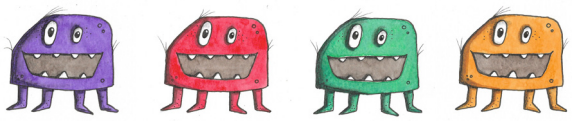
Primary Science Skills and How to Teach Them

Getting to Grips with Scientific Enquiry



Unit 3
Planning and Predicting

Series Author:
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Ali Eley

Primary Science Skills and How to Teach Them

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Unit 3: Planning and Predicting

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Robots and monsters: Rufus Thomas

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Disclaimer

ASE advises teachers to refer to either the CLEAPSS website or SSERC website for up-to-date health and safety information when planning practical activities for children.

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ASE assumes no liability with regard to injuries or damage to property that may occur as a result of using the information contained in these resources. ASE recommends that a full risk assessment is carried out before undertaking in the classroom any of the practical investigations contained in the resources.

The Association For Science Education
Promoting Excellence in Science Teaching and Learning

Primary Science Teaching Trust

Primary Science Skills and How to Teach Them

Getting to Grips with Scientific Enquiry

Introduction to the series

Scientific enquiry is essentially a thinking process. For children to undertake effective science enquiries in the classroom, they need to know how to collect useful data and how to interpret them. Simply meeting science skills during practical activities is rarely enough for them to be learned and embedded.
Primary Science Skills and How to Teach Them has been developed for children aged 7-11. It is based on two books written by Anne Goldsworthy, Rod Watson and Valerie Wood-Robinson. Originally created for children aged 9-13, *Getting to Grips with Graphs* (1999) and *Developing Understanding* (2000) were the outcomes of the AKSIS project: a three-year research collaboration between the Association for Science Education and King's College London, funded by the Wellcome Trust.

Building on the more open-ended, exploratory approach of lower primary, *Primary Science Skills and How to Teach Them* provides teachers with simple strategies and short activities to support upper primary children (aged 7-11) to develop a range of disciplinary knowledge and skills, which can subsequently be applied in their own scientific investigations. The materials cover the skills required at each stage of a scientific enquiry and are mapped to different scientific enquiry types, providing teachers with a comprehensive choice of activities.

Unit 3: Planning and Predicting

Contents:

Unit 3

Planning and Predicting

About this unit

Pupils who can describe the enquiry that they are tackling with clarity tend to make good planning decisions. The modules in this unit are designed to help children develop these characteristics.

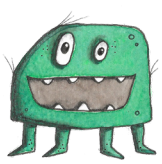
Have you ever started off a scientific enquiry and, halfway through, found that some of your children seem to be working on a completely different problem? Despite our best intentions, children interpret things that we say in very different ways. **Modules 1** and **2** aim to help children clarify what an enquiry is about before they get too engrossed in planning details.

Carefully considered predictions can encourage children to focus on the key variables of an enquiry. **Module 3** helps children to make connections with their knowledge and everyday experiences in order to make informed predictions.

Module 4 uses the 'sticky label approach' to help children develop their understanding of a fair test, with supportive, easy-to-use planning templates

Health & Safety Guidance

Reasonable care has been taken to ensure that activities in this publication do not suggest practices that might be dangerous, and safety warnings are given where appropriate. However, ASE has not tested the activities suggested and can therefore give no guarantee of safety. For further advice on health and safety matters in primary science education, see 'Be Safe! Health and Safety in School Science and Technology for Teachers of 3- to 12-year-olds' (4th edition, ASE, 2011).



Module 1 – How Clear Is Your Question?

Learning Objective:

To identify what will be changed and what will be measured or observed in questions.

Background Information:

When initiating sessions where children can offer their own ideas for investigation, those that can be answered by testing and collecting data do not always clearly identify the variables; e.g. 'Which is the best material for a school bag?' does not specify what they will be measuring or observing and which could be anything from strength to permeability. Vague questions such as this can lead to confusion later when children are carrying out their investigation.

Before planning the details of an investigation, children should know what they are changing and what they are measuring or observing. Their questions should be clear and unambiguous. They should specify the variables.

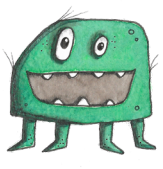
This applies particularly to enquiries where the children are carrying out fair or comparative tests and some pattern seeking enquiries.*

**Questions for identifying and classifying tend to be less formulaic and more along the lines of 'How can we group/sort…?', 'Which materials/animals/rocks are …?' 'Which…can we identify?', 'How do…and …compare?' and 'Are/do all…?' (see Unit 1, Module 2 for ideas on how to generate these questions).*

For observations over time, questions can usually be framed using 'What happens to…when we…?' or 'How do/does…change over…?'

When framing research questions, the following may be useful:

- *A good research question should be focused and not general or too vague: e.g. 'How are animals adapted to different habitats?' becomes 'How are camels adapted to life in the desert?'*
- *A good research question does not ask for opinions: e.g. 'Which source of carbohydrates is the best?' becomes 'Which source of carbohydrates provides the most energy?'*
- *A good research question is generally not answered with yes or no: e.g. 'Has electricity improved our lives?' becomes 'How has electricity improved our lives?'*



Activity – How Clear Is Your Question?

What to do

- Display **Activity Sheet 1**, which lists the following four questions about bubbles:
  1. How does the amount of glycerine in the bubble mix affect the size of the bubbles formed?
  2. What affects how long bubbles last?
  3. Which is the best mixture for bubbles?
  4. What makes a good bubble?

- For each question in turn, ask children to decide whether the question, as it stands, refers to variables in a way that is helpful in planning an investigation. Does it suggest clearly what is to be **changed** by the child and what will be **measured or observed?** Children can use the table on page 9 to record their ideas.

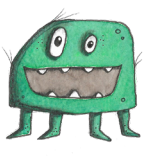
- Collect and compare responses.

- Page 10 shows the correct answers. Only Question 1 clearly states both variables.

- Put children in groups to complete **Activity Sheet 2**.

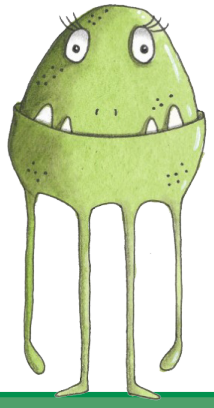
- Conduct a class discussion to consider their responses and ask them to suggest how they could alter some questions to clarify the variables involved.

- If time allows, ask children to look back at the questions that they posed in previous investigations and comment on their clarity.

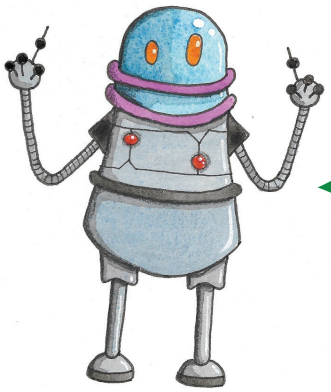


Activity 1 – How Clear is Your Question?

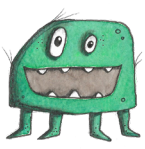
Work in pairs to answer the questions and complete this table



Question	What will be changed	What will be measured or observed
1. How does the amount of glycerine in the bubble mix affect the size of the bubbles formed?		
2. What affects how long bubbles last?		
3. Which is the best mixture for bubbles?		
4. What makes a good bubble?		

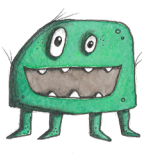


Read each question.
Does it say what will be changed?
Does it say what will be measured or observed?

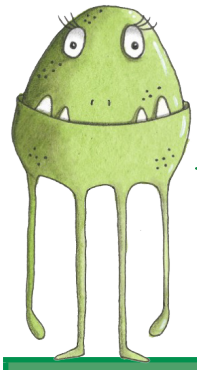


Answers: Activity 1 – How Clear is Your Question?

Question	What will be changed	What will be measured or observed
1. How does the amount of glycerine in the bubble mix affect the size of the bubbles formed?	Amount of glycerine in the bubble mixture	Size of bubbles
2. What affects how long bubbles last?	?	Length of time bubbles last
3. Which is the best mixture for bubbles?	Type of bubble mixture	?
4. What makes a good bubble?	?	?



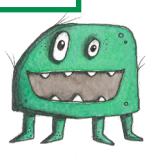
Activity 2– How Clear is Your Question?



Look carefully at each question to see if it mentions what is being changed and what is measured or observed

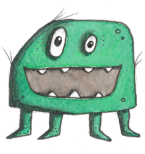
- If you can work out what will be changed or what will be measured/observed, write it in the box.
- If it is not clear, put '?' in the box.

Question	What will be changed	What will be measured or observed
1. Do older people have lower pulse rates?		
2. How can we make sugar dissolve more quickly?		
3. Which fabric will be best for the clothes of someone who works on a farm?		
4. What makes grass grow well?		
5. Do big seeds germinate more quickly?		
6. How can we make a shadow longer?		
7. Does the length of a twanging ruler affect the pitch of sound that is made?		
8. Which material will absorb the most water?		



Answers: Activity 2– How Clear is Your Question?

Question	What will be changed	What will be measured or observed
1. Do older people have lower pulse rates?	Age of people	Pulse rate
2. How can we make sugar dissolve more quickly?	?	Time for sugar to dissolve
3. Which fabric will be best for the clothes of someone who works on a farm?	Type of fabric	?
4. What makes grass grow well?	?	?
5. Do big seeds germinate more quickly?	Size of seed	Time taken to germinate
6. How can we make a shadow longer?	?	Length of shadow
7. Does the length of a twanging ruler affect the pitch of sound that is made?	Length of ruler	Pitch of sound
8. Which material will absorb the most water?	Material	Amount of water absorbed



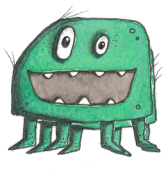
Module 2 – Describing a Scientific Enquiry Clearly

Learning Objective:

To describe clearly what a scientific enquiry is about.

Background Information:

Children do not always see a scientific enquiry in the same way as their teacher. Even when a teacher poses a clear question or gives a clear statement of the problem, children still interpret it in different ways. This, in turn, affects how they carry out the enquiry. This module is designed to help children understand what makes a good description of an investigation.



Activity – Describing a Scientific Enquiry Clearly

What to do

- Introduce the context to the class and make sure that all children are aware of the question posed by the teacher in the activity.

- Ask the class to work in pairs or small groups to evaluate the descriptions written by different children.

