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# Environmental Education

# Our Changing Climate



US high school students collecting phenology data

Teachers examining coastal defences in The Gambia

Trainee teachers discussing climate change

The Journal of the National Association for Environmental Education (UK)

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*On the Cover:* The main picture shows bleached whale bones on a deserted beach. The smaller pictures illustrate feature articles in the journal.

All photos are by authors or the editor, unless otherwise stated.

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#### **Editorial & Vice President's Column**



#### Editorial

Welcome to Environmental Education Volume 112, which has *Our Changing Climate* as its theme.

The focus is not the climate, of course, or whether it really is changing – NAEE takes that as read. Rather, we are looking at how education (viewed broadly) approaches climate change in what it does with learners of all ages, and whether there is a greater enthusiasm (and a changing climate) within schools for this focus.

Whilst there seems to be anecdotal evidence that climate change is getting more attention in educational circles, it's important not to get too carried away by this. Certainly, it is hard to be as positive as Fred van Leeuwen who, at a seminar organised by *Education International* during COP21 said:

*"It would be difficult to find schools where teachers do not address climate change and environmental challenges"* 

I wish I could feel confident that this is the

#### Vice President's Column: from Paris to the classroom

It is hard to avoid climate change; it seems to be everywhere. A glimpse at the media in the last few months showed us examples of climate change being the subject of intense consideration.

Now that we have named the storms that hit Britain alphabetically, we seem to be getting more of them. Through December and January, the inundations of parts of Cumbria, Yorkshire and Deeside raised criticism of the Environment Agency's attempts to control flooding which were met with explanations of the rainfall being far in excess of the average or even the highest recorded.

Those who cited global warming as a cause were rebuffed with claims of partial evidence. The poor souls who were up to case, although van Leeuwen is probably right when he went on to say that where teachers do this, they do so: *"most of the time at their own initiative, and sometimes at the initiative of their students."* 

His point is that it is rare to find climate change as an integral part of what schools do. Rather, where it does happen, much is still tokenistic in some way, or made up of isolated activities separated from the mainstream of school life. Well, you will have your own experience and view of this.

In EE112, you will find a number of feature articles about how schools, universities, NGOs, and businesses are helping young people think about the implications of climate change. Most of these are from the UK, but we also have ideas from Ghana and the USA. What is in here is obviously not fully representative of all that goes on, but nevertheless, I hope you find it both informative and inspiring for your own work.

#### William Scott

their knees in water perhaps felt that they had tangible evidence all around them.

As whales ran aground on the east coast of England and became beached and stranded, there was outcry about the 'vandals' who had hacked off pieces of flesh. There was similar outrage about the painting of a message saying 'MANS FAULT' (sic). The outrage was focused, in roughly equal measure, upon the lack of respect for the creature along with the lack of an apostrophe. There was little broadcast outrage about the point that protesters were making about climate change being the cause of the whales' demise. For some people, poor punctuation seems to matter more than the future of the planet.

These are examples of the issue of climate change with which children in school can associate. We should be regularly relating learning to the outside world and using real events to bring the curriculum to life. This

doesn't mean producing one hour 'curtain up' lessons with writing or the completion of a printed worksheet to provide evidence of progress. Deep and structured studies of flooding, its causes and patterns, along with human attempts to manage floods, might be part of a long study. An understanding of the economic effectiveness of soft engineering solutions such as building levees compared with heavy engineering through pumps and dams should not be beyond the scope of children in the older years of key stage 2. Children should produce graphs, charts, maps, writing, photographs and diagrams to demonstrate to an audience what they have found. However, teachers need to recognise that it is also fine to keep a running conversation about everyday events so that these news items become part of children's world understanding.

What is important is that these conversations happen. Young children should be aware of, and grappling with, the complexity of big picture global issues. Yet many teachers are inhibited because of the controversial nature of the issues under consideration. The Labour Government met a legal challenge when it provided every school with a copy of Al Gore's 'An Inconvenient Truth'. There are groups of campaigners that dispute the concept of global warming and there are many who believe that children should meet and learn facts about events of the distant past rather than consider contentious matters of the present day.

Yet surely, when 196 countries and territories signed up to the Paris Agreement in December 2015 and reached a consensus on reducing climate change, this was a significant enough issue for us to expect young people to engage with in a mature way.

The agreement to limiting global warming to 2 degrees Celsius above pre-industrial levels and to reduce greenhouse gases to zero by the mid-point of the century was reached after eleven meetings to follow up the Kyoto Protocol of 1997.

This edition of the NAEE journal offers practical examples of the sorts of work that teachers can do with children to ensure the issue of climate change becomes part of the learning experience. The suggestions take learning to a deep level; this is important. The issue is of such importance that it cannot be addressed with the stereotypical collage of the water cycle or even with projects to turn off lights, important as they are. For ideas about how to get children discussing big ideas, take a look at the *Philosophy for Children* website.

We are unlikely to see government proposing that children should be debating the significance of climate change beyond the lip service, sound bite, photo opportunity spin. That might set schools wondering about levels of priority. Well, saving the globe sounds quite a high priority. At the same time, we are currently being expected to promote Fundamental British Values, one of which is respect for the rule of law. As countries begin to sign the agreement in April, appropriately on 'Earth Day', this is one law we should help our young to understand.

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Opportunities for Environmental Education across the National Curriculum for England Early Years Foundation Stage & Primary

#### The Environmental Curriculum

Last year, we published a guide illustrating how the new foundation stage and primary curriculums provide numerous opportunities to explore a wide range of the world's most pressing issues. It was well received, and later this year, we shall be publishing a secondary school version of the guide – again, freely available as a PDF on the NAEE website. Watch for details.

# Sustainable procurement and a changing climate Matt Roper

#### Overview

There is a growing awareness within the education sector of the need and potential to 'buy green' and there are plenty of examples of committed individuals taking major steps to become more sustainable in their arrangements with suppliers. However, there are many others who have yet to make changes – perhaps because they're not sure of what they can do, or perhaps because they perceive the move to sustainability as a luxury in these challenging economic times.

We see that the biggest move has been in the buying of greener energy – not surprising, since this is where there is a significant cost to schools, colleges and universities. Switching to solar power, biomass heaters and renewable electricity provision are the three big ways of doing this, and some innovative organisations have already put this in place. But there is much more to consider.

The advantages to a school, college or university of 'going green' are numerous; the first and primary advantage is that you're reducing the environmental impact of your organisation in the local community. Reducing the amount of scarce resources and carbon from the supply chain reduces carbon emissions, and limits the damage done to the Earth by plundering resources for short term gain.

The second advantage is that many of the greener products (e.g. non-toxic cleaning supplies) are better for student and staff health as they have much lower VOCs – the toxins that are found in certain paints, varnishes and plastics. Breathing in the fumes from newly decorated walls and floors is not good news, particularly for young children. So by switching to more eco-friendly products and materials, you're protecting people's health.

The third benefit is educational through setting an example for the students and their

parents and carers. They can be made aware of how important the environment is to everyone, and how the school is taking care to protect it. This message can be absorbed by students and will benefit the environment and society as they become consumers.

The fourth benefit is in differentiating educational establishments from others in a positive way – the switch to green supplies can be great public relations and can be a powerful marketing message to prospective students and/or their parents looking to select a school, college or university. It's a competitive marketplace nowadays and it's hard to think of a better, more positive way of encouraging more customers. We find that organisations that have implemented these changes also tend to have happier staff, as the impact on the organisation of having a green policy can be extremely positive for staff morale and motivation.

And finally, it's important to tackle the false perception that it costs more to 'go green.' Whether this is the case or not depends on a number of factors, not least whether you're getting the best prices in the first place. By joining together with other organisations in the sector, keener prices will be secured. If you reduce your energy or waste consumption through changed behaviour, then the total cost will fall. And once you factor in the greater environmental cost of procuring non-green products, the true cost is arguably less than when buying green ones. In the future, all buying decisions will increasingly need to include the environmental cost in order to comply with legislation (e.g. disposal costs), so behaviours need to start changing now.



#### GreenBuying.co.uk – Who are we?

www.GreenBuying.co.uk is a website that sells a range of UK sourced eco products and supplies. Unlike other websites which sell green supplies as an add-on, GreenBuying only sells eco products. We sell a broad range of supplies, such as eco stationery, recycling bins, eco cleaning products, playground equipment and benches made from plastics diverted from landfill. We're about to go live with ethical telecoms and renewable energy too. We maintain competitive prices along with efficient delivery, as we believe that going green should not mean poorer value for money. In addition, all schools and nurseries enjoy a special 10% discount off all products on the website. We also work with schools to educate students and teachers about the importance of sustainability and sustainable procurement through presentations and student workshops. GreenBuying is also developing a web-based waste exchange, launching in May, so that schools can trade waste materials with other organisations. It will be accessible via GreenBuying.co.uk.

