Mathematics of Planet Earth 2013 AUSTRALIA

United Nations Decade on Biodiversity

Maths in Nature
Shapes of Leaves

Beginning the 2013 biodiversity series in Otherways by Jeanie Clark

Earth, our spinning home, operates through an amazing variety of processes running land, air, waters and life, of which humans are a part. Many processes are linked across these four broad categories, so that as complexity is introduced, up to the level of the Gaia ecosystem, they operate in decreasing isolation.

How do we understand this and communicate ideas about our planet to our children? We probably use the four main branches of Science, and their many sub-branches, which seek to give the building blocks of features and processes – Biology, Earth and Space Sciences, Chemistry and Physics. Hence they are the content areas for Science in the Australian Curriculum and other countries' curriculums. To investigate and communicate these sciences, we have the tools of English and Mathematics, from which the digital tools of Information Technologies are descended.

> ***'Let's get Australians as excited and proud of their mathematicians and scientists as they are about their sports.'***
>
> http://mathsofplanetearth.org.au

The Mathematics of Planet Earth Australia (MPEA) is part of the global effort to promote numeracy in understanding our planet. Their vision is clear (above). Can we get ourselves and children excited and proud about their mathematical skills, especially when used in Science about living things? I hope so! I hope you will become inspired to use MPE as a springboard into Science and Maths, to go further and discover, create and share! And to do this under the overarching aims of the UNDB.

MPE for UNDB

Where can we start? If you think about biodiversity, what are some of the simplest Mathematical concepts that come to mind? Number, shape, sizes, patterns? If you want to see where these concepts come into AC Maths, the easiest document to look at is the '*Scope and Sequence* table' in AusVELS which has all strands, and sub-strands by level.

MPEA places importance on research. I rather like the idea of including research for learning as a practical way to use and develop maths skills for finding out about planet Earth, especially its biodiversity.

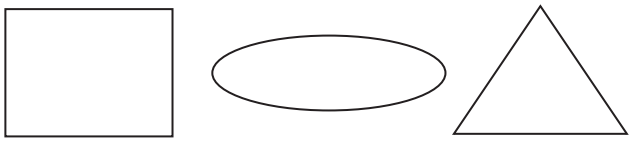
Science research typically involves a question, background knowledge, guessing what will be found, data, reporting, conclusion as to what it means and what next. To this, I would add planning along the way, and communication to others at the end, especially, about what's been learned! Formal reports are of value, but so is the process. Much of this process can be covered by speaking, especially, keeping the focus on discovery and communication.

Shape

What to research? Let's start with an 'easy' concept – shape. How can shape fit in with the MPE and UNDB? Let's just look at plants to keep it easy, but still there is a choice about what part? Leaves are easy to access! Here is a research topic you could follow or use as a model to create your own.

Research question. Develop one. It might be - what are the shapes of leaves in a specific chosen area?

Background What basic shapes can your child draw? These are probably the 2D ones. If you have playdough, what 3D ones can be made and named? (This is not just for six year olds!) Now let's recall leaves. What shapes of leaves can be drawn?



Plan Think of a place where you can go to see what shaped leaves are there. Somewhere you know well? Somewhere entirely new? It doesn't matter.

Hypothesis (an 'educated' guess, based on background knowledge, recorded so it can be returned to after the investigation). What shapes, and how many different ones, do you expect to find? Which might be common shapes and which might be rare?

Data Go to your study site. Record leaf shapes. How will you do this? Planning! If it is a National or State Park, your choice will be drawings or photos – take no samples. Other places may allow you to take samples. If so, pick a reasonable one for each shape. Don't get distracted by colours and size - the aim is to pay attention to shape! For each shape, keep a tally of how many plants have that shape. Do some plants have more than one leaf shape? If so, record both.

Reporting the data – the way you have collected the data will affect the way you can work it mathematically. But this should work for all. Organise your leaf records so you can see what it shows.

Summarise this 'raw data' into a diagram or table. You might use this to create a scaled diagram with each shape a size that represents its number of plants.

Compare your data with your hypothesis to see if you were right, partly right or wrong. Reflect on whether you found anything:

- unexpected – like a leaf which appeared to be two, but had split along its main vein
- exciting – like a leaf shape which doesn't seem to belong with the rest.

(These might seem like red herrings, but they start ideas for future investigations and discoveries.)