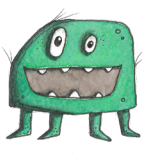
- Collect children's answers to the following questions:
  Which is the most useful description of the investigation?
  Which is the least useful description of the investigation?
  Ask them to justify their choices.

- The following questions would make a useful list of criteria:
  *Do they say what will be changed?**
  Does it say how many values/samples/areas will be measured or observed?
  Do they say what will be measured or observed?
  *Does it say how often it will be measured or observed?***
  *Does it say how long it will be measured or observed for?***
  *Does it mention exploring the relationship (pattern) between the variables?****

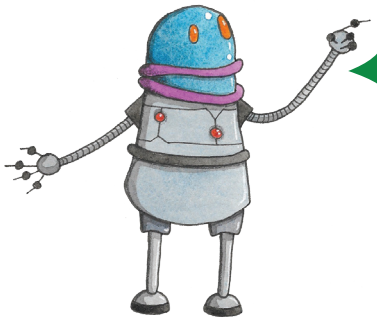
- Finish by emphasising what is good about the most useful description of the investigation.

For each context, there are two activities. The first activity has a greater number of example descriptions and will require a great depth of discussion in order to rank them, whereas the second activity is simplified, with fewer example descriptions and more obvious distinctions between those that are useful and those that are not.

**This may not apply to pattern-seeking investigations, identifying and classifying, research or observations over time.*
***This may not apply to pattern-seeking investigations, identifying and classifying, research or fair/comparative testing.*
****This may not apply to comparative tests, identifying and classifying, research or observations over time.*



Activity Sheet 1a – Absorbency of soils



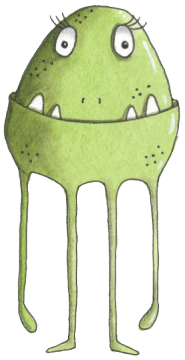
Which one describes the investigation clearly?

A teacher asked his class to investigate this question:
'Which soil absorbs the most water?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Diya *We have to get some soils and pour in water.*
Arjun *We are looking to see if different soils absorb different amounts of water.*
Katie *We are trying to see if soil absorbs water.*
Riley *We are looking at what lives in soil.*
Archie *We are trying to find the best soil for absorbing water.*
Jacob *We will add water to equal samples of different soils until they cannot absorb any more then we will calculate the amount of water absorbed by subtracting what is left in the jug from the amount we started with.*

I can't decide ... how are you going to choose the order from best to worst?



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

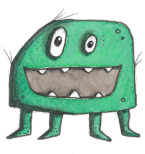
Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

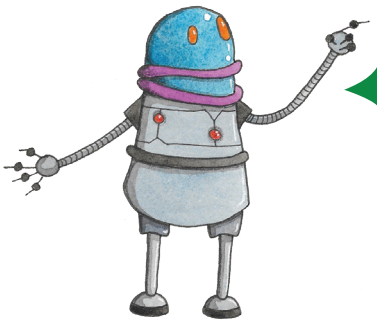
a) _____

b) _____

c) _____



Activity 1b – Absorbency of soils



Which one describes the investigation clearly?

A teacher asked his class to investigate this question:
'Which soil absorbs the most water?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

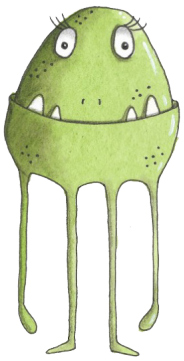
Diya *We have to get some soils and pour in water.*

Arjun *We are looking to see if different soils absorb different amounts of water.*

Riley *We are looking at what lives in soil.*

Jacob *We will add water to equal samples of different soils until they cannot absorb any more then we will calculate the amount of water absorbed by subtracting what is left in the jug from the amount we started with.*

I can't decide ... how are you going to choose the order from best to worst?



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

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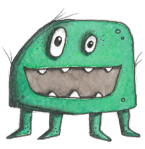
b) _____



Activity 2a – Muffling sound

A teacher asked her class to investigate this question:
'Which material is best for muffling sound?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Priti *We will fill two paper cups with different materials each time, cover our ears with them and then measure how far away from the sound we get before we can't hear it.*

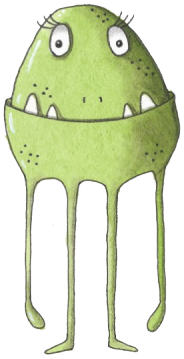
Dembe *We are looking at how far away from sounds we have to stand before we can't hear it with different materials around our ears.*

Hope *We are trying to see if we can hear sound through string telephones.*

Jack *We are filling paper cups with material to see how it affects how loud the sound is.*

Ethan *We are trying to find the materials that muffle the sound.*

Maya *We have to put different materials into paper cups and see what happens to the sound.*



I can't decide ... how are you going to choose the order from best to worst?

1. Order the descriptions from best to worst by writing the children's names in the boxes below:

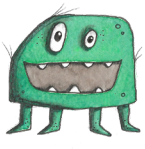
Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

a) _____

b) _____

c) _____



Activity 2b – Muffling sound

A teacher asked her class to investigate this question:
'Which material is best for muffling sound?'

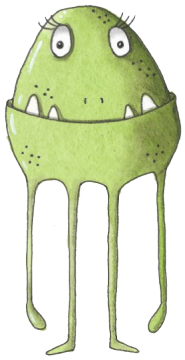
The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Priti *We will fill two paper cups with different materials each time, cover our ears with them and then measure how far away from the sound we get before we can't hear it.*

Dembe *We are looking at how far away from sounds we have to stand before we can't hear it with different materials around our ears.*

Hope *We are trying to see if we can hear sound through string telephones.*

Maya *We have to put different materials into paper cups and see what happens to the sound.*



I can't decide ... how are you going to choose the order from best to worst?

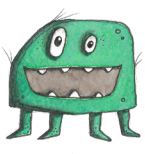
1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

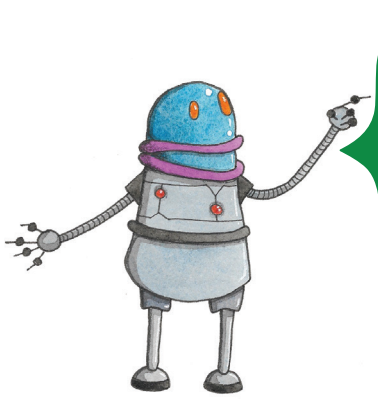
2. Write down two ways in which the best description is better than the worst description:

a) _____

b) _____



Activity 3a – Dissolving sugar



Which one describes the investigation clearly?

A teacher asked his class to investigate this question:
'How does temperature affect the time taken for sugar to dissolve in water?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Andeep *We have got to write down what we are going to do then do it.*

Kirsty *We are looking to see how different water temperatures affect how long it takes for sugar to dissolve.*

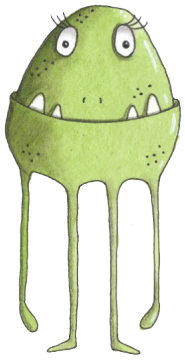
Prishna *We are trying to see if sugar dissolves in water.*

Lawrence *We are adding sugar to hot and cold water to see how long it will take to dissolve.*

Ali *We are trying to find the best temperature for dissolving sugar in water.*

Louise *We have to put the same amount of sugar in water with different temperatures and see what happens.*

I can't decide ... how are you going to choose the order from best to worst?



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

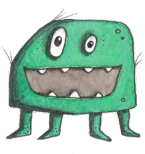
Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

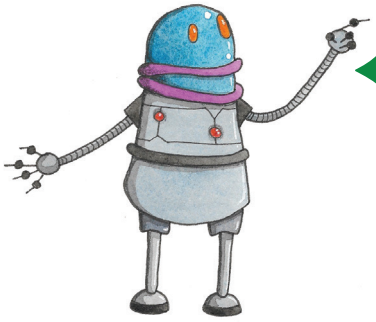
a) _____

b) _____

c) _____



Activity 3b – Dissolving sugar



Which one describes the investigation clearly?

A teacher asked his class to investigate this question:
'How does temperature affect the time taken for sugar to dissolve in water?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

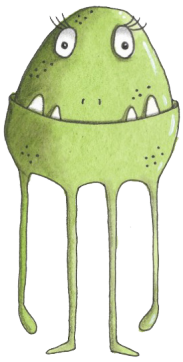
Kirsty *We are looking to see how different water temperatures affect how long it takes for sugar to dissolve.*

Prishna *We are trying to see if sugar dissolves in water.*

Ali *We are trying to find the best temperature for dissolving sugar in water.*

Louise *We have to put the same amount of sugar in water with different temperatures and see what happens.*

I can't decide ... how are you going to choose the order from best to worst?



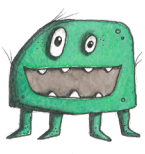
1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

a) _____

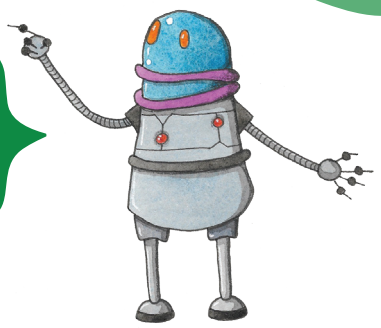
b) _____



Activity 4a – Wriggly worms

A teacher asked his class to investigate this question:
'Which species of worms do we have in our school grounds?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?



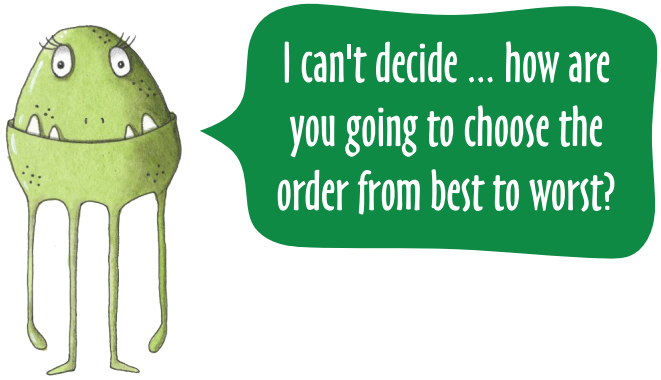
Amir *We have to try to find some worms in the ground.*

Jo *We will dig a pit in several different areas of the school grounds, putting the earth onto a black bag. We will sort through the soil taken out and find all worms with a saddle as these are adults. We will then use a key to identify which species we have.*

Alex *We are trying to find the longest worm.*

Mo *We are looking for adult worms to identify.*

Erik *Once we have found some worms, we will identify any adult ones using a key.*



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

a) _____

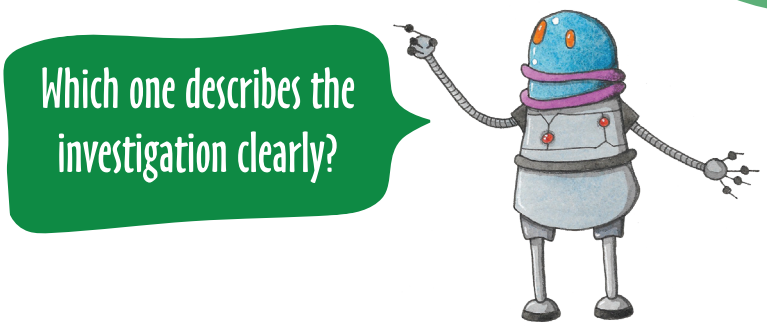
b) _____

c) _____

Activity 4b – Wriggly worms

A teacher asked his class to investigate this question:
'Which species of worms do we have in our school grounds?'