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## Science teacher education for our changing climate

#### **Justin Dillon**

#### Introduction

How do you prepare teachers to teach about climate change? It's not just about subject knowledge, as some of our political leaders seem to think, although if you don't know the difference between weather and climate your students might not see you as much use to them in getting to grips with possibly the biggest challenge facing the planet. With such a complex socio-scientific topic as climate change, a trainee teacher's subject knowledge may need regular updating and they need to source information, assess its validity and applicability and then turn it into information that students can understand and learn using a range of pedagogies (see, for example, The Guardian, 2014).

#### Climate change as a special case

The good news is that climate change and global warming are increasingly familiar terms to young people. Educating them about the underlying science and the challenges facing society is, however, complicated – not just because of the scale and complexity of the issues but also because some people have tried to suggest that there is no scientific consensus that global warming since the industrial revolution is caused by human activity. Trainee teachers will find their pupils may already have established ideas about climate change which they have picked up from the media or from their families.



Student teachers discuss approaches to teaching about a changing climate

Public opinion about the issues seems to depend on various factors including nationality. So, for example, when a representative sample of US adults were asked in 2014 why they thought the Earth was getting warmer, 50% of respondents thought that it was because of 'human activity', 23% said because of 'natural activity' and 25% said there was 'no solid evidence'. The same study carried out five years earlier had found similar levels of responses for 'human activity' (49%) but different responses for 'natural activity' (36%) and 'no solid evidence' (11%) (Pew Research Center, 2015). It would appear that a growing proportion of the US public doubts the scientific evidence.

## Barriers to teaching about climate change

In the UK a number of factors have been identified which can be considered as

barriers to engagement with the issues. Prior to setting up its recent 'Climate' exhibition, the London Science Museum commissioned a number of focus groups which found four key barriers, regardless of participants' opinions, about whether climate change was happening, whether it had a human origin or whether it presented a threat to society:

**Boredom:** climate change is constantly in the media and, for children, it is a topic they encounter in multiple subjects throughout their school career.

**Irritation:** the public do not want to be told what to do and how to live their lives, particularly when it involves foregoing activities they enjoy, such as travelling abroad.

**Powerlessness:** the public feel that individual actions are futile and have no sense of collective impact; they feel there has been little change and have a low awareness of international efforts, for example, the 2009 Copenhagen conference.

**Fear:** the public do not know how bad the impacts will be, the effect it will have on themselves or if it is even too late to act. (TWResearch 2008 and 2009)

While climate change appears to be seen as increasingly important by politicians and industry leaders, the public may see the issue as being relatively low in priority. This state of affairs is likely to continue as long as disinformation campaigns continue and the media insists on giving voice to a handful of sceptics (Roser-Renouf and Maibach, 2010). The situation provides a challenging context within which trainee teachers have to operate.

## Teachers' views of climate change and global warming

As members of the public themselves, teachers are likely to hold views which may not agree with the scientific consensus. The Science Museum's focus groups with secondary school science and geography teachers revealed that some of the science teachers were not convinced that climate change was caused by humans (TWResearch 2010). These findings resonate with Dove's (1995) survey of student teachers' understanding of the greenhouse effect, ozone layer depletion, and acid rain. Dove was puzzled as to why the prospective teachers understood the science behind the ozone layer but did not understand the greenhouse effect and global warming. She hypothesized that while the link between CFCs and the depletion of the ozone layer was well-established, global warming was somewhat contentious – something which is still the case today – at least in some people's eyes.



Laboratory activity in a PGCE class

Teachers participating in the Science Museum's focus groups reported that the uncertainty of climate change science conflicted with their perception of their role as teaching the 'truth' (TWResearch 2010). The implication for trainee science teachers is that, more than ever, they need to learn about the nature of science including the tentative nature of some scientific knowledge. They also need to be able to appreciate that science works through disagreement about interpretations of phenomena in the natural world, and that scientists' values may affect how they interpret data.

## The convergence of science and environmental education

The importance of teaching about values in socio-scientific issues points to a need for a convergence of science and environmental education if students are to receive an education that enables them to face today's 'wicked' problems (Dillon & Scott, 2002; Wals et al., 2014). David Uzzell (1999), however, has criticised some approaches to

environmental education that he described as top-down. Uzzell pointed out that such approaches did not appear to change students' attitudes to the environment and had even less impact on their behaviours. New approaches, involving local communities in taking action have been advocated (Moser and Dilling, 2004, Wals et al., 2014). Others have argued that effective climate change education needs to emphasise the personal connection between the student, fuel use and climate change using methods such as environmental footprint calculations (Cordero et al., 2008). These arguments need to be considered by trainee teachers.



Planning lessons around climate change

#### **Teaching strategies**

Bringing together the science of climate change, the values dimension and the goal to change people's behaviours individually or collectively requires a number of pedagogical approaches to be appreciated by trainee science teachers. Thus science teacher educators might promote teaching strategies which emerged in response to the Science Museum focus groups:

**Focus on humans:** People seem to be interested in the human stories, particularly those relating to:

- the UK: these are emotive and can make the issue personally relevant;
- social justice: the sense of injustice is motivating;
- countries already experiencing the effects: that the effects are happening to

people now helps make the issue seem less remote and more immediate.

**Personal relevance:** Many people fail to relate to the global issue. They want to know how it will impact on them and in what time-frame or they can dismiss the issue as not relevant to them.

Providing examples of adaptation and innovative solutions: Examples of action that could/have been taken can provide a message of hope in an otherwise gloomy picture. People have low awareness of these broader solutions beyond re-using carrier bags and replacing incandescent light bulbs.

**Providing examples of solutions from other countries:** Visitors are intrigued by what other countries have done and how, as it provides hope.

(TWResearch 2008)

#### Final thoughts

Whilst it is too much to expect that preservice teacher education will be able to address all these issues in the requisite depth, given everything else that has to be covered these days, it is clearly necessary that a start is made. Given that there is also a need for science teachers already in post to have such awareness and skills, it could be that a good way forward would be for universities to work at the same time with both science teachers in training *and* those already in schools on these vital issues.

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#### Making connections in a changing climate

#### **Ben Ballin**

The great educational thinker Jerome Bruner once famously asserted that "education is not an island, but part of the continent of culture." If so, then there seems to be a bit of a muddle in the mapmaking department about where some of the key ideas around ESD, EE, Global Learning etc. ought to go. I am going to offer some metaphors that I hope will help.

1. Let us imagine *the environment* as a vast and oceanic swimming pool. Inside this pool, we can find all human activity; everything that has been grown, made or changed by people; plus, all the as-yetunmanipulated remnants of the natural world. In other words, within it we can find pretty much everything. This is what Environmental Education is most interested in (especially the 'natural world', though it would be flying in the face of evidence to see any of the world as untouched by human activity).

**2.** Let us imagine *the global* as the boundaries of that enormous pool: its sides, the pool bottom, the roof above it. This is the limit of where everything in the pool can happen and interact. Again, it covers pretty well everything.

The processes within those boundaries are what Global Learning is most interested in (especially the human ones, although it would be ecologically illiterate to imagine that human beings can exist independently of their environment).



Shoring up coastal defences at Kololi, The Gambia. The tourist beach has been restored once, and is eroding again.

**3.** Let us imagine *sustainable development* as a perpetual-motion machine. This keeps everything moving and interacting inside our boundaried pool. If one element within the pool gets seriously out of balance with another, the machine risks grinding to a halt, and the pool is spoiled. (We might give these elements names like society, economy, culture, the natural world). In other words, the machine's ability to work relies on the idea that human beings can live in balance with the natural world, now and in future, to the benefit of all. So sustainable development, too, involves pretty much everything ... and this is what ESD is most interested in.

#### **Essential learnings**

These are imperfect and scientifically inexact metaphors. However, if we run with them, then what we become interested in is not whether one of these things matters more than another, but how they play out: how the environment operates at scales from the local to the global; how the concept of sustainability affects the way we look at the world; how different elements can work together in more or less benign ways; how the different 'educations' can complement each other and offer distinctive insights.

We can see, too, that things that sometimes appear to be opposed to each other may not be so: humanity vs nature, local vs global, or Global Learning vs ESD vs Environmental Education. We will need them all if we are ever to get our heads around what is going on in our world or do anything useful about it.

