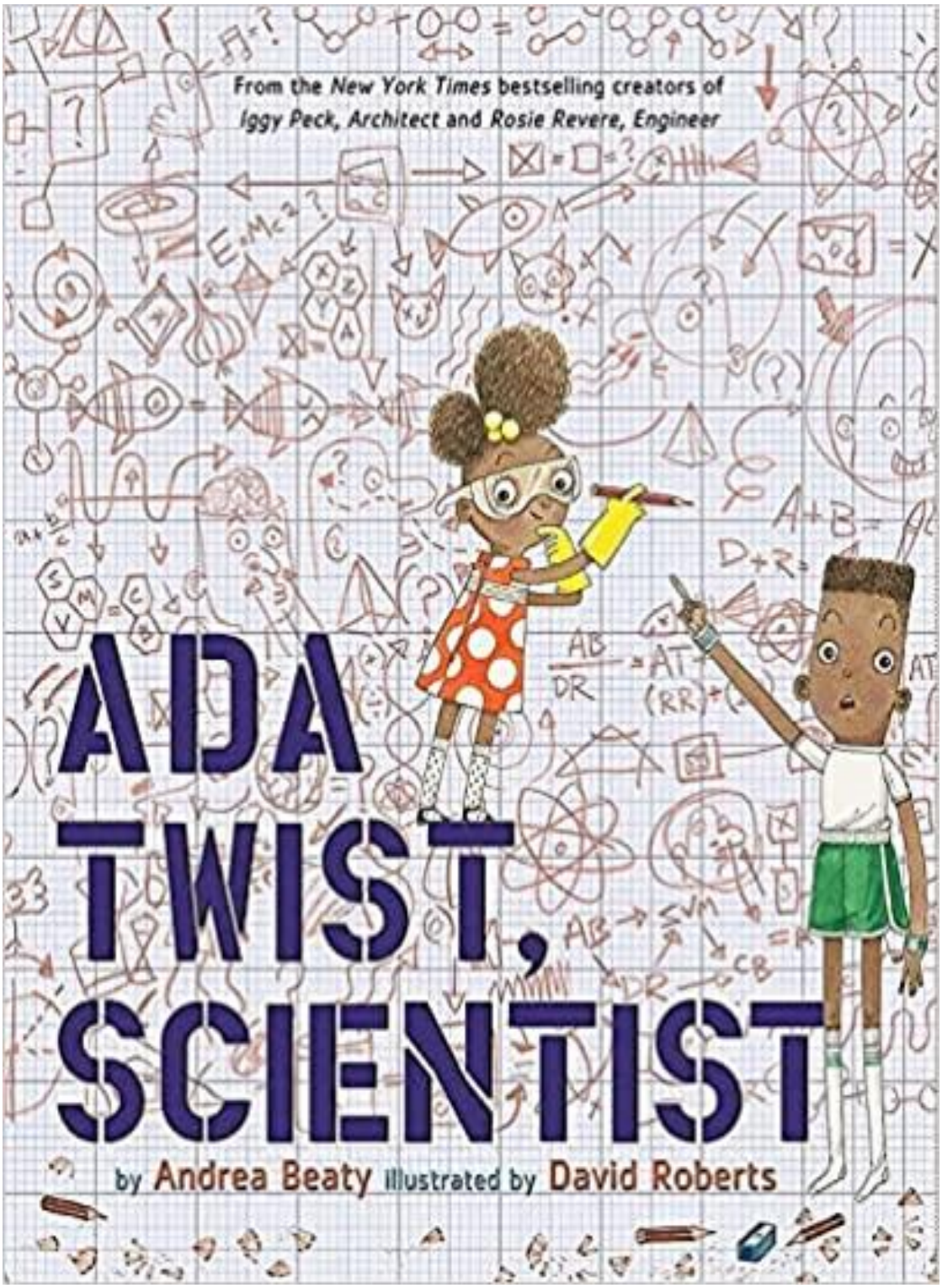
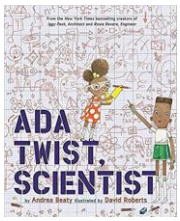
‘STEM through a story’



RAiSE
Raising Aspirations in Science Education



The book ***Ada Twist, Scientist*** **by Andrea Beatty** is the story of a young girl called Ada who has a huge imagination, has always been very curious, has a head full of questions (*Why are there pointy things stuck to a rose? Why are there hairs growing inside your nose?)* and does experiments (often messy ones!) to find the answers.

Ada is not afraid of failure and embarks on fact-finding missions and conducts scientific experiments to try to discover the answers to her questions! When her missions and elaborate scientific experiments don't go as planned, Ada learns the value of thinking her way through problems, continuing to stay curious, perseverance and the importance of asking *'Why?'* Ada Twist is a scientist!

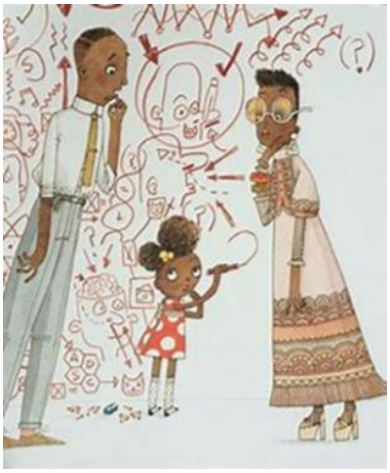
This book provides a context in which to explore how to answer questions through the five different approaches to science enquiry. It also provides a context to look at aspects of Health and Wellbeing (resilience, Growth Mindset, perseverance) and illustrates the themes of creative thinking, problem finding and solving; the children should be encouraged to identify these traits in Ada in the story.

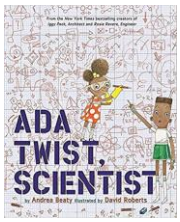
The examples of activities suggested here for Early, First and Second Level learners could be adapted to be used with all learners depending on the learners in your class and how you organise your curriculum.

The suggested learning activities also provide opportunities for the development of Literacy and Numeracy skills to be developed too.