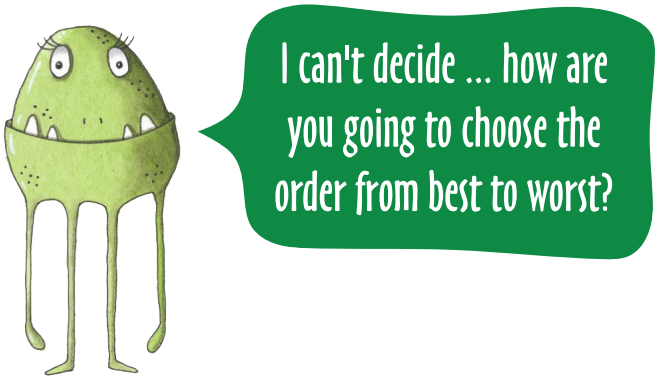
The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?



Jo *We will dig a pit in several different areas of the school grounds, putting the earth onto a black bag. We will sort through the soil taken out and find all worms with a saddle as these are adults. We will then use a key to identify which species we have.*

Alex *We are trying to find the longest worm.*

Erik *Once we have found some worms, we will identify any adult ones using a key.*



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

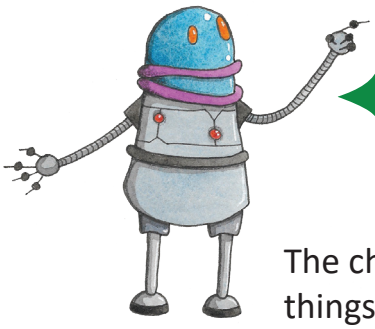
Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

a) _____

b) _____

Activity 5a – Seed dispersal



Which one describes the investigation clearly?

A teacher asked her class to investigate this question:
'Do the longest sycamore seeds land the furthest away from the parent tree?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Kwame *We have to find sycamore seeds and measure them.*

Marshal *We are looking for sycamore seeds at different distances from the parent tree and then measuring the length of the seeds.*

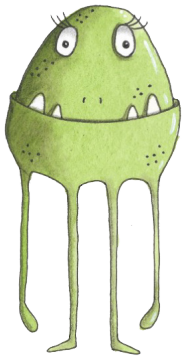
Chloe *We are trying to see how far different-sized sycamore seeds spread from the parent tree.*

Tarum *We are measuring the length of twenty sycamore seeds at five different distances from the parent tree to see if there is a link between seed length and the distance they travel.*

Zena *We are trying to find the sycamore seed the furthest from the tree.*

Jamila *We are trying to find the longest sycamore seed.*

I can't decide ... how are you going to choose the order from best to worst?



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

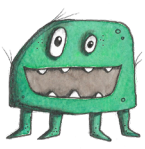
Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

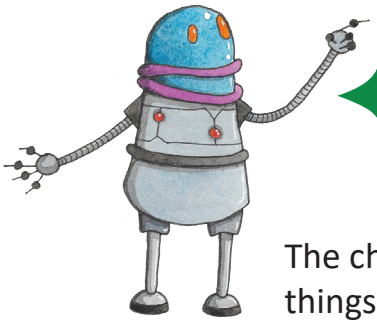
a) _____

b) _____

c) _____



Activity 5b – Seed dispersal



Which one describes the investigation clearly?

A teacher asked her class to investigate this question:
'Do the longest sycamore seeds land the furthest away from the parent tree?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

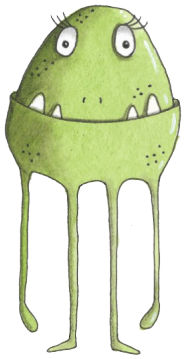
Kwame *We have to find sycamore seeds and measure them.*

Marshal *We are looking for sycamore seeds at different distances from the parent tree and then measuring the length of the seeds.*

Chloe *We are trying to see how far different-sized sycamore seeds spread from the parent tree.*

Tarum *We are measuring the length of twenty sycamore seeds at five different distances from the parent tree to see if there is a link between seed length and the distance they travel.*

I can't decide ... how are you going to choose the order from best to worst?



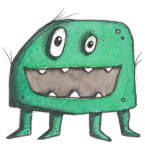
1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

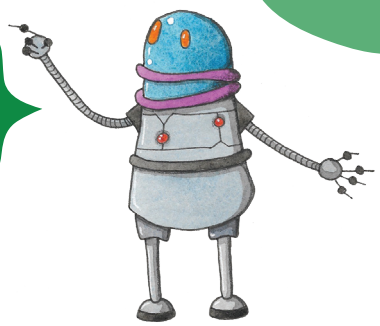
a) _____

b) _____



Activity 6a – Drying puddles

A teacher asked her class to investigate this question:
'How does a puddle change over time?'



The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Munashe *We have to count how many puddles we can find.*

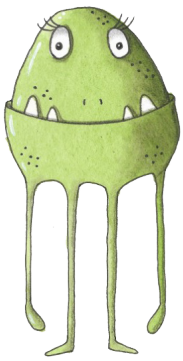
Viktor *We have to watch how a puddle changes over the day by drawing round it.*

Evie *We are trying to find out which puddle lasts the longest.*

Samuel *We are going to watch how the size of a puddle changes by drawing round it every 30 minutes.*

Kamilla *We will pick out a puddle on the playground and draw round it in chalk at the start and then repeat this every 30 minutes for four hours to see how the puddle changes size and shape.*

Francie *We will watch a puddle and see if it gets bigger or smaller.*



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

a) _____

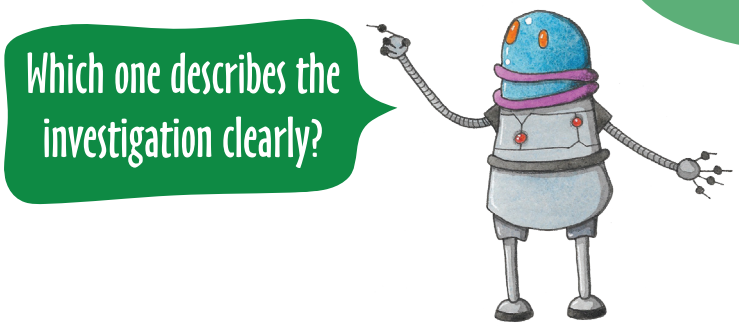
b) _____

c) _____

Activity 6b – Drying puddles

A teacher asked her class to investigate this question:
'How does a puddle change over time?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?



Munashe *We have to count how many puddles we can find.*

Samuel *We are going to watch how the size of a puddle changes by drawing round it every 30 minutes.*

Kamilla *We will pick out a puddle on the playground and draw round it in chalk at the start and then repeat this every 30 minutes for four hours to see how the puddle changes size and shape.*

Francie *We will watch a puddle and see if it gets bigger or smaller.*

1. Order the descriptions from best to worst by writing the children's names in the boxes below:

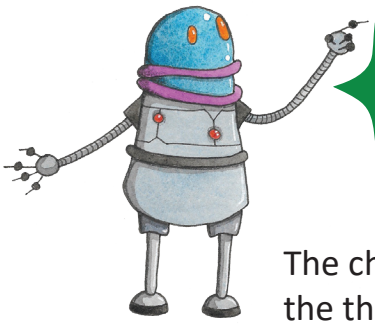
Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

a) _____

b) _____

Activity 7a – Gestation periods



Which one describes the investigation clearly?

A teacher asked his class to investigate this question:
'Do bigger animals have longer gestational periods?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Corina *We have to find out about baby animals.*

Tasha *We are going to research an animal's size and gestation period.*

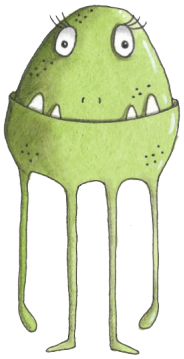
Jaylin *We have to find out the average weight of a number of animals, and then find out how long each animal's gestation period is to see if there is a link.*

Darrell *We are going to research the gestation period of different animals.*

Iman *We will find out the gestation period of different-sized animals to see if there is a link.*

Selena *We will look at how long the gestation period is for big and small animals.*

I can't decide ... how are you going to choose the order from best to worst?



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

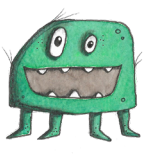
Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

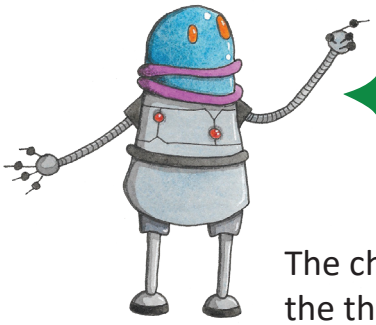
a) _____

b) _____

c) _____



Activity 7b – Gestation periods



Which one describes the investigation clearly?

A teacher asked his class to investigate this question: *'Do bigger animals have longer gestational periods?'*

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

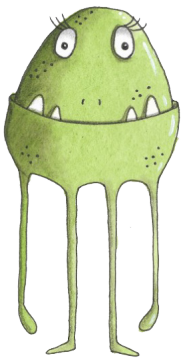
Corina *We have to find out about baby animals.*

Jaylin *We have to find out the average weight of a number of animals, and then find out how long each animal's gestation period is to see if there is a link.*

Darrell *We are going to research the gestation period of different animals.*

Selena *We will look at how long the gestation period is for big and small animals.*

I can't decide ... how are you going to choose the order from best to worst?