Conclusion – a summary statement of what has been learnt and its 'implications'.

Were all the Mathematical shapes you could draw, and/or make, found in the leaf shapes?

What have you discovered from doing this investigation?

Is this line of inquiry ended?

Is there more to discover e.g. leaf shape names?

Communication – Choose some aspect of this investigation to tell to someone else. Communicate in the most interesting way you can. The Rainforest Alliance presents many ideas for leaf-based communications at <http://www.rainforest-lliance.org/sites/default/files/site-documents/education/documents/early-childhood-activities.pdf> in the first half. The second half is a photo communication of the Colombian rainforest's plants. Its leaf shapes have thus gone to a global audience via the web. (How similar/different are these to yours?)

You could tell *Otherways!* Why not send a report? What about a photo with it? The information could be:

- Where you investigated – location and what type of plant place it was.
- How many leaf shapes you found, what they were, and how many plants for each shape.
- What was the most amazing thing you found out during this investigation and/ or what were you most proud of yourself for doing?

Biodiversity

How does this relate to the big picture of science and biodiversity? This research topic is in the science of Botany, a biological science. Leaf shape is very important as a key identifier for naming plants, not just in their families, but at species level. How important? In 2011, the Smithsonian Institute with Colombia Uni and Uni of Maryland, created an app *Leafsnap* – an electronic field guide – to identify trees just by taking a photo of their leaves. As leaf shapes can tell us the species, so they can inform us about biodiversity – the number and variety of plant species at a site. For this knowledge of names of shapes and plants are not needed, but people do tend to like names!

Shape Names

Interested in learning more about leaf shapes? There are over a dozen standard leaf shapes. Their names are not familiar words. Their origins are Latin. There are many collections on the web, including for primary ages. The Uni of Florida's Centre for Aquatic & Invasive Plants poster is a simple one with nine black and white named shapes <http://plants.ifas.ufl.edu/education/misc_pdfs/glossary_of_leaf_shapes_low_res.pdf>. A simple photo key with names and descriptions of 18 leaf shapes is at the Seed Site <http://theseedsite.co.uk/leafshapes.html>. A very detailed, but clear one, with leaf shapes named, b/w drawings, photo examples, a botanical descriptor, and a distance comparison of width by length is the Northwest Missouri State Uni *Guide to Leaf Shapes* <http://cite.nwmissouri.edu/nworc/files/Agriculture/LeafID_Shape/LeafID_Shape_print.html>. For 14 Australian leaf shapes, try this Tasmanian one <http://www.apstas.com/leafglossary.htm>. Woodworkers <http://www.heritagewoodsonline.co.uk/schools/pdfs/look-leaves.pdf> is a UK leaf shapes lesson. Etc.

Measuring

If you have leaf samples, then you can add some more maths concepts of measurement for length – longest, shortest, widest, skinniest, ranking these, ratios of length to width – and area. Easy, low tech methods for finding area of leaves – and any irregular shape – count squares on graph paper. It is well explained in this lesson with teacher instructions from Science Netlinks, of the American Association for the Advancement of Science at

<http://sciencenetlinks.com/lessons/finding-surface-area-leaf/> Older students may be interested in the digital methods. Two are shown and compared at <http://www.math.tamu.edu/~mpilant/math614/StudentFinalProjects/SanPedro_Final.pdf>. What is the importance of surface area? It depends on whether you are a plant that is in a harsh climate or not. The larger the surface area, the more water can be evaporated, possibly dehydrating the plant …to death.

Processes

If you haven't covered the fact that water evaporates from leaves, this would be a good time, and to go further. Where does that leaf water mostly come from? What else does the surface of the leaf do? This is where knowledge of photosynthesis and evapo-transpiration applies, or can be discovered – learnt.

Communicate

What may have been learned from this investigation? The mathematical skills began with shape, needed number and may have been extended into measurements. If a table was drawn of the data, that was statistics. For the MPE themes, we covered two, discovering something about the plants of a study site on this planet. For the UNDB, we have found that the leaf shape helps identify species and indicates the degree of biodiversity. As a science tool, leaf shape is very useful. For biological science, we learnt more about the function and shapes of leaves. For communication, I hope some excitement has been generated about maths, botanical science and/or biodiversity as the young people share their investigations and learning with others – maybe us!