This is nowhere clearer than when looking at the pressing matter of climate change, where local and global processes, human activity and the natural world are intimately and dangerously intertwined.

#### **Global learning lenses**

Other visual metaphors keep cropping up as part of an EU-funded project that I am currently involved in at Tide~ global learning. 'Young people on the global stage' brings teachers and educators together from the UK, Spain, The Gambia and Kenya. (Visual metaphors are, of course, very helpful when teachers are working across the boundaries of language, culture and different education systems).

The project looks at key issues around sustainable development, including questions around poverty/wealth and hunger/food production. This is quite clearly the terrain of Global Learning, ESD and – I would argue – Environmental Education.

One of the things that our partners at FERE CECA in Madrid have brought to the project

is the metaphor of 'global learning lenses'. We might use these lenses as follows:

- a magnifying glass opens up the issue
- **3D glasses** invite us to look at the issue from different perspectives
- **a microscope** subjects it to critical thinking
- a telescope helps us visualise solutions (what our partners call 'utopian thinking')



European and Gambian teachers being shown coastal defences near Banjul, the low-lying capital that is particularly vulnerable to climate change.

Bringing all these visual metaphors together, let us imagine that a year six class is learning about the recent climate change summit in Paris. By borrowing an enquiry process that Tide~ has used in the past, we could ask:

#### What is climate change?

This involves the magnifying glass and the 3D glasses: we are opening up the issue, and looking at it from a number of perspectives. There is some solid science here, including the (Environmental Education) opportunity to take weather measurements, look at leaf-fall and budburst. Children could examine what socalled 'climate sceptics' have to say, and where the balance of evidence presently resides. (This might take us more into the terrain of ESD).

#### Why does it matter?

Using the microscope, we subject the issue to critical scrutiny. Children might look at the differential impacts of climate events on, say, the UK, the Sahel and small island states. They could use a 'mystery' to explore complex chains of cause and effect across the globe. They could follow online news reports about what people are saying in different places in the lead-up to the Paris summit. This involves linking science to geography, English and other subjects. (Global Learning has a great deal to offer us here).

#### What can we do about it?

And so to the telescope, solutions and 'utopian thinking.' As well as geography and science, children could look at technical solutions in design and technology, personal action and morality in PSHE and RE, and the decision-making processes at Paris. They might write persuasive texts to send to local delegates to Paris. For a whole school response, a scheme such as Eco Schools would come into its own. (I think we can detect action-orientated strands of all three 'educations' here).

#### What have we learned and how?

This is a chance for children to purposefully share their learning with others. For example, they could create an assembly, a film, a blog or news bulletin for their peers and the community. The 'lenses' themselves can serve as tools for children's metalearning: exploring how they have learned. In reviewing the ways they have learned about this issue, they may well devise further questions for the future.

This is about empowering children not only as learners, but also as confident citizens. (To borrow a term from the editor of this volume, this is not so much about ESD, EE or Global Learning, but is closer to 'learning as sustainable development', a process of continuous learning that helps keep the perpetual-motion machine going).

In conclusion, and to return to Bruner: if education is part of 'the continent of culture' then it both acts on and is influenced by wider ideas about sustainable development, the environment and the global. At best, these ideas – and their related 'educations' complement each other, offering distinctive insights and approaches.

In addition, we can experiment with tools like 'the global learning lenses' to gain particular kinds of understanding. Together, all these things help learners understand an issue like climate change more fully. In isolation, learners are left with a restricted and partial understanding: a pool without form; boundaries without content; a perpetual-motion machine that operates outside of any context.

One final thought: if 'reality is made, not found' (as Bruner also asserts) then that is not only true of learning, but what we do with it. Through learning, we make the world. In the current climate, it seems to me that this is not simply a matter of theory, but a matter of survival.

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GLOBAL ENVIRONMENTAL EDUCATION PARTNERSHIP

The Global Environmental Education Partnership (GEEP) is a learning network that brings together environmental education policy makers, providers, and practitioners from across the world.

Launched in 2014, its mission is to build capacity to strengthen environmental education, by focusing on policy issues, professional development, evaluation, and the sharing of best practices. Climate change is a key focus, and outputs will include curriculum guidelines, and professional development opportunities.

GEEP aims [i] to promote global expertise and the sharing of experiences; [ii] to improve the quality, practice, and impact of environmental education; and [iii] to expand its reach by working with new and underserved audiences and communities. More detail is available at: ow.ly/ZXaTP

## Generating sparks! Using the solar racing car challenge to teach about renewable energy

#### Mark Walker and David Garlovsky

"Make the fastest solar car you can!" This was the simple challenge posed to the students at Swinton School, Rotherham, on a recent renewable energy project day.

Can you remember learning about electricity using a series of line diagrams filled with obscure shapes and complex equations all bundled together to represent an electrical circuit? Or do you teach about renewable energy by showing a static picture of a solar panel attached to a house?

Electricity is 'invisible' and can't be seen, or (hopefully) touched, meaning it is an abstract concept and one that is difficult to make relevant to students. However, electricity and themes related to its generation are major topics within the national curriculum at secondary school. The physics syllabus requires a knowledge of fuels and energy resources, and of their costs (national curriculum for KS3 and KS4, p. 63). Electrical knowledge relating to serial and parallel circuits, potential difference, and other related themes are also required (p. 68). How can these topics be taught in a lively, engaging manner?

Sheffield Science Educator, David Garlovsky, has developed an approach to teaching these environmental themes in a fun way. He visits schools, introducing students to his self-designed solar-powered model racing cars, but instead of delivering these ready-made, they come in kit form, for students to assemble. They resemble a traditional Meccano kit, but unlike Meccano, many of the components are designed with the aim of teaching a variety of physics, maths and environmental topics.

## The challenge: become a solar motor champion

Children find movement interesting. That is the problem of teaching about electricity and energy using pictures of solar panels or with analogies showing pipes in a hot water system. They are simply not interesting enough. They do not move, and students cannot see or feel what is happening. But motor racing is different, and a solarpowered racing car uses the electricity it produces to create rapid movement, as the cars are equipped with powerful solar panels which generate power even under diffuse light on cloudy days.

Such cars allow teachers to tap into children's competitive spirits, and David starts every lesson by getting students into teams, with the challenge to design the best racing car possible and to race it against the other teams.



One student tests whether reflecting light onto the solar racer makes it go faster

## Tinkering: integrating STEM into the lesson

STEM, the integration of science, technology, engineering and maths, in one single project, covers key parts of the national curriculum, with the design and technology syllabus requiring students to use a 'range of materials and components' to solve their own design problems, and 'understand and use the properties of materials and the performance' (p89).

The solar racer integrates many of the topics of STEM while introducing an environmental theme. Sadly, engineering can still evoke an image of a bloke with a smoke-blackened face and oil-spattered hands, working in a noisy and dirty metal workshop, surrounded by drilling tools. In this out-dated view, engineering and ecology seem incompatible, but the solar racer project shows that engineering can also be environmental. Students can see that there is an alternative to mucky non-

renewable fuels: they actually see that green fuels work.

The use of science process skills is a significant topic under the 'working scientifically' part of the national curriculum where students need to identify variables, apply mathematical concepts, and make observations and measurements (p. 59, p. 70). A unique feature of the solar racer car is the number of features that can be manipulated to influence the functioning of the car. Wheel size, solar panel elevation, car design, wiring, can all be altered, and no two cars are ever alike.

The whole process involves students thinking for themselves with teachers prompting them as much or as little as required. For example, when deciding on the type of wheel to use, prompts can be used to ask them to speculate as to the speed of the car when the wheels are large or small, and ask: how could you test them? If you changed the wheel size, what else must you do? How could you make it a fair test? And this is only one aspect open to experimentation.



Students race all the cars along a ramp, releasing them at the same time so that conditions were the same for all cars.

#### **Teachers' Experiences**

Teachers' experiences have been very positive. Terry Dawson, a maths teacher comments: "The energy of children when they pick up these kits and get started is fantastic. Initially we expect students to follow the instructions provided to them; they work in groups, and once this initial stage is over we give them additional material." Steve Barnet, a teacher of design technology, agrees: "This is just throwing them in at the deep end really."