This story was Inspired by two famous female scientists - Ada Lovelace (a leading 19th century mathematician and the world's first computer programmer (Ada Lovelace (nationalgeographic.com)), and Marie Curie (famous for her work on radioactivity Marie Curie - Kids | Britannica Kids | Homework Help). The story, therefore, can also be used as a reminder that professions are gender neutral, and skills are gender independent; the learners could research famous women scientists as part of this project!

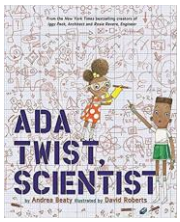
Whilst this book is aimed at 5–7-year-olds, it lends itself in so many ways to be used with older children as can be seen in this project.





It is also worth noting that the activities suggested in this project provide the children opportunities to develop some of the top ten STEM employability skills too:

This poster with guidance notes for teachers can be downloaded from here: https://www.stem.org.uk/resources/elibrary/resource/418157/top-ten-employability-skills



Introduction:

If you do not have the book, you can watch and hear the story being read here:

Ada Twist, Scientist By Andrea Beaty - YouTube

A starting point with the children could be to find out about their understanding of what a scientist is and what they do. Ask the children to children to draw a scientist and what they do and maybe the equipment they use. Some ideas they have might include a man wearing a white lab coat who wears safety glasses and works in a laboratory. This project a great opportunity to broaden the children's understanding about the huge variety of roles and jobs that scientists have in the workplace which include both men and women – palaeontologists, pathologists, nutritionists, environmental scientists, archaeologists, hydrologists etc!

What is a scientist? – a person who is studying or has expert knowledge of one or more of the natural or physical sciences. For any problem they see, scientists try to understand the cause so they can come up with a solution. For example, by investigating what causes a disease, scientists can then try work out how to control its spread or a cure for it. .

What is science? Science is a means of improving our knowledge and understanding of the universe based on the collection of observation-based evidence. Science is very wide and diverse – scientists usually focus on one particular branch of science. For example, scientists may study plants (botany), the universe (astronomy), matter (physics), or animals (zoology).

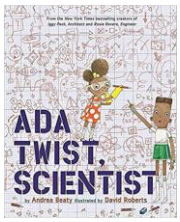
As Ada Twist is a scientist; the character is a good starting point from which to explore this further. These video links are good to use as a way to start!

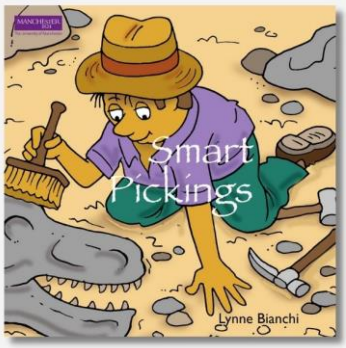
- What does a scientist do? - YouTube

- What Does a Scientist Look Like? Scientist Tools and Types of Scientists, science journal intro - YouTube

- What is a Scientist? - YouTube

Ask the children: What is a hypothesis and how does Ada Twist make them? Take the discussion further by asking them to think of examples of how the world has changed and benefitted from scientific discoveries!

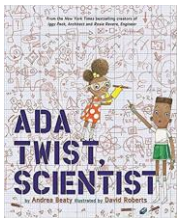




Smart Pickings by Lynne Bianchi is a book written designed to engage children with the world of science, scientists, and science investigations. Using pictures and cartoons the book introduces children to a range of scientists – past and present and encourages them to explore their work and ask, 'Who are they?', 'What are they famous for?', 'How did they make a difference?'.

By selecting a science career, they can think about considering what they could be and how they might follow in the footsteps of others and help to improve our world in the future. The book takes the reader on a journey as they can design their own scientific questions, consider where and how they will go about them and how they will share their learning with others.

The book engages children and helps to promote discussion and to generate ideas about science in the world around us



What is science enquiry?

As we see in the story, science enquiry begins with a question. Different types of questions and situations require different types of enquiry and different ways to find answers; in order to acquire a breadth of science skills, children need to learn to carry out a variety of investigations.

There are five approaches that children need to learn to recognise and use:

- fair testing
- observation over time
- pattern seeking/finding an association
- identifying and classifying
- researching using secondary sources

It is important that children are given the opportunity to carry out many different types of investigations in science.

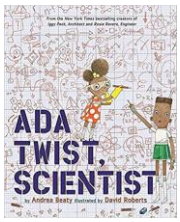
There are strong links between science enquiry to outcomes in Maths and Literacy too. For example, observation over time, pattern seeking/finding an association and identifying and classifying have links to e.g., information and data handling in numeracy, researching using secondary sources could obviously link to outcomes in e.g., reading and writing, and fair testing could easily involve both:

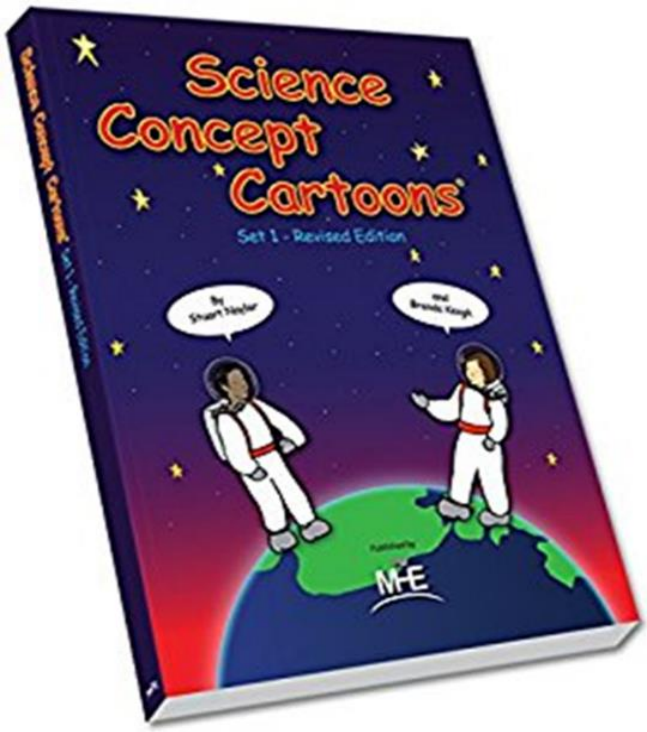
Observation over time	MNU
Pattern seeking/finding an association	
Identifying and classifying	
Researching using secondary sources	LIT
Fair testing	LIT / MNU

It goes without saying that any Maths of Literacy involved in science investigations should match the expectation and attainment in the children's Maths and Literacy learning.