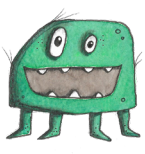
1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

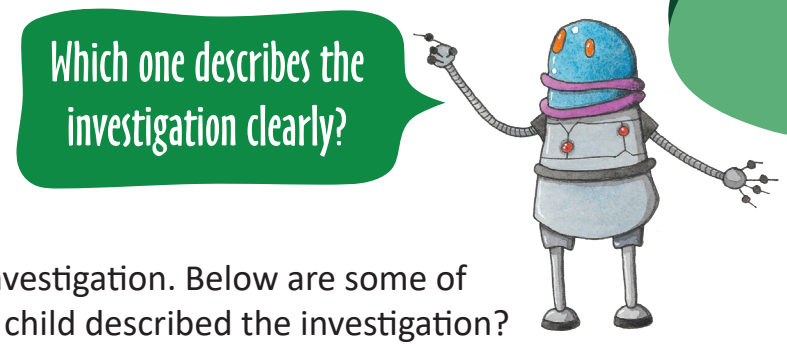
2. Write down two ways in which the best description is better than the worst description:

a) _____

b) _____



Activity 8a – Breakfast boost



A teacher asked his class to investigate this question:
'Does what we eat for breakfast affect how long we can run for?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

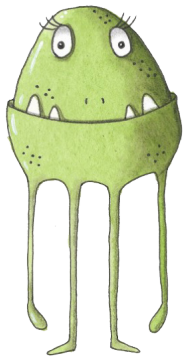
Finley *We have to find out what everyone had for breakfast and then see how fast we can run.*

Irena *We are going find out what everyone had for breakfast to see if it gives them more energy.*

Davis *We are going to measure how far each of us can run for and compare it to what we had for breakfast.*

Rhian *We will find out who is the best runner in the class.*

Aaron *We will survey the class to see what everyone ate for breakfast and then jog around the field perimeter until we cannot run any more. We will measure how many metres each of us managed to run to see if there is a link.*



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

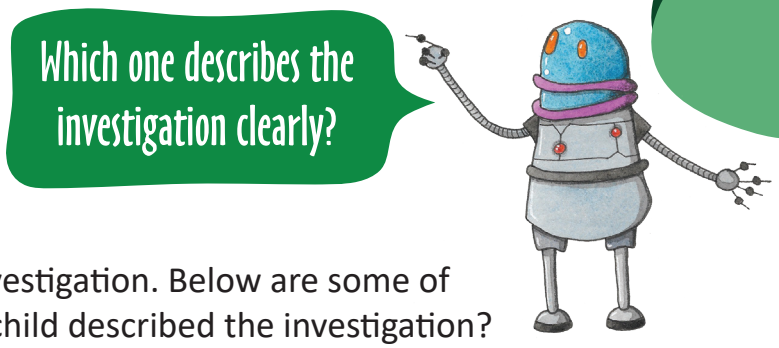
a) _____

b) _____

c) _____

Activity 8b – Breakfast boost

A teacher asked his class to investigate this question:
'Does what we eat for breakfast affect how long we can run for?'

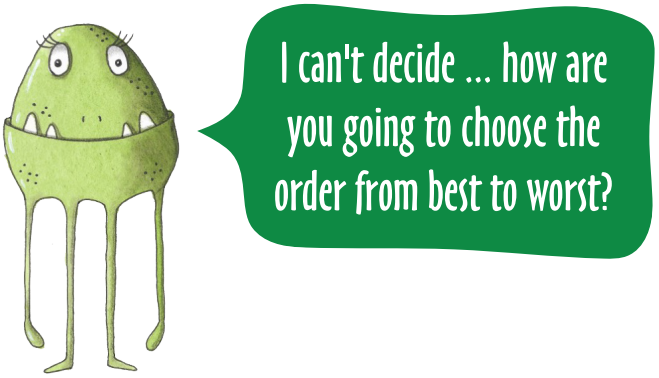


The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Davis *We are going to measure how far each of us can run for and compare it to what we had for breakfast.*

Rhian *We will find out who is the best runner in the class.*

Aaron *We will survey the class to see what everyone ate for breakfast and then jog around the field perimeter until we cannot run any more. We will measure how many metres each of us managed to run to see if there is a link.*



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

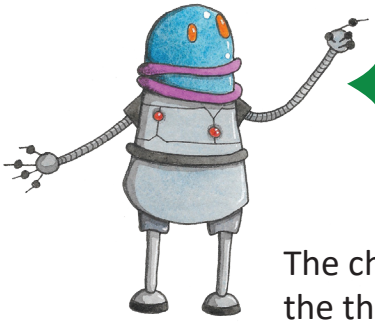
Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

a) _____

b) _____

Activity 9a – Orbiting planets



Which one describes the investigation clearly?

A teacher asked his class to investigate this question:
'Is there a link between the circumference of a planet and the time it takes to orbit the Sun?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Corey *We are going to research Jupiter.*

Toni *We are going to research the size of a planet and the time it takes to orbit the Sun.*

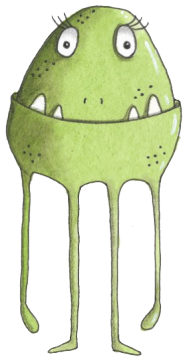
Jay *We have to find out the circumference of each planet in our solar system, and then find out how long each planet takes to orbit the Sun to see if there is a link.*

Dion *We are going to research the circumference of different planets.*

Sam *We will look at how long it takes planets with large and small circumferences to orbit the Sun to see if there is a link.*

Nina *We will find out the time different planets take to orbit the Sun to see if there is a link.*

I can't decide ... how are you going to choose the order from best to worst?



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

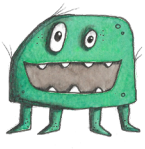
Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

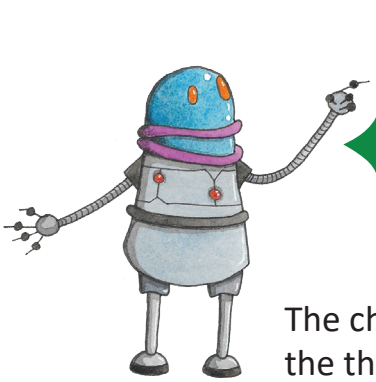
a) _____

b) _____

c) _____



Activity 9b – Orbiting planets



A teacher asked his class to investigate this question:
'Is there a link between the circumference of a planet and the time it takes to orbit the Sun?'

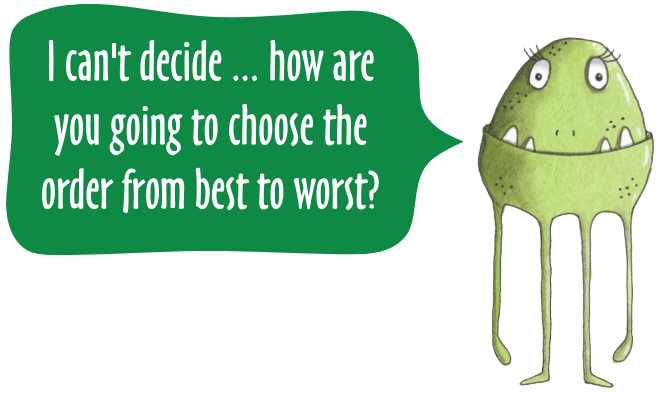
The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?

Corey *We are going to research Jupiter.*

Jay *We have to find out the circumference of each planet in our solar system, and then find out how long each planet takes to orbit the Sun to see if there is a link.*

Dion *We are going to research the circumference of different planets.*

Sam *We will look at how long it takes planets with large and small circumferences to orbit the Sun to see if there is a link.*



1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

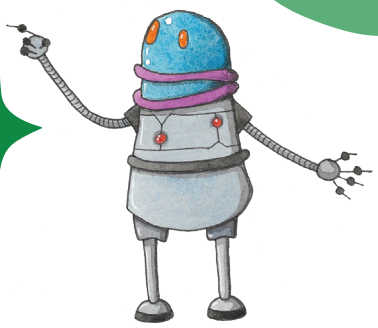
a) _____

b) _____

Activity 10a – Melting ice

A teacher asked his class to investigate this question:
'How does the mass of an ice cube change over time?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?



Joshua *We are trying to find which ice cube melts the fastest.*

Amir *We have to put an ice cube in the classroom and see what happens to the mass.*

Charlie *We are looking to see how the size of the ice cube changes as it melts.*

Maya *We are trying to see how long an ice cube takes to melt in class.*

Oliver *We are putting an ice cube in the class and measuring its mass every 10 minutes.*

Ria *We are measuring the mass of an ice cube every 10 minutes until it has melted to see how it changes.*

1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down three ways in which the best description is better than the worst description:

a) _____

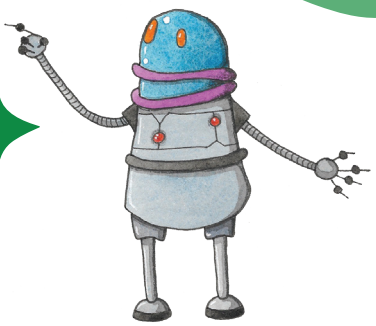
b) _____

c) _____

Activity 10b – Melting ice

A teacher asked his class to investigate this question:
'How does the mass of an ice cube change over time?'

The children were asked to describe the investigation. Below are some of the things they said. How clearly has each child described the investigation?



