The Ogden Trust

making physics matter

'Working scientifically' in primary science

Develop children's skills in pattern seeking

Introduction

Pattern-seeking enquiries involve children making measurements or observations to explore situations where there are variables that they can't easily control. In this type of enquiry, children are trying to answer 'big questions' by identifying patterns in the measurements and observations they record. Often, pattern-seeking enquiries may be preliminary tests that lead on to more systematic enquiries, such as fair tests or comparative tests. The key difference here is that pattern-seeking enquiries are not fair or comparative tests, because certain variables can't be controlled. Children may still identify a possible causal relationship from their data, such as 'the more you wind up a clockwork mouse, the further it will run', but they may find links between variables that can't be explained by cause and effect, such as 'children with longer arms can jump higher'.

Big questions

Here are some examples of 'big questions' that can be explored through pattern seeking in KS1and KS2. There is at least one for every area of the curriculum, so it is easy to plan opportunities for children to revisit this type of enquiry and develop their skills.

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Do trees with bigger leaves lose their leaves first in autumn?	Do bigger seeds grow into bigger plants?	What colour flowers do pollinating insects prefer?	How has the use of insecticides affected bee population?	Is there a relationship between a mammal's size and its gestation period?	Do larger flowers have more petals?
Is there a pattern in where we find moss growing in the school grounds?	What conditions do woodlice prefer to live in?	Do male humans have larger skulls that female humans?	Are foods that are high in energy always high in sugar?	Are the oldest children in our school the tallest?	Is there a pattern between what we eat for breakfast and how fast we can run?
Do you get better at smelling as you get older?	Which age group of children wash their hands the most in a day?	Is there a pattern in where we find volcanos on planet Earth?	Is there a pattern in how long it takes different sized ice lollies to melt?	Do all stretchy materials stretch in the same way?	Is there a pattern between the size and shape of a bird's beak and the food it will eat?
Does the wind always blow the same way?	Which habitat do worms prefer – where can we find the most worms?	Are you more likely to have bad eye sight and to wear glasses if you are older?	Is there a link between how loud it is in school and the time of day? If there is a pattern, is it the same in every area of the school?	Is there a pattern between the size of a planet and the time it takes to travel around the Sun?	Is there a pattern to how bright it is in school over the day? And, if there is a pattern, is it the same in every classroom?
Is there a pattern in the types of materials that are used to make objects in a school?	Do magnetic materials always conduct electricity?	Does the size and shape of a magnet affect how strong it is?	Which room has the most electrical sockets in a house?	Do all objects fall through water in the same way?	Does the temperature of a light bulb go up the longer it is on?

‘Working scientifically’ skills

In experiencing pattern-seeking enquiries, KS1 children will begin to look for patterns in their measurements and observations, and describe them both orally and in writing. They should also be starting to think about cause and effect relationships, and being encouraged to use appropriate vocabulary to discuss these.

For pattern-seeking enquiries, KS2 children should be thinking for themselves when it comes to deciding what they should measure and observe, as well as making decisions about the most appropriate equipment to use to collect data. Children in upper KS2 should be challenged to think even more about their planning, including identifying the variables that they cannot control and suggesting the potential impact those variables might have on the data they collect. Whenever appropriate, KS2 pupils should be choosing to use a data logger to collect the most accurate data they can. KS1 learners will need more support with making decisions about what to observe or measure, but should still be challenged to make their own suggestions.

Children in KS2 should be using far more data analysis techniques to spot patterns, including using tabulated data and a variety of charts and graphs. When describing the relationships, children should use data and graphs to support their explanations. As mentioned earlier, this type of enquiry works well as a preliminary test; so children can use their findings to form and justify their own predictions, going on to propose further investigations to test these predictions.

Resources

There is a range of equipment that schools will find useful to support pattern-seeking enquiries:

Stopwatches/timers	Thermometers	IR thermometers
Data loggers	Light sensors	Temperature sensors
Sound sensors	Clipboards	Books for research
Tape measures/rulers	Graph/squared paper	Access to the internet for research

Reporting learning

Pattern-seeking enquiries are a great opportunity for children to develop their measuring skills and look for different ways to record and analyse their data. In regularly practising this type of enquiry, children will go from making and recording simple data values in KS1 to more systematic and accurate measuring in KS2 that can then be analysed using more complex methods.