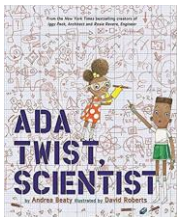
The Benchmarks for Sciences Curriculum for Excellence document contains helpful guides about the scientific skills to be developed within the sciences at Early, First and Second Levels.

Benchmarks | Curriculum for Excellence documents | Curriculum for Excellence | Education Scotland





Concept cartoons are a visual representation of science ideas. The book uses simple cartoon style drawings to put forward a range of viewpoints about science ideas in everyday situations that are designed to motivate and engage pupils and stimulate discussion of their ideas. They provide great starting points for science enquiry! The ideas being put forward are based on research of common areas of misunderstanding in science, with the scientifically correct idea included in the alternatives. The purpose of the alternative ideas is for learners to experience uncertainty and cognitive conflict!



Activity one: Generating questions.

Scientists do not know the answers to the questions they ask. These puzzling questions guide their work in finding the answers to a continually growing list of questions!

Once Ada started asking questions, she did not stop!

Ask the children to look around them and choose an object that they can see.

Ask them to make a detailed drawing of the object and some notes: what does it feel like, sound like, how big/small is it, what is it made from, what is it use for?

Now ask them to create three questions about the object (how, when, where, why…)

Take each question and try to think of two more!

OR: Ask the children to carry out some research about their favourite animal, sport, pet etc. When the have finished their research, ask them to think of three new questions.

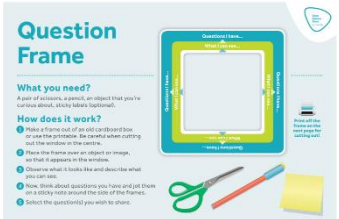
This is how scientists work – they work on finding the answer to one question and the answer then usually results in more questions: scientists ask more questions when they have found the answer to a question and dig deeper to find more answers!

Help the children to develop the art of scientific question-asking by using one of the activities from the Great Science Share for Schools Question Makers e.g., the question spinner, the question frame, the question hand etc.

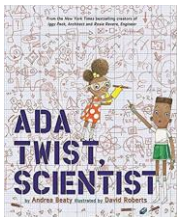
Question Makers — The Great Science Share for Schools (you have to create an account to access the resources)

Ask questions and discuss them with others - talking with others can inspire and generate more questions!

What happens to your question if you change the question word? e.g. What are the planets? to What would happen if the planets were never discovered?



Images from the GSSfS website



Activity two: Science enquiry: observation over time

This type of enquiry allows children to identify and measure events and changes in a range of phenomena. It can take place over seconds, minutes, hours, or days and begins with children making decisions on what and how to observe, as well as how to measure and record any changes. It also allows children to make predictions as time passes and patterns begin to emerge.

This type of enquiry lends itself to observing the natural world but can also be used to compare materials and observe physical processes. There are many opportunities to work outdoors when carrying out these types of enquiries, and children's observations will often lead on to other, different, types of enquiries.

Typical observations over time might be triggered by these types of questions:

What happens to a seed when it germinates?

What happens to bread if it's left out for a long time?

What happens to the ice cube in your hand?

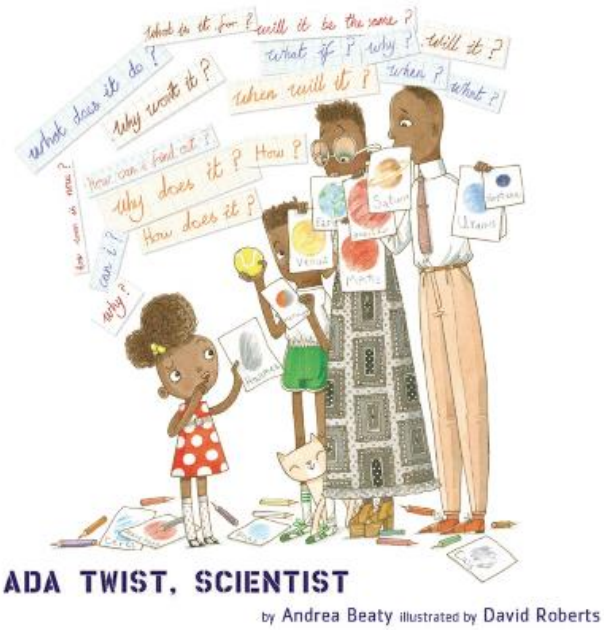
What happens to a puddle when the sun comes out?

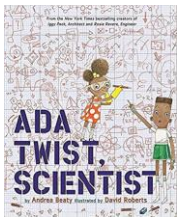
What happens to the flowers on the plant?

How does a nail in saltwater change over time?

How does my heart rate change over the day?

Choose one of these questions or get the children to think of a question and carry out a science enquiry by observing changes over time!





Example Second Level science enquiry: observation over time

In the story, Ada smells a "pungent aroma that curled her toes. Maybe the smell was coming from the dustbin or the compost heap after her father threw away the food he didn't need when had made his cabbage stew!"

When food goes bad it can start to become pungent - this is most often due to the growth of microbes such as bacteria, yeasts, and mould. Odours can come from two sources: chemicals that are released from the food as the microbes decompose it, or by chemicals produced directly by the microbes themselves.

Composting is the natural process of decomposition and recycling of organic material (such as leaves, grass, fruit, and vegetable scraps) into compost. Composting food waste for use in the garden rather than sending it to landfill helps prevent climate change; composting can prevent hundreds of thousands of greenhouse gas emissions being added to the atmosphere.

Many schools and homes have a composting bin or heap, but rarely do children have the opportunity to actually see what happens during the process and observe the changes over time. It is possible to set up a small scale 'composting bin' in the classroom using simple materials so that they can see the process and observe changes over time.

How do the materials in a compost bin change when they decompose to form compost?