Joshua *We are trying to find which ice cube melts the fastest.*

Amir *We have to put an ice cube in the classroom and see what happens to the mass.*

Oliver *We are putting an ice cube in the class and measuring its mass every 10 minutes.*

Ria *We are measuring the mass of an ice cube every 10 minutes until it has melted to see how it changes.*

1. Order the descriptions from best to worst by writing the children's names in the boxes below:

Best.....Worst

2. Write down two ways in which the best description is better than the worst description:

a) _____

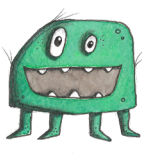
b) _____

Answers: Activity Sheet 1a – Absorbency of soils

Pupil	Comment	Order
Diya	Does not mention using different soils and does not mention measuring how much water is absorbed.	5
Arjun	Mentions using different soils and implies there will be several. Mentions amount of water being absorbed and implies measuring this.	2
Katie	The wrong investigation is described. This investigation is about how much water is absorbed by soils, rather than whether or not soils absorb water.	4
Riley	Does not describe the investigation.	Worst – 6
Archie	Mentions soils and implies there will be different ones tested. Does not mention amount of water explicitly. 'Best at absorbing' implies that only one extreme result will be sought and others ignored.	3
Jacob	Mentions using different soils and implies there will be several. Mentions amount of water absorbed and states how this will be measured.	Best – 1

Answers: Activity Sheet 1b – Absorbency of soils

Pupil	Comment	Order
Diya	Does not mention using different soils and does not mention measuring how much water is absorbed.	5
Arjun	Mentions using different soils and implies there will be several. Mentions amount of water being absorbed and implies measuring this.	2
Riley	Does not describe the investigation.	Worst – 6
Jacob	Mentions using different soils and implies there will be several. Mentions amount of water absorbed and states how this will be measured.	Best – 1

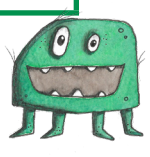


Answers: Activity Sheet 2a – Muffling sounds

Pupil	Comment	Order
Priti	Mentions using different materials and implies several will be tested. Mentions measuring the distance from the sound source each time.	Best – 1
Dembe	Mentions using different materials and implies more than one will be tested. Mentions measuring the distance from sound source but implies the sound source might change.	2
Hope	Does not describe the investigation. Does not mention using different materials. Does not mention measuring the distance from the sound source. Does not mention that the volume of sound heard will be measured.	Worst – 6
Jack	Mentions using material but implies that only one will be tested. Does not mention measuring the distance from the sound source but implies measuring the volume of sound heard.	3
Ethan	Mentions materials and implies that several will be tested. Does not mention how the volume of sound will be measured.	5
Maya	Mentions materials and implies that several will be tested. Does not mention measuring the distance from the sound source. Does not imply volume of sound heard will be measured.	4

Answers: Activity Sheet 2b – Muffling sounds

Pupil	Comment	Order
Priti	Mentions using different materials and implies that several will be tested. Mentions measuring the distance from the sound source each time.	Best – 1
Dembe	Mentions using different materials and implies that more than one will be tested. Mentions measuring the distance from sound source but implies that the sound source might change.	2
Hope	Does not describe the investigation. Does not mention using different materials. Does not mention measuring the distance from the sound source. Does not mention that the volume of sound heard will be measured.	Worst – 4
Ethan	Mentions materials and implies that several will be tested. Does not mention how the volume of sound heard will be measured.	3

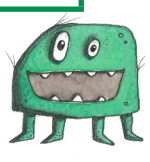


Answers: Activity Sheet 3a – Dissolving sugar

Pupil	Comment	Order
Andeep	Not a description of the investigation.	Worst – 6
Kirsty	Mentions temperature and implies that several different temperatures will be tested. Mentions measuring time (how long). Suggests that the pattern will be considered but not said explicitly.	Best – 1
Prisha	The wrong investigation described. This investigation is about how temperature affects the time taken for sugar to dissolve, not whether or not it dissolves.	5
Lawrence	Mentions temperature but suggests that only two temperatures will be tested (hot and cold). Mentions measuring time (how long). Does not say that the pattern will be considered.	2
Ali	Mentions temperature and implies that several different temperatures will be tested. Does not mention time explicitly. 'Best temperature' implies that only one extreme result will be sought, not the general pattern.	3
Louise	Mentions temperature and implies that several different temperatures will be tested. Does not mention time or general pattern.	4

Answers: Activity Sheet 3b – Dissolving sugar

Pupil	Comment	Order
Kirsti	Mentions temperature and implies that several different temperatures will be tested. Mentions measuring time (how long). Suggests that the pattern will be considered but not said explicitly.	Best – 1
Prisha	The wrong investigation described. This investigation is about how temperature affects the time taken for sugar to dissolve, not whether it dissolves.	Worst – 4
Ali	Mentions temperature and implies that several different temperatures will be tested. Does not mention time explicitly. 'Best temperature' implies that only one extreme result will be sought, not the general pattern.	2
Louise	Mentions temperature and implies that several different temperatures will be tested. Does not mention time or general pattern.	3

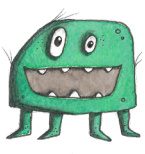


Answers: Activity Sheet 4a – Wriggly worms

Pupil	Comment	Order
Amir	Does not describe the investigation. Mentions searching for worms in the ground but implies that only one area will be used. Does not mention identifying species.	4
Jo	Mentions searching for worms in several different areas. Mentions observing adult worms carefully and identifying using a key.	Best – 1
Alex	Does not describe the investigation.	Worst – 5
Mo	Mentions identifying adult worms but does not mention from where worms will be obtained and how they will be identified.	3
Erik	Mentions observing adult worms and identifying using a key. Does not mention from where these worms will be obtained.	2

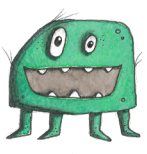
Answers: Activity Sheet 4b – Wriggly worms

Pupil	Comment	Order
Jo	Mentions searching for worms in several different areas. Mentions observing adult worms carefully and identifying using a key.	Best – 1
Alex	Does not describe the investigation.	Worst – 3
Erik	Mentions observing adult worms and identifying using a key. Does not mention from where these worms will be obtained.	2



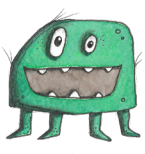
Answers: Activity Sheet 5a – Seed dispersal

Pupil	Comment	Order
Kwame	Mentions measuring sycamore seeds but does not specify what will be measured. Implies that several seeds will be measured. Does not mention measuring distance from tree. Does not mention looking for a relationship or pattern.	Worst – 6
Marshall	Mentions collecting sycamore seeds and mentions measuring them but does not specify what aspect will be measured. Mentions selecting seeds found at different distances from the parent tree and implies that several different distances will be measured. Does not mention looking for a relationship or pattern.	2
Chloe	Mentions sycamore seeds and implies that they will be measured but does not specify what aspect will be measured. Implies measuring the distance that seeds are found from the tree and that several distances will be measured. Does not mention looking for a relationship or pattern.	3
Tarun	Mentions measuring the length of sycamore seeds and states that 20 at each distance will be measured. Mentions testing different distances from the parent tree and states that five distances will be tested. Mentions looking for a general pattern.	Best – 1
Zena	Mentions finding one sycamore seed and does not mention measuring its length. 'The furthest' suggests that only one extreme result will be sought and no other distances from the tree considered. Does not mention looking for a relationship or pattern.	4
Jamila	Does not describe the investigation. The investigation is about how the length of a sycamore seed affects how far away from the parent tree it flies, not solely how long sycamore seeds grow. Does not mention looking for a relationship or pattern.	5



Answers: Activity Sheet 5b – Seed dispersal

Pupil	Comment	Order
Kwame	Mentions measuring sycamore seeds but does not specify what will be measured. Implies that several seeds will be measured. Does not mention measuring distance from tree. Does not mention looking for a relationship or pattern.	5
Marshall	Mentions collecting sycamore seeds and mentions measuring them but does not specify what aspect will be measured. Mentions selecting seeds found at different distances from the parent tree and implies that several different distances will be measured. Does not mention looking for a relationship or pattern.	2
Chloe	Mentions sycamore seeds and implies that they will be measured but does not specify what aspect will be measured. Implies measuring the distance seeds are found from the tree and that several distances will be measured. Does not mention looking for a relationship or pattern.	Worst – 6
Tarun	Mentions measuring the length of sycamore seeds and states that 20 at each distance will be measured. Mentions testing different distances from the parent tree and states that five distances will be tested. Mentions looking for a general pattern.	Best – 1

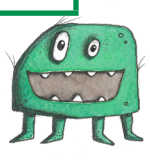


Answers: Activity Sheet 6a – Drying puddles

Pupil	Comment	Order
Munashe	Does not describe the investigation. Does not mention observing how a puddle changes over time.	Worst – 6
Viktor	Mentions observing how a puddle changes and how this will be done (by drawing round it) but does not mention how often this will be done, nor over what timeframe.	3
Evie	Does not describe the investigation. Mentions observing puddles over time and comparing how long puddles last but does not mention observing one puddle to see how it changes.	5
Samuel	Mentions observing a puddle every 30 minutes and drawing around it each time to see how the size changes. Does not mention over what timeframe this will happen.	2
Kamilla	Mentions observing a puddle every 30 minutes and drawing around it each time to see how the size and shape changes. Clearly describes the timeframe over which this will happen.	Best – 1
Francie	Mentions observing a puddle over time to see how the size changes. Does not mention how often the puddle will be observed nor over what time frame.	4

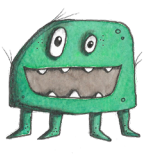
Answers: Activity Sheet 6b – Drying puddles

Pupil	Comment	Order
Munashe	Does not describe the investigation. Does not mention observing how a puddle changes over time.	Worst – 4
Samuel	Mentions observing a puddle every 30 minutes and drawing around it each time to see how the size changes. Does not mention over what timeframe this will happen.	2
Kamilla	Mentions observing a puddle every 30 minutes and drawing around it each time to see how the size and shape changes. Clearly describes the timeframe over which this will happen.	Best – 1
Francie	Mentions observing a puddle over time to see how the size changes. Does not mention how often the puddle will be observed nor over what timeframe.	3



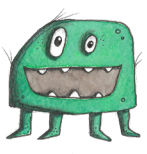
Answers: Activity Sheet 7a – Gestation periods

Pupil	Comment	Order
Corina	Does not describe the investigation. The investigation is about gestation periods, not the resulting baby animals.	Worst – 6
Tasha	Mentions investigating the size and gestation period for an animal but implies that only one will be researched. Does not mention looking for a relationship or pattern.	4
Jaylin	Mentions finding the average weight and gestation period for animals and implies that several will be researched. Mentions looking for a relationship or pattern.	Best – 1
Darrell	Mentions researching the gestation period for animals and implies that several will be researched. Does not mention researching the size of these animals. Does not mention looking for a general pattern.	5
Iman	Mentions investigating the gestation period of different-sized animals, implying that several animals will be researched. Does not mention finding out the average weight of these animals. Mentions looking for a general pattern.	2
Selena	Mentions investigating the size and gestation period for animals but implies that only two extreme animals at either end of the size range will be researched. Does not mention looking for a relationship or pattern.	3