What really impresses the teachers is the cross-curricular nature of the kits. *"We give the students the basic kits and the instructions and then leave it to them to build the prototypes"*, says Terry. *"We can integrate whatever we want into the lessons; maths, science, even English."* Chris Williams, a science teacher, adds: *"The students don't realise they are using engineering and maths skills, but when this is pointed out to them they realise the wide ranging implications of what they are doing."* 

Even the teachers don't know where the work will go. Steve Barnet says: "We give the students ownership, and put the onus on them to find things out. What we find is that when we ask the students to adapt the buggy, they come up with some weird and wonderful designs. They will redesign this, or readapt that. They then might think they have to reduce the weight, so they begin to take things off. Later they might think about friction and how to reduce that."

#### A ray of inspiration: What angle is best?

An excellent example of how inquiry can be integrated into teaching with the solar racer is deciding on the best positioning for the angle of the solar panels. We prompt students with the question: does the height and angle at which the panels are placed influence the speed of the racer? And then ask: how could you investigate this?

An understanding of how the seasons influence solar luminance is mentioned in the national curriculum (p. 67), and use of this challenge helps teach the concepts involved. Students can actively observe how different light qualities influence the functioning of the racer. For example, what happens to the car (and why) when it runs into a shadow? Students typically see that the car slows as it enters a darkened area where not enough light can be collected by the solar panels. From this initial observation, a more detailed study can be made.

When we asked: "if you raise the panels what might happen?" one student, Liam, Environmental Education Volume 112 | 13 thought the car might "collect more sun and go faster." We then dismantled the panel and raised it so it was distinctly tilted, and Liam could see how this affected the performance of the car. Another student decided to put aluminium foil behind the racer to direct light onto the panel.



Solar-Active model car with a three-speed gearbox, powered by a single solar cell

Such questions can be used to initiate a series of investigations, with students having to decide how to conduct the study. They have to realise that it is not enough simply to raise and lower the panel, but all other aspects of the racer must be kept the same when the panel is placed at different heights. Students can experiment trying out different combinations, before deciding which angle of alignment is the most productive. After studying this problem, students can then relate their observations to how the strength of the sun varies at different times of the year because of the Earth's rotation and its tilted axis.

#### A renewable fuel

The national curriculum requires students to learn about the production of carbon dioxide by human activity and its possible effect on the climate (p. 64). The solar racer provides a way of introducing this topic. We use it to prompt students to compare the solar car with conventional cars, asking: what are the advantages and disadvantages of each? There are now increasing numbers of electric and hybrid cars on our roads, and the solar racer allows students to investigate at first hand the advantages and disadvantages of each. The solar racer uses renewable, sustainable solar energy, and shows that this is not simply dream thinking but is a method with real potential to replace diesel or petrol driven cars in the future.

#### **Recycling materials**

Special emphasis is put on the recycled nature of the parts used in the car. As much as possible every component of the kit is made up of pre-used material.

For example, the plastic wheel arches are made up of reclaimed credit cards, and the boxes the cars are delivered in are made of recycled materials. In this way, students use material from existing products to make new things for new purposes. They mimic what happens in the actual car industry where new cars contain increasing amounts of recycled and refurbished materials. All this has the additional advantage that students learn to be creative. For example, although students are offered a number of different types of wheel, some came up with the idea of using old CDs instead. These proved beneficial because they caused no rolling resistance and were light, although they had trouble on uneven ground.

Solar Active! has been using these cars in schools around Sheffield for over 15 years. Over this time, it has modified their makeup, and developed a range of accompanying teaching materials. A basic conviction remains, however, that such hands-on, investigative activities help bring renewable energy alive in a way that formal teaching never can. It's also the case that, over this period, concerns about our changing climate have intensified, and our need to move to renewable forms of energy because of this have become clear. This project has the potential to help students engage with both these vital ideas.

#### Reference

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#### Does changing our behaviour at school actually make a difference in terms of climate change? And if it does, how can we know?

#### Sheila Gundry

Bins slopping with school dinner waste.... images of tonnes of unnecessary waste dumped in landfill sites.... waste can really capture children's attention. What's more, it's a tangible issue for children and young people to tackle. For example, they can set up recycling systems or collect break-time fruit waste for composting – things that even young children can take responsibility for and know that they are doing their bit to reduce waste, increase sustainability, and address climate change.

Working in Devon schools, Resource Futures and Devon County Council have been investigating how best to encourage these initial steps, how to scale up to more comprehensive behavioural change, and how to measure if, or how, it is working. In particular, we have looked at behavioural change in terms of:

- Are there measureable changes in schools, such as reducing residual waste or increases in recycling over the long term?
- 2. When children understand more about the issues, does this affect their behaviour at school?
- 3. Does it affect their home life? When children are encouraged to pass on their learning to their families, does this actually happen?

## 1. Long term changes in residual waste and recycling

Being faced with a heap of all the waste from one day at school brings home to children and adults just how big this problem is, and the potential climate change impact if it were all to go to landfill<sup>1</sup> and produce more greenhouse gas. We help children in Devon to audit this waste: they sort it into standard categories (paper, cans, etc.) and weigh each category. They then develop their action plan, which includes [i] specific proposals for each waste stream that is an issue in their school (such as paper towels or fruit waste), and [ii] ways of raising understanding and awareness across the school community, for example, through assemblies or curriculum-linked workshops. After around six months, when they have made good progress with their action plan, we help them undertake a second audit.



Weighing collected waste

The 49 Devon primary schools that have had a second audit since 2010, gave the following results:

	Residual waste (g) / pupil / day	Residual * waste (kg) / pupil / year	Recycling rate
Audit 1	118	23.6	20%
Audit 2	66	13.2	47%
Change	- 52	- 10.4	

\* Estimated NB, all data are averages.

The table shows that, on average, each pupil produces about 10kg less waste per year at school after taking action. That is a reduction of 44%, which would be over 3 tonnes a year for a school with 300 pupils. To illustrate that amount, it is more than three baby elephants by weight. The data also shows that schools have increased their recycling rate from 20% to 47%. These results have been achieved both by schools making changes to their systems, and by pupils and staff changing their behaviour in terms of waste.

## 2. Understanding the issues, and how this affects behaviour

It is straightforward to gain feedback from teachers on how effective they think curriculum-linked workshops are. For example, data [1] from 147 Devon teachers in 2014-15 show that they all said that waste workshops overall were 'excellent' or 'good', with 99 per cent thinking that communicating aspects of the Reduce, Re-use, Recycle message was also 'excellent' or 'good'. 99% of the 2,375 children surveyed in 2014/15 said that they had learnt something new from the session they were involved in, with 99% enjoying or really enjoying it. This is clearly important for motivation to take action.

Gaining feedback on longer-term impacts is harder to achieve. Looking just at recycling, with 66 Devon teachers who have been involved in longer-term waste education programmes, we found the following:

#### Have you noticed any of the following changes in your school following Resource Futures' audits, workshops and assemblies?

Question	% agreed
New or improved school recycling facilities	46%
Pupils more enthusiastic about recycling and reducing waste	91%
Increased amount of waste being recycled	58%

So whilst over 90% of pupils are more enthusiastic about recycling, according to their teachers, a lower percentage of schools (58%) are actually increasing the amount of waste being recycled. This could well be because only 46% of schools have new or improved recycling facilities, which shows that both enthusiasm and good facilities are needed for behavioural change to create significant increases in recycling rates.

#### 3. Taking the message home

Whilst we can show clear changes of behaviour at school, does waste education make any difference to behaviour at home?

In spring 2015, we surveyed 3,470 parents/carers from 26 Devon primary schools. The response rate was 19% (645 people), and a large majority (82%) said that their child had talked to them about waste. When asked what their child had talked about, it was clear that the 'importance of recycling at home' and the 'Reduce, Re-use, Recycle' message were the main areas that were discussed, see graph below:



We were also interested in whether their child's involvement in workshops had influenced their family's approach to waste and recycling. Many (59%) said it had and, of those who said that they had not been influenced, the majority said that they were already recycling as much as possible at home.

The 59% who responded 'yes' were then asked *how* their behaviour was influenced:



Most of these respondents said that they were 'recycling more' as a result of their child's involvement in workshops. When they were asked to estimate how much

more their household was recycling, 44% of them said that it was a 'few more items each week', but 22% said that they were now putting in half as much again.