Details of how to do this can be found here:

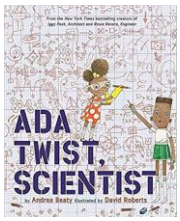
https://www.sserc.org.uk/wp-content/uploads/2019/07/PB_50.pdf

***This also contains important 'Health and Safety' considerations when undertaking this enquiry*.**

This enquiry links to this outcome and benchmark:

I have contributed to investigations into the role of microorganisms in producing and breaking down some materials. ***SCN 2-13a***

- *Investigates, observes and records how microscopic organisms are necessary for the process of decomposition (the breaking down of dead material – decay).*



Activity three: Science enquiry: pattern seeking/finding an association

Pattern-seeking science enquiries involve observations or surveys where variables aren't easily controlled. These investigations answer questions through the identification of patterns in the results and enable children to find out more about the world. They provide rich contexts to learn about habitats, diet, weather and animal and plant behaviour. When children gather the information and notice the patterns involved, this helps them to form important conclusions about why these patterns occurred.

Pattern-seeking questions might include (and may also involve collecting data from secondary sources):

Are the oldest children in our school the tallest?

Do bigger seeds grow into bigger plants?

Is there a pattern in where we find moss growing in the school grounds?

Do all flowers have the same number of petals?

Does every planet take the same time to orbit the Sun?

Do all apples have the same number of seeds?

Which flowers do bees prefer?

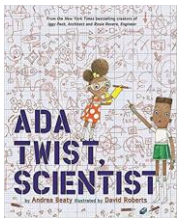
Pattern-seeking enquiries can lead to more systematic enquiries, such as fair tests. The key difference is that pattern-seeking enquiries are not fair or comparative tests because certain variables can't be controlled.

Choose one of these questions or get the children to think of a question and carry out a science enquiry by pattern seeking/finding an association!

Example First Level science enquiry: pattern seeking/finding an association

On the first day of Spring, Ada was busy testing the sounds that make mockingbirds sing. As part of her investigation, Ada might also need to know how to make high and low pitched sounds in order to choose the right sounds that make mockingbirds sing!

Sounds are caused by something vibrating. Sources of sound include musical instruments and loudspeakers. Sounds can vary in loudness and in pitch. Loudness is linked to the size of the vibrations causing the sound. The pitch of a sound is determined by the frequency (how many times something vibrates in one second); the higher the frequency, the higher the pitch of the sound.



What pattern is there/what association is there between the pitch of a sound and the vibrations that produced it?

Set up a carousel of stations for the children to explore the sounds made by, for example:

- Elastic band: cut in half and fix it to the tabletop with a clip. Pull the elastic band upwards and pluck it. Stetch it higher and pluck it – what happens? The pitch changes. Try with thin and thick elastic bands. Try giving a 'big tweak and a little tweak – pitch doesn't change but the volume does.

- Elastic band and a cardboard box: Take a box and stretch a rubber bad around it as shown. Put two pencils/pens under the band and listen to the sound produced by plucking the band between the pencils/pens. Keep increasing the distance between the pens and listen to the sound produced each time. The shortest length makes a high pitch sound and as the length increases the pitch becomes lower.

- Ruler and an elastic band and a pencil; sliding the pencil along the ruler alters the length of the elastic band that is being plucked to see what happens to the pitch.

- Twanging Rulers: Hold the ruler firmly by one end on the table and then 'twang' the other. Change the length of the ruler overhang and listen to the change of the 'twang'. Do all the rulers make the same twanging sound? Does the sound change if you push more/less of the ruler over the edge? Are the sounds different if you use a thin or a thick ruler?

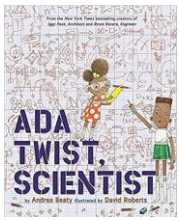
- Stringed instruments

As the children explore each one, they explore what they can do to change the pitch and consider what is the pattern/association between the pitch of the sound and the vibrations that produced it.

This enquiry links to this outcome and benchmark:

By collaborating in experiments on different ways of producing sound from vibrations, I can demonstrate how to change the pitch of the sound. ***SCN 1-11a***

- *Demonstrates how sounds can be made higher or lower pitch by altering tightness, length, width or thickness or other physical characteristics of the sound source*



Activity four: Science enquiry: identifying and classifying

Children begin identifying and classifying objects in the world around them from a very young age. In this type of enquiry, children make observations and measurements to help them look for similarities and differences. This will help them to organise things into groups and make connections.

Identifying and classifying enquiries provide great opportunities for children to make and record detailed observations, including diagrams. Scientific diagrams are very different to drawings or pictures and the relevant skills to produce a scientific diagram need to be taught early. Younger children will be able to record what they see in a drawing; children should be supported to become skilled in producing scientific drawings of their observations, which increase in fine detail as they move up the school.

Children will need access to a variety of equipment that will support them in making closer observations such as magnifying glasses, binoculars, telescopes, microscopes, and digital microscopes.

As children progress through school, they should be learning to use identification keys to help them with this type of enquiry, as well as learning how to create their own branched key.

Identifying and classifying questions might include:

We need to sort these toys into baskets – can we make a key or guide to help us?

If we had a power cut, which things in the kitchen would still work?

We need to choose a material to make an umbrella. Which materials are waterproof?

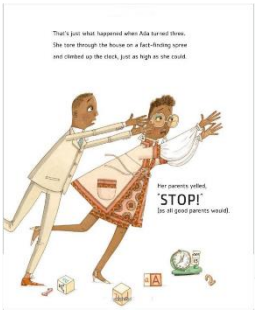
How can we group the food that we eat?

How would you make a classification key for vertebrates/invertebrates?

Can we use the classification keys to identify all the animals that we saw in our mini beast hunt?

What types of trees are in our playground?

Choose one of these questions or get the children to think of a question and carry out a science enquiry by identifying and classifying!



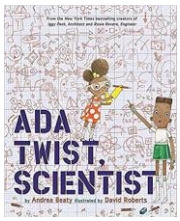
Example Early Level science enquiry: identifying and classifying

Ada Twist was a quiet but curious baby. One day she piled up her stuffed bears and broke out of her crib. Ada was on the go! She tore through her room exploring everything…. But look at the mess she has made in her room…!