Answers: Activity Sheet 7b – Gestation periods

Pupil	Comment	Order
Corina	Does not describe the investigation. The investigation is about gestation periods, not the resulting baby animals.	Worst – 4
Jaylin	Mentions finding the average weight and gestation period for animals and implies that several will be researched. Mentions looking for a relationship or pattern.	Best – 1
Darrell	Mentions researching the gestation period for animals and implies that several will be researched. Does not mention researching the size of these animals. Does not mention looking for a general pattern.	3
Selena	Mentions investigating the size and gestation period for animals but implies that only two extreme animals at either end of the size range will be researched. Does not mention looking for a relationship or pattern.	2

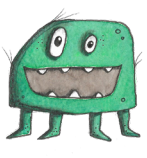


Answers: Activity Sheet 8a – Breakfast boost

Pupil	Comment	Order
Finley	Wrong investigation described. Mentions finding out what everyone had for breakfast but then states that they will measure how fast children can run and not how far. Does not mention looking for a general pattern.	4
Irena	Mentions finding out what each pupil had for breakfast. Does not explicitly state how they will measure children's energy levels. Implies looking for a pattern.	3
Davis	Mentions looking at how far each pupil can run but does not explicitly say that this will be measured. Mentions looking for a link to what was eaten for breakfast.	2
Rhian	Does not describe the investigation. The investigation is to look for a link between how far someone runs and what they had for breakfast, not to find out who is the best runner.	Worst – 5
Aaron	Mentions finding out what each pupil had for breakfast. Mentions measuring the distance run by each pupil. Mentions looking for a link between the two sets of data.	Best – 1

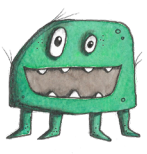
Answers: Activity Sheet 8b – Breakfast boost

Pupil	Comment	Order
Davis	Mentions looking at how far each pupil can run but does not explicitly say that this will be measured. Mentions looking for a link to what was eaten for breakfast.	2
Rhian	Does not describe the investigation. The investigation is to look for a link between how far someone runs and what they had for breakfast, not to find out who is the best runner.	Worst – 3
Aaron	Mentions finding out what each pupil had for breakfast. Mentions measuring the distance run by each pupil. Mentions looking for a link between the two sets of data.	Best – 1



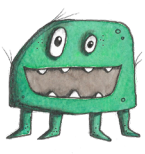
Answers: Activity Sheet 9a – Orbiting planets

Pupil	Comment	Order
Corey	Does not describe the investigation. The investigation is about the circumference of planets and the time it takes them to orbit – not a planet in general.	Worst – 6
Toni	Mentions investigating the size and orbital period for a planet but implies that only one will be researched. Does not mention circumference, just size in general. Does not mention looking for a relationship or pattern.	4
Jay	Mentions finding the circumference and orbital period for planets and implies that all in our solar system will be researched. Mentions looking for a relationship or pattern.	Best – 1
Dion	Mentions researching the circumference of planets and implies that several will be researched. Does not mention researching the orbital periods. Does not mention looking for a general pattern.	5
Nina	Mentions investigating the orbital periods of different planets implying that several will be researched. Does not mention finding the circumference of these planets. Mentions looking for a general pattern.	3
Sam	Mentions investigating the circumference and orbital period of planets but implies that only two extreme planets at either end of the size range will be researched. Mentions looking for a relationship or pattern.	2



Answers: Activity Sheet 9b – Orbiting planets

Pupil	Comment	Order
Corey	Does not describe the investigation. The investigation is about the circumference of planets and the time it takes them to orbit – not a planet in general.	5
Jay	Mentions finding the circumference and orbital period for planets and implies that all in our solar system will be researched. Mentions looking for a relationship or pattern.	2
Dion	Mentions researching the circumference of planets and implies that several will be researched. Does not mention researching the orbital periods. Does not mention looking for a general pattern.	Worst – 6
Sam	Mentions investigating the circumference and orbital period of planets but implies that only two extreme planets at either end of the size range will be researched. Mentions looking for a relationship or pattern.	Best – 1

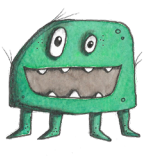


Answers: Activity Sheet 10a – Melting ice

Pupil	Comment	Order
Joshua	Does not describe the investigation. Does not mention measuring the mass. Implies that they will time how long several ice cubes take to melt.	Worst – 6
Amir	Implies measuring the mass of an ice cube. Does not mention how often this will happen or how long for.	3
Charlie	Mentions measuring the ice cube over time. Does not mention measuring the mass – simply states size, which could be mass, height, circumference, etc. Does not mention how often they will take measurements or how long for.	4
Maya	Not a description of the investigation. Mentions observing one ice cube over time but mentions measuring time taken to melt rather than mass over time.	5
Oliver	Mentions measuring the ice cube every ten minutes but not how long this will be done for. Mentions measuring the mass.	2
Ria	Mentions measuring the mass. Mentions how often this will happen and how long for.	Best – 1

Answers: Activity Sheet 10b – Melting ice

Pupil	Comment	Order
Joshua	Does not describe the investigation. Does not mention measuring the mass. Implies that they will time how long several ice cubes take to melt.	Worst – 4
Amir	Implies measuring the mass of an ice cube. Does not mention how often this will happen or how long for.	3
Oliver	Mentions measuring the ice cube every ten minutes but not how long this will be done for. Mentions measuring the mass.	2
Ria	Mentions measuring the mass. Mentions how often this will happen and how long for.	Best – 1



Module 3 – Improving Predictions

Learning Objective:

To improve predictions by connecting them to everyday experiences and, where possible, scientific knowledge.

Background information:

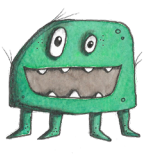
When making predictions, children should give a reason for their prediction based on their scientific knowledge; where that is not possible, reasons should be based on past experiences and careful observations. However, often the predictions that children make seem little more than a guess and they need help to develop their suggestions further and verbalise their thinking.

This module describes strategies to help children improve their predictions.

Activity 1 offers them the opportunity to think about what makes a good scientific prediction by evaluating some given by others.

And **Activity 2** helps children to think about what they already know about an area of science to enable them to add a 'because' to their 'I think…'.

It is important to note that predictions cannot be wrong – predictions are not about getting the 'right answer'. Unexpected outcomes just mean that the investigation brought to light something that may not have been thought about before.



Activity 1 – Improving Predictions: What makes a good scientific prediction?

What to do

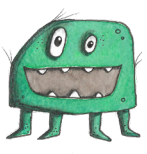
- Choose the activity sheet that you would like your children to use.
- Give the activity sheet to children in small groups.
- Make sure that they understand the context; have the equipment available for the class and quickly demonstrate any testing to be done if appropriate.
- Discuss the first two predictions offered on the chosen activity sheet, asking children to identify good and bad points in each. The following questions should be used to guide their thoughts:
  'Have they said what they think will happen?
  'Is a reason given based on things that they have experienced or scientific knowledge?'
  'Have they described what will happen across all their results and not just one extreme result?'
  'Do they use scientific vocabulary?'

  Emphasise that they are not being asked to agree or disagree with the predictions and they are to focus on the questions above only, not the underlying science.
- Ask them to complete the rest of the table in their groups, discussing each of the remaining examples using the questions to guide them, and then compiling good bits to create a 'best possible' prediction*.
- Review responses as a class.

**Best possible predictions do not have to be scientifically correct, but do have to be based on everyday experience or scientific knowledge. Where possible, children should use the correct scientific vocabulary. Where appropriate, children should describe an overall pattern across all results rather than talking about what they think will happen in one specific instance. Examples of best possible predictions can be found below:*

"I think the more viscous a liquid is, the slower it will run down the ramp as I know viscous liquids such as honey move more slowly than thinner liquids such as water when you pour them out of jars and bottles."

"I think the flat-bottomed boat will hold the most marbles before sinking because the bigger the surface area in contact with the water, the more upthrust there is to push back up and stop the boat sinking."



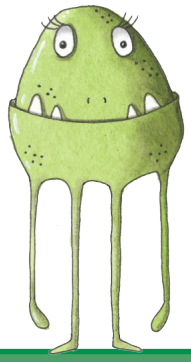
Activity 1a – Watering plants

How does the amount of water a plant is given affect its growth?

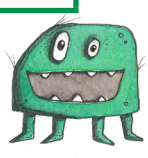
Some children are going to investigate how much water pea plants need to grow well. They are going to give each pea plant a different amount of water and measure the difference in height after a week. Each day, one plant will be given no water, one 100 mls of water, one 200 mls of water, one 300 mls of water, one 400 mls of water and one 500 mls of water.

They make predictions about what they think might happen. Look at what each child says and complete the table.

Work together to complete the table below. Think carefully about what makes a good prediction



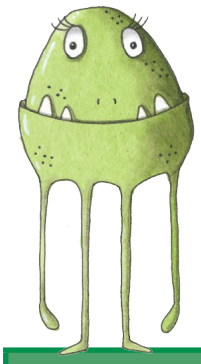
What children predicted	Good points and bad points
I think the plant with no water will die because plants need water to live.	
I think the plant with the most water will grow the most as every part – stem, leaves and flowers – needs water to function.	
I think that the more water we give the plants the better they will grow up to 300 ml, but after that they won't do so well because plants need water to grow, but if they have too much and they have to stand in water their roots go all mushy because my mum's did.	
Plants need water to grow.	
I think both the plants with water will grow the same amount because they will use what they need, and the rest of the water will evaporate and dry out.	
All the plants will grow.	
What would your best possible prediction look like?	



Activity 1b – High energy

Are foods that are high in energy always high in sugar?

Some children are going to investigate high energy foods to see if they also contain a lot of sugar. They will compare the nutritional information per 100 g of ten high energy foods.



Work together to complete the table below. Think carefully about what makes a good prediction

They make predictions about what information they might find out. Look at what each child says and complete the table.

What children predicted	Good points and bad points
I think that high energy foods will also be high in sugar, and they will make your teeth fall out.	
I don't think all high energy foods will also be high in sugar because my mum is diabetic, and she has high energy sugar-free food.	
I think all sugar is bad for you.	
I don't think all high energy foods will also be high in sugar because nuts give you lots of energy and they don't have sugar in them.	
You can use sweeteners instead of sugar.	
I think all high sugar foods will be high energy but not the other way round because starch and fat give you energy too.	
What would your best possible prediction look like?	

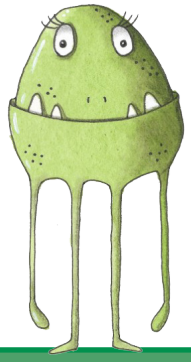
Activity 1c – Different liquids

How does the type of liquid affect the time it takes to run down the slope?