And what do the parents think about being taught by their children – are they pleased, angry, disparaging? The responses we had were really positive:

"I am really encouraged to see this being taught at school and love how enthused my daughter now is about the 3Rs" – Parent, Sandford Primary

"Although we were doing lots anyway, the kids really listened and understood the things presented to them and recycle, etc. for themselves not just because we tell them to!" - Parent, Stoke Gabriel Primary

"Great idea for kids to learn hands on and bring that attitude home to educate parents who are less aware" - Parent, Holsworthy Primary

"Lilly came home excited about what she had learnt and asked the days we recycle and put our bins out" - Parent, Fremington Primary

So overall, does changing our behaviour at

#### Pictures are only worth a thousand words if carefully chosen

#### **Morgan Phillips**

As every great teacher knows, a picture is worth a thousand words. But the story you end up with depends on the picture you pick. Get it right and you can stimulate new perspectives, behaviours and emotions. Get it wrong and you might reinforce negative stereotypes, leave people feeling helpless, or create a totally false impression about the subject in hand.

As a society, we have never shared so many photographs. Social media streams are filled with images that are seeking to hook us into an issue. In classrooms we are using photos and videos more than ever before. There is growing interest in this area school actually make a difference in terms of climate change? Waste audit evidence from Devon schools shows that children can make a difference in terms of reducing school waste. This is important particularly with food waste which, in areas that use landfill sites [2], rots to produce methane, a key greenhouse gas. Learning about the issues plays a useful role and is much appreciated by teachers but a direct link with climate change is, of course, harder to establish. And as for taking the message **home**, well, children do talk to their parents about waste issues and parents say they have made practical changes as a result, so it seems that this can help the climate too.

#### Notes

**1** Devon County Council funded the work discussed in this article, and it owns the data cited in this article.

2 Much of Devon's residual waste now goes to Energy from Waste plants, rather than landfill sites.

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in the sustainability communications world with plenty to learn for environmental educators.



Research into the effect images have on audiences can help us make smarter choices. Climate Outreach have recently launched Climate Visuals, a library of images for climate change communications. The library has been compiled based on new research into what makes an effective image. They have distilled their key findings down to seven key principles for visual communication of climate change images:

- Show 'real people' not staged photo opportunities
- Tell new stories
- Show climate causes at scale
- Climate impacts are emotionally powerful
- Show local (but serious) climate impacts
- Be very careful with protest imagery
- Understand your audience

More detail can be found at climatevisuals.org, along with a gallery of images to download and use in your work.

Climate Visuals is worth exploring alongside Common Cause for Nature (PIRC, 2013), which looks at communications more broadly, and is designed for conservation organisations. But, similar to Climate Visuals, PIRC make recommendations that translate to a broader range of environmental and development issues.



It is particularly important to consider the emotional power of images. Climate Outreach found that *"survey participants ...* were moved more by climate impacts – e.g. floods, and the destruction wrought by extreme weather – than by causes or solutions", but warn us that although *"images of climate impacts can prompt a* desire to respond ... they are emotionally powerful, [and can therefore] also be overwhelming." PIRC also flag up this problem: "Strongly negative messages can evoke feelings of terror or dismay – focusing our attention, and conveying a sense of importance, but also leaving us feeling disempowered, overwhelmed and paralysed (it's too big a problem – what can I possibly do about it?), and so less motivated to act. Instead, we frequently try to avoid these threats, or want to exert control elsewhere – often by chasing materialistic comforts, with largely negative effects on the environment."

PIRC recommend that we "take care when raising awareness – including of scary and depressing things – so that audiences are not overwhelmed."

Climate Outreach suggest we couple "*images* of climate impacts with a concrete behavioural action for people."

Rob Bowden, from Lifeworlds Learning, gave an excellent practical example at a recent Eco-Schools roadshow event. In teaching about deforestation, he ensures that bleak images of destroyed habitats are countered by images showing the positive actions of children and adults taking action to redress it. Images of tree-planting days and animals thriving in forest environments provide the main backdrop for the session.

Keep Britain Tidy recently commissioned TV presenter and naturalist Chris Packham to create an exhibition of photos, two of which are included here, to raise awareness of the impact litter has on the natural world. His photos juxtapose litter and nature, communicating the wonder of the natural world and the seriousness of the issue, but in a way that does not leave the viewer feeling helpless or totally overwhelmed.

Pictures are worth a thousand words and evoke a thousand emotions; use images and use them wisely.

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#### Highcliffe St Mark's Eco Action Committee at work

#### Tamsin Milroy

Highcliffe St Mark Primary is an Eco-School in Dorset which tries to make its children aware of climate change and how they can make a difference. One of our key principles is to make links between our everyday choices and how these impact on the climate and the world, and we actively promote taking responsibility for actions and choices. We do this by showing the children how to make a difference to the environment in what they do, whether that is walking to school, switching off unnecessary items, reducing and recycling waste, or making consumer choices with a smaller carbon footprint. As well as encouraging the children to make such impactful choices, we empower them to campaign for these issues at home. We also teach outside to give children a better appreciation of their local natural environment, and this has multiple benefits. As one of the children said: "It makes me want to go outside when I get home."

An eco-action committee is elected every term with two pupils per class, and we plan our work using the nine Eco-school themes. Energy is a theme we cover every year.



Recording energy data

Ensuring that people remember to switch off un-needed items and making sure we are not wasting energy are ideas that even the youngest children can grasp. An annual event such as a *switch off fortnight* is a powerful way of reinforcing this. One year group analyses our energy bills and reports back to the eco-committee, and eco-reps monitor class energy use. They award a card and Zingy mascot to classes that do well, or a card reminding them of what they need to improve. This creates healthy competition between children *and* teachers. The children also carry out a home energy audit, and some parents say their children become quite militant about this, sometimes leaving them in the dark.

The eco-committee has a sub group that meets with our site manager to collect monthly meter readings and conduct energy audits, and an energy consultant has given us suggestions about changes to the buildings. We take our findings and recommendations to governors, and, helpfully, the children have seen considerable changes. For example, the key stage one building now has LED lights, the printers have timer clocks, and the swimming pool has a new cover.

The children are also very aware that how they travel to school affects global warming, and to discourage the use of cars, October is 'Walk to School Month', which is reinforced by a walk to school week in May. To encourage the children who have to come by car to walk some of the way, we have a 'park and stride' scheme which reduces pollution nearer to school. We now have walk to school targets to meet, which are set by the children.

At Highcliffe St Mark, we understand that our changing climate will play a huge part in the children's future lives. We also know that it is our responsibility to help them acquire the knowledge, tools and skills to deal with what they will inevitably face. The school's eco-committee plays a key role in all this, and relishes the challenge.

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#### Is it time for Nature Schools?

#### **Gary Mantle**

The Wiltshire Wildlife Trust has a long history of involvement in providing informal and formal environmental education. Over the years, general nature studies have given way to specific activities tailored to help teachers meet attainment targets. We have worked with hundreds of schools; creating wildlife areas, running teacher training sessions, giving presentations to school assemblies and providing both classes and whole schools with programmes of work.

In the Trust's Strategy for 2015-2020, we set out two aims, the second of which is to inspire and support people to live more sustainably. This is to be achieved by five objectives, one of which is to provide, support and encourage outdoor learning. Environmental education is also a key thread that runs throughout the other four objectives: improving health & wellbeing of people through greater engagement with nature and green exercise; promoting sustainable living; responding positively to the challenge of climate change, and developing nature centres at sites across the County - for example we now offer a diversity of activities that schools can book using the facilities at the Trust's Langford Lakes and Lower Moor Farm nature reserves.

The current funding of the Trust's educational work is based on a combination of grants and charges made to schools for services provided. Long term funding for staff to deliver environmental education has always been a challenge for the Trust and volunteers continue to play an important part, particularly in running Watch Clubs for our junior members and supporting staff during school visits to our nature centres.

However, despite the best efforts of all of us involved in environmental education, the Trust has noticed increasing levels of environmental illiteracy and a growing disconnect between people and nature. I was shocked when a work colleague told me how she had to reject lots of nurseries in her search to find one where the children could play outdoors on grass. Amazingly some had replaced the grass with a kind of 'astro turf'. It exemplifies a sanitised and constrained world that divorces people from nature. At a recent national conference, I heard speaker after speaker describe how children have become virtual prisoners, confined to their homes and school classrooms. Hardly any children now have the freedom to explore, learn about and enjoy the natural world as I did. The result is not just environmental illiteracy, but a negative impact on the health and wellbeing of our young people.

The Trust is doing more work with schools and young people now than ever before, but it often feels like we are just scratching the surface. When head teachers, teachers, school governors, parents and pupils experience first-hand the benefits of outdoor learning, a frequent question we hear is: 'why is this not included as a regular part of every child's education?' It is a good question.



Viper's bugloss on Salisbury Plain

As readers of this journal will be well aware, there are many benefits from allowing young people to learn in a natural environment. Working outdoors with young people, Trust staff frequently witness transformations taking place; a halt in anti-social behaviour, greater team working, increased creativity and concentration, more personal confidence, a greater appetite for learning, as well as the acquisition of new skills and increased environmental awareness and understanding. Sometimes the impact on individuals is almost miraculous.