Year 1 and 2 children could be using tally charts to record, and then developing these into pictograms to look for patterns. As they progress into KS2, children will be making measurements of quantities, such as length (cm), temperature (°C), volume (dB), and time (s), learning how to display this data accurately in tables, and then using bar charts to analyse their findings.

By the time they get to upper KS2, children will be looking more carefully at the accuracy of their measurements, including measuring lengths to the nearest mm, or temperatures to one decimal place. At this stage, children will be selecting the most accurate measuring equipment available and repeating measurements to check the reliability of their data. This will provide some great opportunities for children to regularly develop their skills in calculating the mean, average and range of a data set. Upper KS2 learners will then go on to learn how to independently draw scatter graphs and line graphs of their data to help them describe the patterns they notice in a more quantitative way, again regularly practising mathematical skills.

The data analysis that happens here provides a great opportunity for children to develop their **conclusion** writing; however, it also forms an ideal platform from which children can work on the development of **predictions** and proposing further enquiries to test their ideas. In asking children to form predictions based on data from a pattern-seeking enquiry, the children can use the data they have collected to justify their ideas for how things might be in a different but related situation, or even to generalise about how things might always be. Such predictions can enable learners to go on to create their own 'big questions', and plan tests to see if their prediction is correct. Taking this approach not only allows for more pupil-centred enquiry, it also gives children a more realistic appreciation of how the scientific process works, and how one question always leads on to even more.

Additional information

There are many real examples of pattern-seeking enquiries that lead to fascinating discoveries about the world and universe around us that you might want to share with pupils.

- There are many examples of patterns in nature that have been investigated and interpreted by a whole range of scientists. Symmetry, fractals, and spirals have been endlessly observed and modelled using mathematics. The Fibonacci Sequence is a fascinating mathematical model that describes patterns in nature that you can find more here **https://www.livescience.com/37470-fibonacci-sequence.html**, and a wonderful book to use with classes when learning about the Fibonacci Sequence is *Blockhead: The life of Fibonacci* by Joseph D'Agnese.

- Astronomers use pattern-seeking enquiries to discover more about our unknown universe, and it is this pattern-seeking that has led to the discovery of hundreds of new planets, orbiting different stars. The Planet Hunters citizen science project enables participants to look for patterns in the light from distant stars to help identify whether they may have planets orbiting them or not. **https://www.planethunters.org**

Planning

Curriculum Mapping	Identify a potential pattern-seeking enquiry in every science unit.	Aim for each class to revisit pattern-seeking five or six times over the academic year.	Plan to include scenarios where children get to suggest their own pattern-seeking enquiries.
Progression Planning	Using National Curriculum documents, map out Age Related Expectations (ARE) for pattern-seeking enquiries.	Establish age specific success criteria for pattern-seeking enquiries.	Develop a collection of exemplar outcomes to support consistent expectations (WAGOLL).
Resource Audit	Take stock of science and maths resources, making a comprehensive list of items that would support this type of enquiry.	Provide teaching staff with a list of resources that their pupils should get the opportunity to use over the year.	Put procedures in place for teachers to alert senior leadership when resources are broken, faulty or missing.
Support and Challenge	Ensure that teachers are aware of ARE for the academic years before and after the one they are teaching.	Teachers develop support materials for children working below ARE in their class. Examples include classroom displays, writing frames or sentence starters.	Teachers develop extension tasks for gifted and talented learners to extend their 'working scientifically' skills.
Quality Assurance	Review children's work to look for coverage of all enquiry types as well as progression and challenge across year groups.	Carry out a 'learning walk' while all classes focus on pattern seeking – identify good practice and highlight areas for development.	Lead pupil voice work that focuses on 'working scientifically', exploring children's perceptions on experiences and levels of understanding.
Celebrate	Have a 'working scientifically' notice board with a display that changes to a new type of enquiry each half term.	Display high-quality examples of pattern seeking enquiry work from each class and identify key features and progression.	As a special whole school focus, put in place a system of reward for individual success in 'working scientifically'.