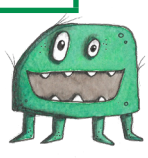
Some children are going to investigate the time it takes different liquids to run down a slope. They will put a drop of each liquid onto a tilted ramp and time how long it takes each liquid to run to the bottom of the slope. They will test honey, washing up liquid, cooking oil and water.

They make predictions about what they think might happen. Look at what each child says and complete the table.

Work together to complete the table below. Think carefully about what makes a good prediction



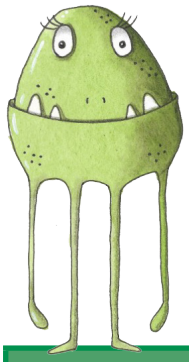
What children predicted	Good points and bad points
I think the runniest liquid will be the best.	
I think the thinner the liquid the less time it will take to run down the ramp because thin liquids flow faster.	
I think the honey will not run because it is too sticky.	
I think the thicker liquids are heavier and heavier things get faster as they roll down slopes, so I think the thicker the liquid is, the faster it will run down the ramp.	
I think the more viscous a liquid is, the longer it will take to run down the ramp.	
I think water will be the first down and it will take 20 seconds to run down the slope.	
What would your best possible prediction look like?	



Activity 1d – Minibeast hunt

How does the variety of minibeasts in our school grounds change over the year?

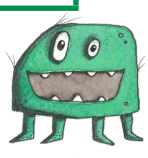
Some children are going to investigate the different minibeasts that can be found in their school grounds at different times of the year. They will hunt for minibeasts in the school grounds in autumn, winter, summer and spring.



Work together to complete the table below. Think carefully about what makes a good prediction

They make predictions about what they think might happen. Look at what each child says and complete the table.

What children predicted	Good points and bad points
I think there will be more minibeasts in summer as there are more flowers out and lots of minibeasts get their food from the nectar in flowers.	
I think there will be fewer types of minibeast in winter as some die when it gets cold.	
I think as the temperature rises, more types of minibeast will be found because new insects like butterflies will hatch out which are easier to spot.	
I think the colder it is, the fewer types of minibeasts we will see as they have to find shelter.	
I think the amount of different minibeasts will stay the same. There is no reason for it to change at different times of the year.	
I never see butterflies or bees in winter. I think they hibernate.	
What would your best possible prediction look like?	



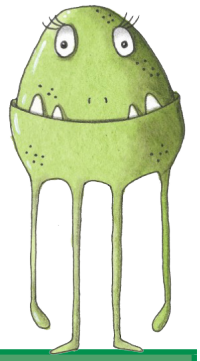
Activity 1e – Levers

How does the position of the fulcrum affect how much effort it takes to lift a load?

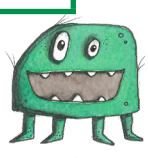
Some children are going to investigate how easy it is to lift a load using levers. They will use a piece of wood as a lever and try to lift a 1 kg weight, moving the fulcrum to different positions each time. They will put the fulcrum at 5 cm, 10 cm, 15 cm, 20 cm and 25 cm from the load.

They make predictions about what they think might happen. Look at what each child says and complete the table.

Work together to complete the table below. Think carefully about what makes a good prediction



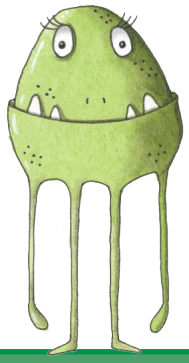
What children predicted	Good points and bad points
I think the heavy load will snap the lever.	
I think the lever with a fulcrum in the middle will lift it the easiest because that is where the fulcrum is on a seesaw and I can make my dad go up on a seesaw.	
I think the fulcrum near the load will take the least effort.	
I think the closer the fulcrum is to the load, the less effort it will take because the lever is longer and higher to push down on so it will be easier. My mum uses a long spoon to open paint tins.	
I think the further the fulcrum is from the load, the easier it will be to lift the load as the distance between the end you push and the fulcrum is smaller so it will take less effort.	
I think it will be harder to lift the load the further the fulcrum is from the load.	
What would your best possible prediction look like?	



Activity 1f – Boat shapes

How does the shape of a boat affect how many marbles it can hold?

Some children are going to investigate how a boat's shape affects the load it can carry. They will use a piece of plasticine, create a boat and see how many marbles they can add to it before it sinks, and then they will reshape the plasticine and repeat with another shape.

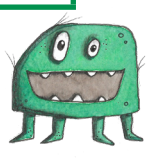


Work together to complete the table below. Think carefully about what makes a good prediction

They will make a canoe-shaped boat with a v-shaped hull and tall sides and a wide, rectangular, flat-bottomed boat.

They make predictions about what they think might happen. Look at what each child says and complete the table.

What children predicted	Good points and bad points
I think the flat-bottomed boat will win.	
I think the canoe-shaped boat will hold more marbles as the tall sides will stop the water from getting in and sinking it.	
The bigger the surface area touching the water, the more marbles the boat will be able to carry as there will be more water pushing back against it so the flat-bottom boat will carry more marbles.	
I think water will go over the sides of the flat-bottomed boat when the marbles are put in and it sits lower in the water.	
The small bottom of the canoe will mean there is not as much upthrust so it won't hold as many marbles.	
The flat-bottomed boat looks bigger.	
What would your best possible prediction look like?	



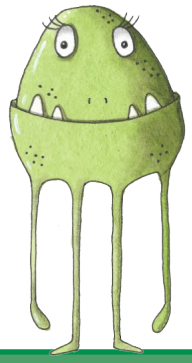
Activity 1g – Reflective materials

Which material is the most reflective?

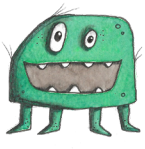
Some children are going to investigate reflective materials. They will shine a torch onto the material and see how much 'bounces' or is reflected onto the paper. They will test a range of materials of different colours and textures.

They make predictions about what they think might happen. Look at what each child says and complete the table.

Work together to complete the table below. Think carefully about what makes a good prediction



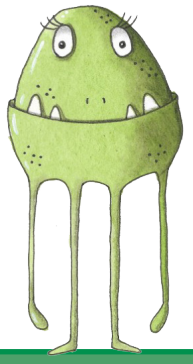
What children predicted	Good points and bad points
I think smooth materials will reflect the most light as the light will all bounce back at the same angle and won't be scattered in all directions.	
I think shiny surfaces will be the best.	
I think rough surfaces will make the light reflect at different angles but they will still reflect as much light as smooth surfaces.	
I think dark materials will absorb the light and not reflect it.	
I think silvery and shiny materials will reflect lots of light because mirrors are silvery and shiny.	
I think the smoother the material, the more light will be reflected.	
What would your best possible prediction look like?	



Activity 1h – Shadows

How does my shadow change over a day?

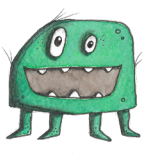
Some children are going to investigate their shadows. They will stand in the same spot at different times of the day and get a partner to draw around their shadow with chalk. They will do this at 10am, 11am, 12pm, 1pm and 2pm.



Work together to complete the table below. Think carefully about what makes a good prediction

They make predictions about what they think might happen. They think about how the shadow might change in length and direction. Look at what each child says and complete the table.

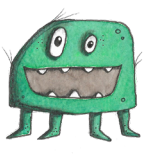
What children predicted	Good points and bad points
I think my shadow will stay the same size and shape because I will be the same size and shape.	
I think the shadow will move around me because the sun is in different places in the sky at different times of the day.	
I think the shadow will get darker.	
I think the shadow will get smaller when it is 12pm as the sun is high in the sky and less light is blocked by my body.	
The longest shadow will be at 9am.	
I think when the sun is lower in the sky the shadows will be longer as my body will block more light.	
What would your best possible prediction look like?	



Answers: Activity Sheet 1a

Watering plants

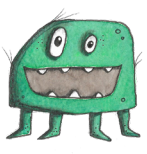
What children predicted	Good points and bad points
I think the plant with no water will die because plants need water to live.	Gives a reason for prediction based on scientific knowledge and understanding. Does not mention the other two plants.
I think the plant with the most water will grow the most as every part – stem, leaves and flowers – needs water to function.	Gives a reason for prediction based on scientific knowledge. Only mentions one extreme result.
I think that the more water we give the plants the better they will grow up to 300 ml but after that they won't do so well because plants need water to grow, but if they have too much and they have to stand in water their roots go all mushy because my mum's did.	Gives a reason for prediction based on some scientific knowledge and some everyday experience. Gives a general pattern until they think there will be too much water.
Plants need water to grow.	This does not say what they think will happen to plant growth.
I think both the plants with water will grow the same amount because they will use what they need, and the rest of the water will evaporate and dry out.	Gives a reason for prediction based on scientific knowledge and understanding. Does not say if the plants with water will grow more or less than the one without water.
All the plants will grow.	This does not say if there will be any differences in the plant growth or whether they think that they will all grow by the same amount. Does not give a reason for prediction.
What would your best possible prediction look like? See Teacher's Notes on page 49 for some examples.	



Answers: Activity Sheet 1b

High energy

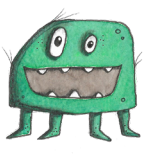
What children predicted	Good points and bad points
I think that high energy foods will also be high in sugar and they will make your teeth fall out.	Does not give a reason for the prediction. Unnecessary science knowledge.
I don't think all high energy foods will also be high in sugar because my mum is diabetic, and she has high energy sugar-free food.	Gives a reason based on everyday experience.
I think all sugar is bad for you.	This does not say what they think they will find out about sugar and calories.
I don't think all high energy foods will also be high in sugar because nuts give you lots of energy and they don't have sugar in them.	Gives a reason based on scientific knowledge and understanding.
You can use sweeteners instead of sugar.	This does not say what they think they will find out about sugar and calories.
I think all high sugar foods will be high energy but not the other way round because starch and fat give you energy too.	Gives a reason based on scientific knowledge and understanding.
What would your best possible prediction look like? See Teacher's Notes on page 49 for some examples.	