So why is this not part of every child's education? Recently we have tried reframing the question and started looking for ways to embed this natural learning into the educational system. As a result, we have identified both the need and the opportunity to set up Nature Schools where we can provide enhanced learning opportunities through the use of outdoor classrooms and long term, regular contact with the natural environment.



Young children learning in the outdoor classroom

Our first tactic has been to look at the plans to build more schools. In Wiltshire and Swindon there are plans to build 80,000 new homes in the next 10 years. Alongside this will be several new schools. We have therefore approached the developers and the local council to promote the need for all new schools to be built as Nature Schools. In addition to meeting government standards for school premises and the codes for sustainable construction, we would like all new schools to be built so that they open onto a nature area as an extension of the formal school grounds rather than have an enclosed playground. There should be an orchard and an area where pupils can learn to grow food. The response from the council and developers has been very positive.

But we want to go further than this. There have been many school nature areas that have fallen into disrepair when a key teacher leaves. What we need is to see a new generation of Nature Schools, where regular close contact with nature is part of the whole ethos and vision of the school, enshrined in the foundation principles and governance arrangements. In our ideal Nature School, wildlife observations will be part of the daily routine and every child will be guaranteed the opportunity to learn outdoors. This could include outdoor physical education (which is better for children's health and wellbeing than being confined indoors), learning practical skills (such as growing food, using tools and constructing) and artistic skills (using nature as an inspiration to help engage students in their creative development in a natural studio).

One of the barriers to outdoor learning is that few teachers are trained or have the experience of leading classes outdoors, despite the growing evidence showing how this can have a powerful effect on pupils' health and wellbeing and their academic attainment. Every teacher in our Nature Schools will be trained and qualified to take classes outdoors.

The educational focus of a Nature School will be on creating a social learning community with a clear view of the world and a real sense of place which:

- Has a growing awareness of its environmental impact (footprint), has a strategy for steadily reducing it, and uses these as a focus for learning
- Values outdoor, environmental, experiential and exploratory play as ways to learn and engage with realworld issues in authentic settings
- Is outward-looking, and whose work is not only based in its local context (the environment, society and culture), but which has real links to real communities in other parts of the world
- Recognises that there is an interdependence and shared responsibility for who we are, where we live and what we do, in relation to both social and environmental justice
- Understands that it can, and should, contribute to maximising learning and

gaining skills, and enhancing social cohesion.

It will be important that Nature Schools can demonstrate academic excellence. We are collecting evidence to show [i] that such a Nature School approach allows all children to thrive irrespective of their individual learning style and that pupils can achieve high academic performance; and [ii] that the stimulation provided in an outdoor environment can allow all children to unlock their potential.



A Wiltshire white horse

Nature supports engagement across the curriculum and helps make learning more relevant, meaningful, enjoyable and accessible for students, and Nature Schools will offer a different sort of balanced curriculum:

- Providing emotional time and physical space for child-led learning to come alive
- Giving children the chance to gain both the physical and wellbeing benefits that nature offers such as increased self-esteem and greater resilience to face the challenges of growing up in a fast paced world
- Placing an emphasis on personal development and not just academic outcomes, as working with children outdoors helps them thrive and learn about themselves

Lessons could include:

• Creative writing within the school grounds, moving out of the classroom for greater inspiration and ideas

- Maths in a woodland, measuring and recording heights and circumferences of different plant species, estimating total numbers of plants in an area and using graphs to show results
- Design and technology lessons using basic tools such as a pole lathe to create a wooden toy
- Science field studies observing how animals and plants have adapted to their environment

Each Nature School will offer enhanced opportunities for learning and personal development. Part of the ethos of a Nature School is that every child matters and they are supported as they develop:

- Positive mental attitude, selfmotivation and independence
- Resourcefulness, self-regulation and resilience to challenge and failure
- Perseverance, self-confidence and communication skills
- Risk management and outdoor safety
- Empathy and intrinsic motivation
- Social and communication skills



Six-spot burnet moth on greater knapweed

With our colleagues in the other Wildlife Trusts we are now exploring how we can turn the vision, ethos and benefits of Nature Schools into a reality in the new landscape of academy trusts and free schools. The challenge is considerable, but the benefits are even greater.

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#### Changing climates, different cultures, school curricula and children's perceptions

#### Elsa Lee, Richard Irvine, Barbara Bodenhorn and Amarbayasgalan Dorj

What can talking and walking with children in different parts of the world tell us about how humans are responding to changing climates, and what does this mean for school curricula? In a recent comparative study of children's perceptions and articulations of place in the UK, Mexico, Mongolia, and Alaska<sup>1</sup>, we explored children's experience of environmental change, and sought to identify whether a sense of the changing climate featured in children's thinking about their dwelling places.

In each location data were gathered during classroom-based mapping activities, followed by walks planned and led by the children themselves. This provided them with opportunities to show us the places that were important to them, and to share observations or reflections about these places. In each location the children's strength of attachment to place was palpable and there were remarkable similarities in the way that this attachment developed. However, awareness of place and how attachment translates into responses to a changing climate varied.

In fenland rural locations in East Anglia in the UK, children demonstrated strong connections to their dwelling places, expressed through kinship and friendship ties, excitement about places where they play, and accounts of foraging activities such as gathering berries in the bushes, and picking fruit in the remnants of old orchards. Contrary to assumptions that children are part of a 'bubble-wrap generation' (Malone, 2007) and suffering from 'nature deficit disorder' (Louv, 2005), it was striking how much personal experience the children had of their surroundings (see also Irvine *et al.* 

forthcoming). However, in the 80 miles we walked with 200 East Anglian primary school children, remarkably little was said about climate change, except some mention of flooding.

Walks with primary school children in rural Mexico yielded a profound sense of connection to place, from knowledge of local medicinal plants to a lively awareness of the spiritual aspects of the landscape. Although changes were commented on (for example, "the trees look stressed"), they were not necessarily connected to the concept of 'climate change', which was only used in an abstract sense.

In arctic Alaska, classroom sessions and walks yielded a striking range of information and curiosity about environmental issues with reference to the way the beach has shrunk; the impact of permafrost melt on ice cellars; fall storms; and the shrinking of the polar ice cap. When asked what they thought future changes might bring, students talked about potential threats to the animals they depend on for food. Some children, in making observations and asking questions about weather and climate, were keen to discuss these in both local and global terms, though others only made links between their daily experiences of change and global concepts when prompted.

Walks in rural Mongolia yielded a comparable connection to place, with accounts of play and interaction with their surroundings strikingly similar to those observed in the UK. However, children in Mongolia were more likely to move from observations about place to claims about climate change. For example, in northern Mongolia, as in the UK, fruit picking was a key theme; but in Mongolia the early arrival of this fruit was described to us as a sign of climate change. Indeed, the Mongolian children were quicker to highlight changes such as the drying of rivers and loss of grassland, and to explicitly link these with processes of climate change. Many of these issues directly impacted the livelihoods of families and local populations through herding, and featured prominently on the news and in family conversations.

<sup>&</sup>lt;sup>1</sup> In East Anglia in the UK, we worked with 200 children aged between 7 and 11. In Oaxaca, Mexico, we worked with 79 children aged between 9 and 11. In Barrow, Alaska, we worked with 64 children aged between 10 and 12. In Mongonmorit Soum and Bayangoul Soum in Mongolia, we worked with 57 children aged between 9 and 10.

Mongolian children drew on this wider discourse of climate change as a national and global issue, linking it to their own sense of place.



Grasses on the Norfolk coast

With these findings in mind, we went back and interviewed some of the children in the East Anglian schools to ask them more directly about their knowledge and understanding of climate change. These interviews were highly revealing. Most children professed to having either no knowledge or very scant knowledge of terms such as 'climate change' or 'global warming'. However, when pressed they were often able to offer very reasonable explanations of them, citing school lessons, parental conversations, or news and documentary programmes where they had encountered the concepts.

Some children expressed fear and concern about the issues: "I hate listening to the news at night because I can't sleep", but almost invariably initially children expressed the belief that climate change was something that happened elsewhere; "in big cities", "in the North Pole", "in the rainforest" – even "in Scotland".

What is clear from the cross-cultural dimension of this research is that children living in different regions of the world are responding differently to the knowledge that climates are changing. Whilst the strength of connection to dwelling places in each region was profound, variation in local awareness was evident. This study identifies a more sharply focused, interconnected approach to these issues in Mongolia and Alaska where environmental factors directly impact subsistence activities in which youth are involved from a relatively early age.