We need tidy up and to sort these toys into boxes – how can we group them?

Replicate the scenario in Ada's bedroom by providing a variety of toys made of different materials. Ask the children what they think the toys are made from – they will probably be made of things like plastic, metal, fabric, and wood. Get the children to separate them accordingly into baskets or boxes and discuss why they made those decisions.

Can they suggest sorting them in other ways? E.g., Smooth, or rough? Soft or hard? Heavy or light? Colour? etc. Again, get the children to separate them accordingly and discuss why they have made those decisions.



This enquiry links to this outcome and benchmark:

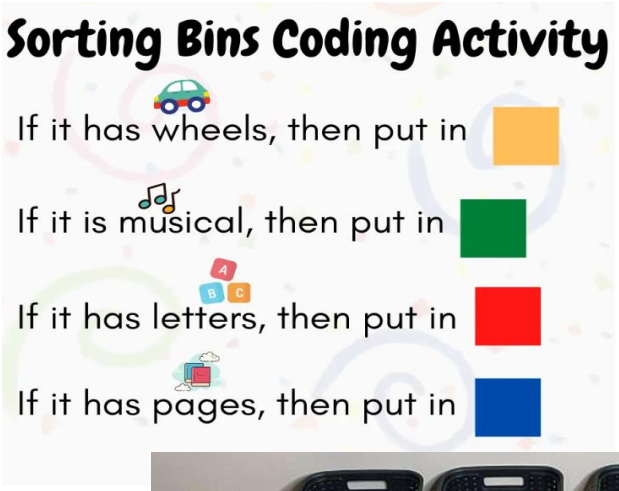
Through creative play, I explore different materials and can share my reasoning for selecting materials for different purposes. ***SCN 0-15a***

- *Explores and sorts materials into different groups depending on their properties, for example, whether they are strong, smooth, rough and if they float or sink.*

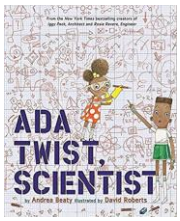
Some of the suggestions the children will have for grouping/classifying them won't involve the materials that the toys are made from but that is ok as this activity also links to the Maths outcome:

I can match objects, and sort using my own and others' criteria, sharing my ideas with others. ***MNU 0-20b***

These kinds of activities also provide great contexts for teaching the Computer Science concept of ***'selection'***. This involves using **if…then** statements:



I can explore computational thinking processes involved in a variety of everyday tasks and can identify patterns in objects or information ***TCH 0-13a***



Activity five: Science enquiry: researching using secondary sources

Research enquiries are a great opportunity to use a science context to practise and develop 'Reading for Information' and writing 'Explanation, Report or Discursive texts.' Children can use a range of secondary sources to help them find the answers to their 'big questions'. They could also plan, create, and use research tools, such as questionnaires and interviews, to collect their own data.

This type of enquiry is a great opportunity for collaborative learning during the researching and sharing of information but also in the presentation of their findings to a variety of audiences.

Research enquiries help to develop children's scientific literacy as they learn to compare and evaluate information from different sources. Children can learn to recognise the differences between fact and opinion and consider the concept of bias. This is a great context for teaching them about reputable sources too - FAKE NEWS!

Visits and visitors are also a good source of both answers and questions!

Researching using secondary sources questions might include:

Where does salt come from?

Are all microbes harmful to us?

How does a barometer work?

What are microplastics and how are they harming the planet?

Which materials can be recycled?

How does a cactus survive in a desert with no water?

Who was Mary Anning and what did she discover?

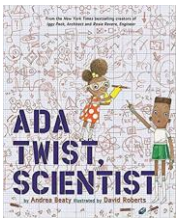
How much energy do low energy lightbulbs save us?

What is the most common spider in the UK?

What happens when we go to the opticians?

This type of enquiry is also ideal for learning about how real scientists work, both interesting scientists from history, but also scientists working in your local community.

Choose one of these questions or get the children to think of a question and carry out a science enquiry by researching using secondary sources!



When Ada's family started helping her with her experiments, they begin doing research by reading.

Ada becomes very interested in noses and smelling because she smells a "pungent aroma that curled her toes." Ada asks: "How does a nose know there's something to smell?"

Example science enquiry researching using secondary resources: How does our nose (ears, eyes, how do we taste/touch) **work?**

Children can research the nose and how it works. We have five senses that help us perceive the world around us so the children could be divided into five groups to research how each sense works and present their findings to the class.

This enquiry links to these outcomes:

I have explored my senses and can discuss their reliability and limitations in responding to the environment. ***SCN 1-12b***

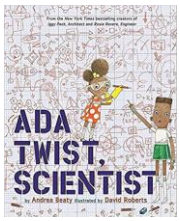
I have explored the structure and function of sensory organs to develop my understanding of body actions in response to outside conditions. ***SCN 2-12b***

For learners working at **Early Level** (or indeed, at any Level), this type of research does not have to be carried out using e.g., books, websites etc but could be done through contact with people in the community such as the optician, school nurse etc. You could invite visitors into school or even a visit to somewhere locally, (perhaps in small groups), may be possible. The children could think of things they want to find out during their visit, including focussing on the question that led to the enquiry, or when the visitors are in school. They could make a record of what they see on their visit and share with others what they found out. After their visit or the visitor has been into school, they could look at books and other sources of information about the e.g., the nose, ears, eyes, or the senses generally etc.

The children could learn about how their senses work with these clips: Senses

This enquiry links to this outcome:

I can identify my senses and use them to explore the world around me. ***SCN 0-12a***



Activity six: Science enquiry: fair testing

Fair test questions involve making comparisons, often trying to find out which is the 'best' or 'most.' Through fair testing, children are encouraged to see that one thing has an effect on another, identifying the differences they have noticed and exploring all the variables (any phenomena subject to change) that may have an effect. Children decide which variable to investigate and how to measure or observe the effects.

It's important children really understand what a fair test is before they carry out their own. They should learn to recognise when tests are fair, be able to generate fair test questions themselves and be familiar with and confident in identifying variables.

