to Debbie's award as a primary science teacher of the year in 2007 (AstraZeneca Science Teaching Trust). More recently, the full paper was awarded a prize, as one of three best papers, when presented at an international symposium on sustainability and humanities held at Canterbury.

REFERENCES

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debbie.myers@northumbria.ac.uk

RESEARCH UPDATE

The Journal of Emergent Science

The Journal of Emergent Science (JES) is published by the ASE in partnership with the Primary Science Teaching Trust. This journal is open access and covers the early years through to the end of the primary phase. Issue 17 (summer 2019) includes a rich collection of articles that encourage active teacher reflection and support professional development.

In this issue, a group of PSTT Fellows present an article on using real science research to enhance primary science classroom teaching. They argue that cutting-edge science research can provide an incredible stimulus to primary school children's emergent ideas in science. They describe how devising primary science investigations that are allied to this cutting-edge research helps to contextualise research. The article can be downloaded **here**

See the **News** page for more about how PSTT Fellows are using their expertise to link cutting-edge science research to the primary science curriculum.

A recent '**I bet you didn't know...**' article, written by Katharine Pemberton, outlines how the discovery that conditions on one of Saturn's moons may be able to support life makes us wonder what else could be living in our Solar System. Download this article and the accompanying teacher powerpoint **here**.

Issue 17 of JES also contains an article by PSTT Fellow Alison Trew and colleagues at Exeter University that describes a collaborative project involving researchers, teachers, children and the wider community. The project was based on a recently rediscovered invention - the pulsiogium. This instrument was developed by the late 16th/early 17th century Italian physician Santorio in order to measure pulse. The article explores how studying this invention enables children to explain and debate the concept of comparative measurement as well as develop an understanding of how scientists worked at that time. Download the article **here**.

For a comprehensive review of the literature relating to the provision of whole school science experiences, see **Science Days leading to Science Weeks: Why have them?** This is written by Professor Dudley E. Shallcross and Naomi K. R. Shallcross working with PSTT Fellows Michele Grimshaw, Kathy G. Schofield, Nina Spilsbury, Peter Sainsbury, and Paul Tyler.

KEY DATES

Primary Science Teacher Awards

Nominations open in January 2020

Do you know an outstanding primary science teacher? Why not nominate them for next year's awards?

These awards celebrate amazing primary science teaching across the UK, recognising talented teachers in early years, Key Stage 1 and Key Stage 2. Teachers who win this award are not only judged to be outstanding practitioners in their own classrooms, they also support and develop colleagues in their own schools and others either locally, regionally or nationally. Award-winning teachers are also innovative, creative, enthusiastic and will have significantly raised the profile of science in their own schools and beyond.

ASE annual conference

8th-11th January 2020

University of Reading

Book by 25th October to secure the early bird ticket prices. Full information and the conference preview can be found here

British Science Week

6th-15th March 2020

@ScienceWeekUK

#BSW20

The Big Bang Fair

11th-14th March 2020

Birmingham NEC

Great Science Share for Schools

16th June 2020

#GreatSciShare

Are you registered for the Great Science Share for Schools?

Don't miss out on taking part in the **Great Science Share for Schools** on 16th June 2020.

The Great Science Share for Schools is a national campaign to inspire young people into science and engineering by sharing their scientific questions. You'll benefit from taking part by:

- *encouraging young people to communicate their scientific questions and investigations with new audiences*
- *improving teacher confidence in teaching children to think and work scientifically*
- *raising the profile of school science, improving the science capital of children and families*

Watch out for registration information for 2020 and download resources and information at www.greatscishare.org.uk

Any questions or ideas email us at greatscishare@manchester.ac.uk and follow us on Twitter.

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Primary Science Teaching Trust · 12 Whiteladies Road · Clifton · Bristol · BS8 1PD