In contrast, in the regions where daily lives were less ostensibly dependent on stable climates, there was little sense of the interconnectedness of local with global; that for example, flooding can be a local instantiation of a global environmental change. Indeed, in the UK there appears to be a tendency to distancing, through denial ("my dad does not believe in it"), levity ("it will be good if it gets warmer here"), or locating the problem as something that happens elsewhere. And for some children it was clear that fear underlies this distancing.

What does this mean for schools and curricula? How can curricula and teachers address an issue of the magnitude of climate change with its potential to induce fear and action paralysis?

We are working on a comparative analysis of curricula in each of these regions but our initial findings suggest that for teachers in the UK it is important to understand what motivates (or demotivates) children's responses. What might appear to be flippancy on their part in the face of changing climates is very likely to be caused by fear and *not* ignorance or dis-emplacement. This sense of trepidation is significant because it may impede learning of powerful knowledge and achievement in high stakes assessments (akin to the notion of action paralysis identified by other researchers, e.g. Connell *et al.*, 1999; Duhn, 2012).

In Mongolia, a more engaged and involved approach is evident. Children (and adults) appear to see local problems as *problems that they as Mongolians can and should engage with* and for this reason the futures the children envisage are more optimistic, in spite of the problems they observe. Perhaps here concern adds urgency to children's learning and accelerates their understanding in a world where climates are undoubtedly changing.

In the UK where there exists a social and cultural ambivalence towards the notion of

human-made climate change, parental employment patterns have changed and work is seldom emplaced in the locality. The importance of stable climates no longer features in people's daily lives and whilst awareness of global problems is sometimes acknowledged, they are *problems for someone else to engage with*. But despite this dis-emplacement, children still hold a profound connection to their dwelling places. Perhaps this makes solid bedrock on which to build awareness of the impact of global processes and empowerment to deal with these impacts.

Our initial findings suggest that facilitating interchange (through letters and video conferencing, for example) between children in schools in distant localities with different outlooks (between arctic Alaska and East Anglia, for example) might kick-start this process, but further investigation is needed.

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The authors work on the project, *Pathways to Understanding the Changing Climate: time and place in cultural learning about the environment*, which is funded by the Arts and Humanities Research Council.

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Thanks to the vision and benevolence of the late Hugh Kenrick, who had a great passion for birds and wildlife, West Midlands schools can bid to NAEE for financial support to take their pupils to outdoor centres for hands-on learning opportunities in the natural environment. NAEE offers school bursaries of up to £400. The bursaries can cover centre fees and transport costs and can be used for visits to 5 environmental education centres which include a farm, a botanic garden, a conservation park, and a community garden.

Priority will be given to schools that have limited or no access to green areas where they are located.

In return, we ask that you write a short piece for this journal about your visit and how it linked to your work in school. In return, your school will also be given a year's NAEE membership.

#### You can apply for a bursary by downloading an application form from our website: ow.ly/YYjvC

This also sets out some ideas for a range of curriculum areas about getting the most out of your visit.

## Climate change in my backyard – a view from Chicago

#### Jennifer Schwarz Ballard

#### Background

In collaboration with the National Ecological Observatory Network [NEON] and schools and teachers throughout Illinois, and with support from NASA, the Chicago Botanic Garden has developed its *Climate Change in My Backyard* curriculum project which targets 11 to 18 year olds (US school grades 5 to 12) in Illinois. The rationale for the development of the curriculum was that there was a clear gap in available classroom resources that engaged students with locally relevant climate impacts, or that provided them with the opportunity to participate in ongoing research on the impacts of climate on ecosystems.

Educators at the Garden began working with expert Chicago-region teachers in 2009 to develop the programme, in consultation with the Garden's Director of Plant Science and Conservation. Following this, the curriculum was pilot-tested in 17 Illinois schools with Garden staff working with teachers to evolve the most effective ways in which to work with students and approach the curriculum.

#### Focus

The programme is divided into three 'grade bands': 5- 6, 7-9, and 10-12. Each band has four units that address a critical aspect of a systems approach to understanding climate and its impacts on humans and the environment:

- Understanding the Earth as a system
- Identifying key changing conditions of the Earth system
- Recognizing Earth-system responses to natural and human-induced changes
- Predicting the consequences of changes for human civilization

As students move through the programme, these topics are examined in progressively greater detail and sophistication. For example, in *Understanding the Earth as a system,* these are the topics covered:

#### Grades 5 to 6

Students assess their current knowledge of, and beliefs about, climate change. They then begin to explore the various Earth systems that create climate, including the Earth's energy balance and the greenhouse effect. They learn what the natural and human causes are of greenhouse gas emissions and explore how the sun's energy, greenhouse gases, and the Earth's surface interact to moderate global average temperature. They use a NASA data analysis tool to model different energy and greenhouse gas scenarios.

#### Grades 7 to 9

This has two sections that consider different Earth systems and how they interact.

In 1A, continuing to use the NASA data analysis tool, students further explore the Earth systems that create and affect climate, the causes of greenhouse gas emissions, and how global average temperatures are moderated.

In 1B, students learn about the biosphere as a system. They explore how organisms interact with each other and their environment, how disturbances (such as climate change) can be felt throughout a food web. Finally, students learn about ecosystem services – the importance to humans of healthy, intact ecosystems.

#### Grades 10 to 12

Students learn about the carbon cycle and the role that plants play in maintaining atmospheric concentrations of CO<sub>2</sub>, including photosynthesis and respiration of different plants under different conditions. They define provisioning, regulating, and cultural ecosystem services and look at the ways that they contribute to human wellbeing.

The complete Grades 5-12 activity guides can be found on the Chicago Botanic Garden website: www.chicagobotanic.org.

#### Answering key questions

The four units of the curriculum are designed to answer four key questions posed by NASA:

- 1. How is the global Earth system changing?
- 2. What are the key changing conditions of the Earth system?
- 3. How does the Earth system respond to natural and human-induced changes?

4. What are the environmental and human consequences?

Students explore these questions by investigating how climate affects their local plants and ecosystems. They collect phenological data to contribute to Project BudBurst, and analyze the data they collect using NASA and NOAA climate and atmospheric data, as well as NASA satellite imagery. They learn about the effects of changing climates on ecosystems, and then broaden their perspectives by exploring the effects of climate change on human communities around the world. We know that providing context for large data sets through local, visible changes to plant biology can make climate change a tangible phenomenon and help students make meaning of what can be quite abstract data.



Middle school students collect data on prairie plants

#### Project BudBurst

Launched in 2007, Project BudBurst (www.budburst.org) is a US citizen science project that provides opportunities for individuals and families to contribute to research on climate change. Anyone observing floral species in their backyard or community throughout the growing season can enter their observations into a web form connected to the BudBurst database. The website includes detailed information on phenology (the study of plant and animal life cycle events and how these are influenced by seasonal and other variations in climate). climate change, and plant identification, as well as guidelines for family, youth, and inschool activities.

By using a context that people can relate to on a personal level – gardens and plant growth – and by providing specific information on common species like the dandelion and lilac (in addition to common US native plants) the *BudBurst* website is suitable for all ages and locations.



High school teachers learn how to teach about the impacts of climate change

#### Professional development

In addition to the curriculum, the Botanic Garden runs professional development programmes for teachers and schools to ensure that the background understanding and pedagogical expertise is in place to enable the implementation of the curriculum successfully in the classroom. The Garden continues to consult with schools on request to help them introduce the climate change curriculum and to offer teachers in those schools additional opportunities to further develop their skills.

#### In conclusion

The Botanic Garden continues to fulfill its mission to cultivate the power of plants to sustain and enrich life by ensuring that the next generation of citizens is informed and prepared to address the environmental challenges of today. We have expanded our climate education work beyond school grounds with the *Connect: Community* + *Climate* + *Action* project (www.connectcca.org) in an effort to engage all constituencies and communities in

climate-postitive action.

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#### The New Wild



In *The New Wild: Why Invasive Species Will be Nature's Salvation,* Fred Pearce argues that trying to keep out alien species looks increasingly flawed and that we should celebrate the dynamism of such species and the novel ecosystems they create. Further, in an era of climate change and widespread ecological damage, we should be finding ways to help nature regenerate. Pearce thinks that embracing the 'new wild' is our best chance of doing this.