A note about comparative and fair test enquiries: these are very similar but there are differences:

Comparative tests: these compare one event with another e.g. ***Does the red car go down the ramp faster than the blue car?***

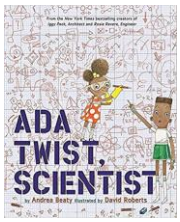
In more complex comparative tests, several different materials, events, or artefacts are compared e.g. ***Which is the best material for mopping up spilt water?*** Here the size of material and the time to soak up the water are controlled.

A comparative test (where we just compare two things) is simpler than a fair test, so this is where we should start with young children.

Fair tests: these are used to identify a casual relationship between two variables. A variable is identified to change that can be quantified and then the effect of changing it on another variable is tested while keeping all the other variables the same e.g. ***How does changing the height of the ramp affect how quickly a toy car rolls down it?*** The type of car, the type of surface on the ramp, the position of the car on the ramp, the position of the starting point etc. are all kept the same; the only thing changed is the height of the ramp.

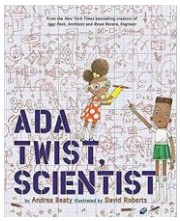
Fair tests *are suitable when variables are numeric and can be changed e.g., investigating the relationship between the surface area of the parachute and the falling time.* ***Comparative tests*** *are used when categoric variables are compared e.g., the material a parachute is made from.*

Fair testing is the most commonly used type of investigation in schools, but it can be used incorrectly to answer questions best solved by other methods. Therefore, it's important to understand the types of questions best suited to fair testing!



Examples of science enquiry questions that children might ask and the type of enquiry approach that could be used to answer the questions:

	Question	Fair test?	Type of enquiry
1.	Which of these things stick to a magnet?		Id & Class
2.	Sycamore seeds spin as they fall. How do other seeds fall?		Pattern seeking
3.	What happens to our snowman when the Sun shines?		Obs over time
4.	How does the sound change if we put more water in a bottle?	Yes	
5.	Can people with the longest legs jump furthest?		Pattern seeking
6.	How much bread could you make from a field of wheat?		Research
7.	How far can a snail travel in 5 minutes?		Obs over time
8.	Which musical instrument makes the loudest sound? Which makes the deepest sound?		Id & Class
9.	Which toy car goes fastest down the slope?	Yes	
10.	Which minibeasts can we find on the compost heap?		Id & Class
11.	What attracts bees to our flowers?		Research
12.	It is icy outside - which of our shoes has the most grip?	Yes	



Fair testing questions might include:

Which material is the best for keeping Teddy dry?

What type of boats stay afloat the longest?

On which ramp do the cars go down fastest?

Where will the plants grow the tallest?

Which is the strongest magnet?

How does adding different amounts of sand to soil affect how quickly water drains through it?

How does the temperature of tea affect how long it takes for a sugar cube to dissolve?

How does the volume of a drum change as you move further away from it?

Choose one of these questions or get the children to think of a question and carry out a science enquiry by fair testing!

In the classroom, a 'deliberate mistakes' approach can be very effective in helping children learn how to carry out fair testing science enquiry.

Which surface will a car travel the farthest on?

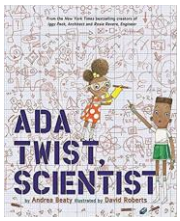
A deliberate mistakes approach here would involve really exaggerating how 'unfair' the investigation is – e.g., big, and little cars, give some a big push and others not, start from different places, alter the height of the ramp etc.

What the children can learn from this is that in order to learn anything useful **the test needs to be fair**.

The children can also see that in order to make the test fair, we need to keep most things the same and **only change one thing at a time**. If we change more than one thing, then we can't tell what makes a difference to the result.

The question we wanted to answer is:

Does changing the surface of the ramp make a difference to how far the car travels?



Fair test questions have this kind of format:

If I change . . .(variables)

What happens to . . .(measure or observe)?

One variable is changed and everything else is kept the same.

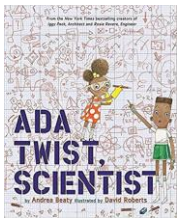
The components of a fair test are these:

What are you trying to find out?	Aim
What do you think will happen?	Hypothesis
What are you going to change?	Variable
What will stay the same?	Constants
What will you do?	Method
What happened?	Observations, data, and results
What did you find out?	Conclusion
How could you improve your test?	Evaluation

When the children come to reporting about their enquiry, it isn't always necessary to cover all of these components all of the time! It is better to focus on a particular aspect of reporting for each enquiry so that children can focus on developing skills in that area, rather than try to do all of these at once and every time they carry out a fair test enquiry.

Fair test enquiries provide opportunities for children to work on all aspects of reporting, from creating written instructions to describe their plan, to tabulating data, graph-drawing, or writing conclusions and evaluating.

A written report is not the only way the children can capture and report on their enquiry. For example, using technology offers many alternative ways e.g. video, photographs, eBooks, science workbooks in number on the iPad etc.



Science enquiry by fair testing; Planning with the children

Anne Goldsworthy is well known in primary science for her 'Post-it' approach to planning for a fair test enquiry.

Post-it planners | PSTT Taps

Post-it-note-planning-guidelines-for-teachers.pdf (glowscotland.org.uk)

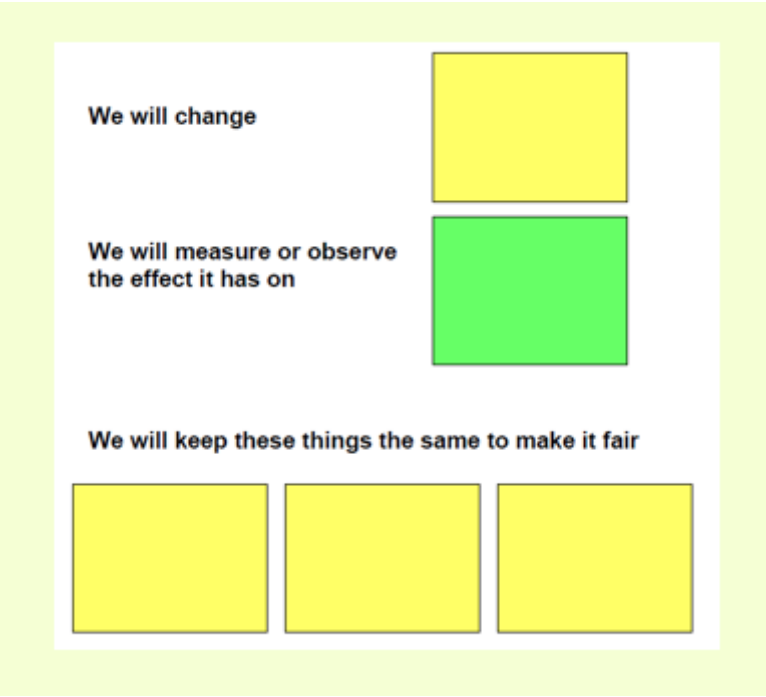
https://www.fabscience.co.uk/sticky-note-planning

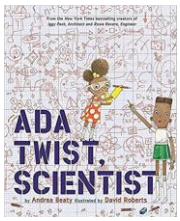
This approach helps the children to:

- identify what to change or vary
- identify what to measure or observe
- decide on one thing to change and one thing to measure, while keeping everything else the same

The approach uses Post-it notes in two colours.

Choose one colour and ask the children to write one thing that could be changed. Use a new Post-it for each thing they think of. (If I change…(variable)) Using the second colour, write down one thing that could be measured/observed (What will happen to…) Use a new Post-it for each one.





Here is an example: ***What makes plants grow the best?***

The things that could be changed are on yellow and the things that could be measured or observed are on green.

Start off by populating the top left hand and top right hand corners of the planning board,

Choose one thing to change and move the Post it note down to 'We will change' and move the rest of them down to the 'We will keep these the same…'

Choose one thing to measure or observe and move that Post it down to 'We will measure/observe'.

Then move the one thing that is going to be changed down to 'When I change' and move the one thing that is going to be measured/or observed down to 'What will happen to ' so that you can explore the children's ideas/ predictions etc.

Planning Board- Example

Class/Group planning Board

Our question is… *What things make plants grow the best?*

We could change	We could measure/observe
Light, Temp, Amount of soil, Size of pot, Type of seed, Spacing of seeds	No. seeds germinating, Height of plant, No. of leaves
We will change	**We will measure/observe**
Temp	No. seeds germinating

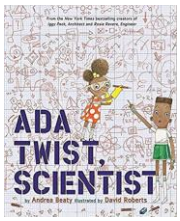
We will keep these the same…

Light | Amount of soil | Size of pot | Type of seed | Spacing of seeds |

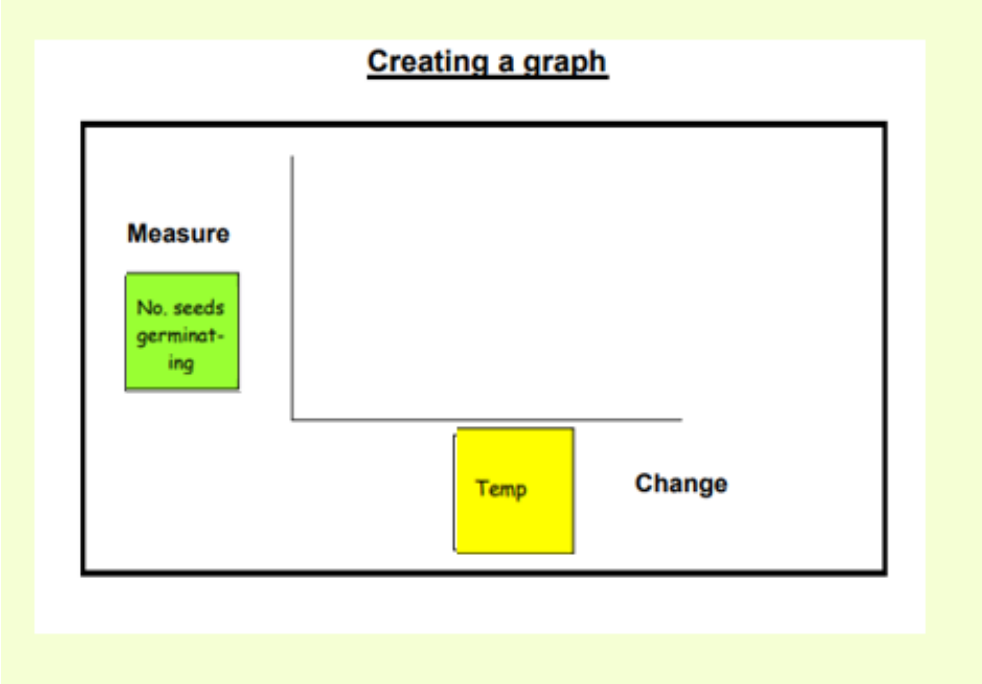
When I change:	What will happen to:
Temp	No. seeds germinating

We think that…*the warmer the temperature, the more seeds will germinate*

Why?... *because plants normally grow best in summer when it is warm*

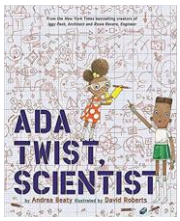


Show the children how to construct a graph of their results (if appropriate) – the 'measure' Post-it goes on the y axis and the thing that was changed goes on the x axis



This approach for planning with the children means that a number of different enquires can be planned for and carried out by different groups of children. The children have the opportunity to lead their own learning and each group has something different to report back to the class rather than everyone doing the same investigation, giving a real purpose for each investigation.

Fair testing is a specific way to set up a science enquiry by isolating and controlling variables. Any science enquiry, however, needs to be fair, even if it isn't a fair test. To be more precise, what we really mean by 'fair' is valid. Just because we aren't carrying out a fair test, it doesn't mean that we can't make the enquiry fair!



Example Early and First Level science enquiry: fair testing

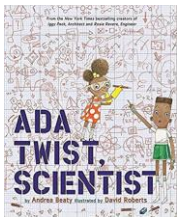
When Ada is trying to find out what is causing the horrible smell, she thinks it might be the cat and decides to try to give the cat a bath in the washing machine! Poor cat!