Like many of us, including, perhaps, most who will read this, Fred Pearce used to think of invasive species as embodiments of evil – in-comers, not only disturbing 'natural' ecosystems, but also barging out of the way those with a greater right to be there. There are, after all, all kinds of horror stories about real damage being done to native species and much-valued habitats. But this book says: what if traditional ecology is wrong, and we should really be tolerating or even welcoming and applauding the invaders?

In a similar vein, a recent article in the Economist, *Invasive Species – day of the triffids* argues for a measured and pragmatic approach to alien species. Not everyone is so relaxed. The database of such species, managed by the International Union for Conservation of Nature, now lists 3,163 plants and 820 animals, and the EU is poised to approve a list of 37 plant and animal species that member-states must eradicate if possible.

But, as the Economist notes, Chris Thomas, a biologist at the University of York, has calculated that of the country's 677 most widespread plant species, 68 were introduced by humans before 1500 and another 56 after that date – and not one of these introduced species ranks among the 50 most widespread plants in the country. Even Himalayan balsam, which is every purist's hate plant is so rare that it only just makes the list.

Pearce has a focus on climate change, although the Economist article oddly doesn't.

However, a new report from the RSPB, *The Nature of Climate Change – Europe's wildlife at risk* certainly does:

"The wildlife we typically accept as being part of our 'native' flora and fauna is moving, and new species are arriving as colonists, partly driven by climate change. The assemblage of species we consider "native" is therefore in a state of flux.

We cannot arrest the changes, so to aid adaptation it will be important to enable species to colonise new areas via provision of sufficient, suitably-protected habitat, in areas that will become more climatically suitable over time ..."

Clearly not everyone will agree and the early reviews of the book bear this out, with comments ranging from "*a very rational case*", "*a remarkable and provoking read*" to "*waving the white flag for ecosystems all over the world*".

#### William Scott, University of Bath

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The New Wild: Why Invasive Species will be Nature's Salvation. Fred Pearce. Icon Books. ISBN 978-1848318342

#### Meteorology - in 30 seconds

If you want to really understand the climate, and how it is changing, to what extent do you have to understand weather? I thought about this question, and related ones such as, what's the difference anyway, as I read this new book edited by Adam Scaife. It sets out to explore 50 significant events and phenomena, each of which is explained "in half a minute".

Neither Scaife's Introduction, nor Julia Sligo's Foreword, say what the relationship between weather and climate is; indeed, the combined phrase 'weather and climate' occurs frequently as if there is no real need to bother about differences, although I did note that weather is *forecast*, whereas climate is *predicted*. But I suspect that this question of difference is one that people do ask, as they puzzle over what to think about climate change. Such puzzlement is entirely understandable, especially given how much weather changes and how unpredictable it is, despite the best efforts of the UK Met office. This is where Scaife works as the Head of Monthly to Decadal Prediction.

This is a nice looking book, both inside and out. It is well set out, with good use of colour, and the illustrations are attractive. It makes you want to open it, and, once open, to turn the pages. It embodies a neat idea: each of the 50 topics is summarised in 300 words (the equivalent of 30 seconds worth of text, written by experts on weather and/or climate) and pictures. There are 7 sections: the elements, the global atmosphere, the sun, weather watching and forecasting, can we change the weather?, weather cycles, and extreme weather. Each begins with a glossary of terms (I think it's essential to read these before moving on), has a twopage profile of a key contributor to our understanding, and discusses at least 4 phenomena; sometimes many more.

Whilst reading the book, I think I learned something on every page, and I am sure I'll not be alone in this. And yet, I wonder how effective the book will prove to be. For example, I think that a lot of people will find the 30 second claim rather unrealistic. It usually took me longer than this to read the text, sometimes well over a minute. There are two main reasons for this: [i] some of the text is guite idea-dense, as though squeezing it into 300 words had meant compromises with readability; and [ii] much of the material is just unfamiliar, and absorbing it slows you down. But, you should slow down if you want to understand these complex issues, and as you get into the book, the 30-second claim looks more and more like a marketing gimmick. This is a pity, as this is a book to linger over rather than speed-read. 90-Second Meteorology would have been just as good a title. The world needs slow books as well as slow food.

I was a little surprised that each section didn't have a specific suggestion for further reading – even if it was only to the Met Office website. And this raises another issue, which is that the printed page has obvious limits when it comes to explaining phenomena like atmospheric systems which are 3-dimensional and dynamic. The entry on Jet Streams is a good example. Whilst the text is informative (and I learned something from it), how much more helpful it would have been to have had a reference to a website where there is a dynamic representation of a jet stream moving across a globe – such as: ow.ly/XxInZ. A similar argument can be made about weather forecasting with sites such as ow.ly/XxIDF showing the forecast movement of cyclones and anti-cyclones (and much more) across the north Atlantic. Then there is the guite mesmeric ow.ly/XxIOH that shows weather across the planet at a variety of heights in a number of map projections. A missed opportunity, I think.

By all means buy this attractive book, but don't think its brief explanations will really satisfy you. You will want to read more – but, then, perhaps that's a measure of a good book.

William Scott, University of Bath

30-Second Meteorology. Adam Scaife (Ed). Ivy Press ISBN: 978-1-78240-310-4

#### Webwatch



All the links shown on the next two pages relate to climate change and/or climate change education. There are, of course, many more such pages, but these serve as examples for what is now available on the web.

#### The IPCC

The Intergovernmental Panel on Climate Change was set up by the UN in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. It reviews and assesses scientific, technical and socio-economic information relevant to understanding climate change. ipcc.ch

#### The Met Office

The Met Office is the UK's National Weather Service and has provided science-based data on the country's weather since 1845. It has a particular interest in change, and in 1990 opened the Hadley Research Centre into the Earth's climate and how it is changing.

www.metoffice.gov.uk/climate-guide

#### The Grantham Institute

The Grantham Research Institute was established by the LSE in 2008 to create a centre for policy-relevant research and training on climate change and the environment. It brings together international expertise on economics, finance, geography, the environment, international development and political economy.

www.lse.ac.uk/GranthamInstitute



#### NASA

The National Aeronautics and Space Administration is the US government agency responsible for the civilian space programme, aeronautics, and aerospace research. It also has a great interest in what it calls the Earth System Science. Because of this, it has an interest in climate change, and climate change education.

#### climate.nasa.gov



#### The Royal Society

The UK Royal Society is a selfgoverning Fellowship of distinguished scientists drawn from all areas of science, engineering, and medicine. It began in the 1660s, and has an interest in our changing climate. In 2014, the Royal Society produced 'A short guide to climate science', that summarised the answers to 20 common questions.

#### royalsociety.org/policy/climate-change

#### The European Environment Agency

The EEA's role is to provide sound, independent information on the environment. It is an information source for those involved in developing, adopting, implementing and evaluating environmental policy, and also for the general public. Climate change is central to its activities.

#### www.eea.europa.eu

#### DECC

The UK Department of Energy & Climate Change (DECC) works to make sure the UK has secure, clean, affordable energy supplies and to promote international action to mitigate climate change. It leads UK government efforts to cut UK greenhouse gas emissions by at least 80% by 2050.

#### ow.ly/RzUSJ

#### CO<sub>2</sub>Now

Since 2008, the CO<sub>2</sub>Now blog has been posting the latest readings for atmospheric CO<sub>2</sub> and other climate change indicators from leading science sources. It's an independent, citizen-run website that aims to make it easier for the public to access and monitor information that is essential for understanding global changes in the earth's climate and biosphere.

co2now.org

#### **Climate Change Curriculum**

This is a curriculum resource for teachers providing published scientific data on climate change, and to help students gain experience of understanding methodology.

ow.ly/RzXDc



ECN is the UK's long-term, environmental monitoring and research programme. It collects, analyses and interprets data from a network of sites. Its datasets are a national resource that improves understanding of how and why environments change. It provides online tutorials about weather and climate.

www.ecn.ac.uk



#### **Talking Climate**

Talking Climate provides a series of guides about effective communication on climate change. It has a database of ideas and a blog.

#### talkingclimate.org



#### Earth Overshoot Day

Global overshoot is when our annual demand for the goods and services that the biosphere provides exceeds what the Earth's ecosystems can renew in a year. Overshoot means we draw down the planet's principal rather than living off its interest. This leads to a depletion of Earth's life-supporting natural capital and a buildup of  $CO_2$  in the atmosphere.

www.overshootday.org

#### 350.org

This is a grassroots climate movement that sets out to hold leaders to account.

www.350.org

#### The Paris Agreement

The UN's website about what happens after the Paris Agreement on climate.

ow.ly/WfN0C

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