What could Ada have to do to get the cat dry quickly?

Do warmer temperatures cause things to dry quicker?

When clothes dry on the washing line, it is evaporation that causes the water in the wet clothes to turn to water vapour which leaves the clothes dry. Carry out an investigation into drying washing at different temperatures to find out the affect temperature has on evaporation.

Early Level: find out the best way to get things dry. This could be done as a comparative test by wetting two identical pieces of cloth, wringing the excess water out and placing each piece in an open tray. The trays could then be placed in e.g., one in the sunshine and one in the shade The children could make predictions about which will dry first. Talk about why it helps to keep some things the same when you are investigating.



What can make things dry more quickly?

First Level: plan the investigation with the children and get them to think about all the things that they could change –e.g., type of fabric, temperature of the drying location, temperature of the water used to soak the cloth, the shape of the cloth, time left to dry etc. How they are going to tell how dry the cloths are after they have been left for some time (what are they going to measure or observe) - will they feel them, observe them, measure their temperature, find their weight or something else?

Carry out the investigation and record the results. What did they find out?

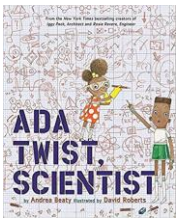
These enquiries link to this outcome:

By investigating how water can change from one form to another, I can relate my findings to everyday experiences. ***SCN 0-05a / SCN 1-05a***

What makes the tallest 'geyser'?

Ada uses diet coke, mint Mentos, and food colouring to do a colourful and very messy, experiment!

Sometimes you'll see this called ***a coke and mento geyser***, as the eruption looks like a geyser. Please select a suitable location and risk assess the activity too; the stream of coke can reach about 6 meters high; the middle of a field or on a large lawn is ideal.



Position the bottle on the ground so that it will not tip over – you might need to put down something flat, like a small piece of wood, to hold it up. You want the bottle to be stable before conducting the experiment.

What happens when coke and Mentos mix?

There are several theories, but it's thought that the many small pores on the surface of the Mento speed up the release of the carbon dioxide from the fizzy drink. As soon as the Mentos hit the coke, bubbles cling to the surfaces of the sweets thanks to the tiny pits and imperfections on surface of the sweets called nucleation sites. The Mentos then quickly rise to the surface of the liquid. Because Mentos are heavy, they sink to the bottom of the bottle, but the gas released by clinging to the Mentos, pushes the coke up and out of the bottle in an incredible stream approximately 6 metres high.

Any fizzy drink will produce a similar effect, but diet drinks seem to work best; this is most likely because of the particular chemicals in diet drinks.

The reaction isn't a chemical reaction but a physical reaction - the molecules haven't been chemically changed, just re-arranged! The "why" behind the geysers is a physical reaction called nucleation.

The children could plan and investigate a number of factors that might affect the height of the 'geyser': the number of Mentos, type of fizzy drink, fruit flavoured Mentos vs mint flavoured, type of sweet the temperature of the fizzy drink (warm vs cold vs room temperature?) Flat vs fizzy? How are the children going to be consistent in the way they drop the Mentos into the coke every time? What are they going to measure/observe?

Measure the height of the eruption by placing the bottle next to the wall of a brick building, after getting permission from the building's owner. Measure the height of the geyser by counting the number of bricks that are wet once the geyser stops. If you want a more specific measurement, use chalk to mark off 50 cm increments before you drop the Mentos into the bottle of soda.

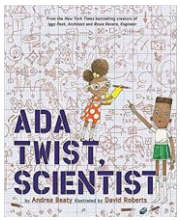
Measure the volume of the geyser by noting the volume of a full bottle of coke before you drop the Mentos into it and then when the geyser stops, measure how much liquid is left inside.

Mentos Geyser Experiment - Mentos & Coke Experiment (stevespanglerscience.com)

Mentos STEM Challenge with Diet Coke - Awesome Science Fair Project - YouTube

Soda and Mentos Experiment - YouTube

This activity is an opportunity to focus on developing the scientific skills as presented in the table on page 14 of the Benchmarks for Sciences Curriculum for Excellence document. It also provides a context in which to discuss the characteristics of gases



This enquiry therefore links to this outcome:

By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. ***SCN 2-15a***

- Explores and describes the characteristics of solids, liquids, and gases, for example, solids retain the same volume and shape, liquids keep the same volume but the shape changes to fit the container and that gases change shape and volume to fill the container.

Activity six: female scientists

As identified previously, Ada Twist, Scientist is a great starting point to discuss female scientists who have had an impact in the scientific world.

Ada Twist is named after two female scientists: Marie Curie and Ada Lovelace.

Separate the class into groups and provide them with resources to read about female scientists including Marie Curie and Ada Lovelace e.g., Jane Goodall, Katherine Johnson, Mary Anning, Rosalind Franklin, Caroline Herschel, Sarah Gilbert, or ones of their choosing!

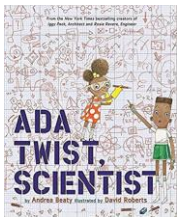
These resources could be nonfiction books or online resources that are suitable for the children They could try to find out:

- When did your scientist live? (They be still alive of course!)
- What field of science did/do they study?
- What 3 ways have they contributed to/are they contributing to their field of science
- Has the world been changed or benefitted from their scientific discoveries?

Finally…

‘Ada Twist had all the traits of a great scientist’.

Discuss what character traits does she possess that makes her a perfect scientist!



References:

- J Turner, B Keogh, S Naylor & L Lawrence (2011) It's not fair – or is it? a guide to developing children's ideas through primary science enquiry. Millgate House & ASE.
- A Goldsworthy & R Feasey (1994) Making sense of primary science investigations. ASE.
- B Keogh & S Naylor (2010) Science Questions stories. Millgate House
- Enquiry Approaches - Primary Science Teaching Trust (pstt.org.uk)
- More than a Fair test: The Different Types of Scientific Enquiry in Primary Science - Danny Nic's Science Fix

This resource was created by Kim Aplin, PSDO, Aberdeenshire Council