Answers: Activity Sheet 1c

Different liquids

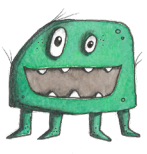
What children predicted	Good points and bad points
I think the runniest liquid will be the best.	Best is not clear – does this mean it will take the most or least time? No reason given for prediction.
I think the thinner the liquid the less time it will take to run down the ramp because thin liquids flow faster.	Gives a reason for prediction based on everyday observations. Implies that a general pattern will be found.
I think the honey will not run because it is too sticky.	Gives a reason based on everyday experience. Only mentions what will happen with honey.
I think the thicker liquids are heavier and heavier things get faster as they roll down slopes, so I think the thicker the liquid is, the faster it will run down the ramp.	Gives a reason for prediction based on everyday observations. Implies that a general pattern will be found. (This prediction is not scientifically correct but is still a good prediction.)
I think the more viscous a liquid is, the longer it will take to run down the ramp.	Uses 'viscous' correctly. Predicts a general pattern. No reason given for prediction.
I think water will be the first down and it will take 20 seconds to run down the slope.	Only mentions what will happen for water. Prediction does not need to include estimations of times. No reason given for prediction.
What would your best possible prediction look like?* See Teacher's Notes on page 49 for some examples. **The scientific reason for this is beyond expectations for Key Stage 2 (ages 7-11). Children should only be expected to give reasons based on everyday observations and experience.*	



Answers: Activity Sheet 1d

Minibeast hunt

What children predicted	Good points and bad points
I think there will be more minibeasts in summer as there are more flowers out and lots of minibeasts get their food from the nectar in flowers.	Reason given for prediction based on scientific knowledge. Does not mention greater variety or minibeasts, instead implies greater number.
I think there will be fewer types of minibeast in winter as some die when it gets cold.	Gives a reason for prediction based on scientific knowledge. Only mentions what will happen in winter.
I think as the temperature rises, more types of minibeast will be found because new insects like butterflies will hatch out which are easier to spot.	Gives a prediction for an overall pattern for all seasons. Gives a reason for prediction based on scientific knowledge.
I think the colder it is, the fewer types of minibeasts we will see as they have to find shelter.	Predicts a general pattern based on some scientific knowledge.
I think the amount of different minibeasts will stay the same. There is no reason for it to change at different times of the year.	Considers the whole year. No reason for prediction given.
I never see butterflies or bees in winter. I think they hibernate.	Implies that there will be fewer different minibeasts found in winter. Prediction is not clear. Only covers what will happen in winter.
What would your best possible prediction look like? See Teacher's Notes on page 49 for some examples.	



Answers: Activity Sheet 1e

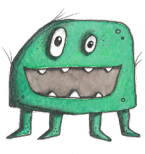
Levers

What children predicted	Good points and bad points
I think the heavy load will snap the lever.	This does not say what they think will happen as the fulcrum position alters.
I think the lever with a fulcrum in the middle will lift it the easiest because that is where the fulcrum is on a seesaw and I can make my dad go up on a seesaw.	Reason given for prediction based on everyday experience. Only mentions what will happen when the fulcrum is placed in the middle of the lever.
I think the fulcrum near the load will take the least effort.	No reason given for prediction.
I think the closer the fulcrum is to the load, the less effort it will take because the lever is longer and higher to push down on so it will be easier. My mum uses a long spoon to open paint tins.	Reason given for prediction based on everyday experience.
I think the further the fulcrum is from the load, the easier it will be to lift the load as the distance between the end you push and the fulcrum is smaller so it will take less effort.	Gives a prediction for an overall pattern regarding the position of the fulcrum. Reason given for prediction based on everyday experience. (This prediction is not scientifically correct but is still a good prediction.)
I think it will be harder to lift the load the further the fulcrum is from the load.	Gives a prediction for an overall pattern regarding the position of the fulcrum. No reason given for prediction.

What would your best possible prediction look like?*

See Teacher's Notes on page 49 for some examples.

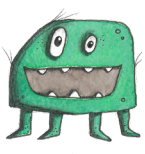
**The scientific reason for this is beyond expectations for Key Stage 2 (ages 7-11). Children should only be expected to give reasons based on everyday observations and experience.*



Answers: Activity Sheet 1f

Boat shapes

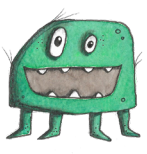
What children predicted	Good points and bad points
I think the flat-bottomed boat will win.	Does not make it explicit what 'winning' means. No reason given for prediction.
I think the canoe-shaped boat will hold more marbles as the tall sides will stop the water from getting in and sinking it.	Gives a reason based on everyday observations.
The bigger the surface area touching the water, the more marbles the boat will be able to carry as there will be more water pushing back against it so the flat-bottom boat will carry more marbles.	Gives a reason based on scientific knowledge and understanding. Predicts a general pattern.
I think water will go over the sides of the flat-bottomed boat when the marbles are put in and it sits lower in the water.	No reason given for prediction although some evidence of everyday experience influencing the prediction.
The small bottom of the canoe will mean there is not as much upthrust so it won't hold as many marbles.	Gives a reason based on scientific knowledge and understanding. Uses 'upthrust' correctly.
The flat-bottomed boat looks bigger.	This does not say what they think will happen to the amount of marbles it will hold before sinking and does not mention the canoe-shaped boat.
What would your best possible prediction look like? See Teacher's Notes on page 49 for some examples.	



Answers: Activity Sheet 1g

Reflective materials

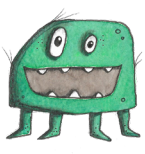
What children predicted	Good points and bad points
I think smooth materials will reflect the most light as the light will all bounce back at the same angle and won't be scattered in all directions.	Gives reason for prediction based on scientific knowledge and understanding. Only mentions what will happen with smooth materials but infers other results.
I think shiny surfaces will be the best.	No reason given for prediction. Does not make explicit what 'best' means.
I think rough surfaces will make the light reflect at different angles but they will still reflect as much light as smooth surfaces.	Gives reason for prediction based on scientific knowledge and understanding.
I think dark materials will absorb the light and not reflect it.	Implies a reason for prediction based on scientific knowledge. Only mentions what will happen to dark materials.
I think silvery and shiny materials will reflect lots of light because mirrors are silvery and shiny.	Gives reason for prediction based on everyday experience.
I think the smoother the material, the more light will be reflected.	Prediction describes a general pattern. No reason given for prediction.
What would your best possible prediction look like? See Teacher's Notes on page 49 for some examples.	



Answers: Activity Sheet 1h

Shadows

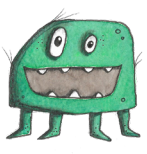
What children predicted	Good points and bad points
I think my shadow will stay the same size and shape because I will be the same size and shape.	Gives reason for prediction based on everyday experience.
I think the shadow will move around me because the sun is in different places in the sky at different times of the day.	Gives reason for prediction based on scientific knowledge and understanding.
I think the shadow will get darker.	No reason given for prediction.
I think the shadow will get smaller when it is 12pm as the sun is high in the sky and less light is blocked by my body.	Gives reason for prediction based on scientific knowledge and understanding. Only mentions what will happen to the shadow at 12pm.
The longest shadow will be at 9am.	No reason given for prediction.
I think when the sun is lower in the sky the shadows will be longer as my body will block more light.	Gives reason for prediction based on scientific knowledge and understanding. Implies what will happen when the sun is high in the sky.
What would your best possible prediction look like? See Teacher's Notes on page 49 for some examples.	



Activity 2 – Improving Predictions: What do we already know?

What to do

- When planning an enquiry, have the equipment available to show the class.
- Allow children a short while to explore any items to be tested; for example, before making a prediction about which material is best at reflecting light, children can investigate the different materials together with hand lenses and torches. For investigations involving observations over time, it may be best to ask children to make a prediction after the first few observations or measurements have been recorded.
- In small groups, ask children to write down three or four things that they already know about the scientific concept they will be investigating, for example, reflection.
- Each group should then swap lists with at least two other groups and underline any statements they agree with.
- Collect and discuss any statements that have been underlined at least twice.
- Collate on a class list.
- Encourage children to refer to the list when giving a reason for their prediction.



Module 4 – Setting Up a Fair or Comparative Test: The sticky label approach

Learning Objective:

To identify variables involved in a fair test.

Background information:

Comparative and fair testing help children to explore relationships between variables.

In comparative tests, the independent variable or 'what we change' will be discrete, described in words, e.g. 'How does the type of string affect how far a balloon rocket travels?'.

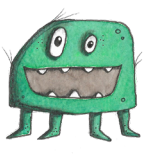
In fair tests, the independent variable or 'what we change' will be continuous and described in numbers, e.g. 'How does the height of the puppet affect the height of the shadow produced?'.

It should be mentioned that **all** initial general questions and subsequent responses can lead to both fair and comparative investigations.

When planning both types of enquiry, children need to identify the independent variable (*what we change*), dependent variable (*what we measure or observe*) and the control variables (*what we keep the same*). This is something that they can struggle with, so it is important that we teach them how to go about it. The sticky label approach is one way of doing this.

So that teachers can familiarise themselves with the approach, four worked examples follow. The approach can be easily applied to any fair or comparative test, in any topic.

Initially, this approach should be teacher-led, with the whole class using one large set of resource sheets together. However, once children are more familiar with the method, some children should be able to set up their own fair or comparative test in small groups, see page 84.



Strategy – The sticky label approach

Shadow Puppet: Fair Test example

What to do

- Show the children a card figure casting a shadow on a wall.
- Put children into small groups and ask them to consider ideas in response to the general question *'What might affect the height of the shadow produced by a shadow puppet?'*
- Take in responses from the groups, record on sticky labels and stick them onto the board*, for example:

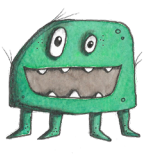
Distance between puppet and light source

Distance between puppet and wall

Height of puppet

- Tell children that these are all things we could change in an investigation.
- Discuss how they would measure the effect of changing one of these; in this case, it would be to measure the height of the shadow produced, which would be measured in millimetres or centimetres.
- Write this on another sticky label of a **different colour**, to indicate that this is different from those above.

Height of shadow produced (mm/cm)



- Take one example from the *'What might affect the height of the shadow produced by a shadow puppet'* sticky labels, e.g. the height of the puppet, and show children how to set up a fair test by moving the sticky labels onto the Planning Sheet as follows:

We will change:

Height of puppet

We will measure or observe the effect on:

Height of shadow produced (mm/cm)

We will keep these things the same:

Distance between puppet and light source

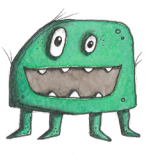
Distance between puppet and wall

- Look at the *'We will keep these things the same'* sticky notes. Ask children, *'Why do we have to keep these things the same?'.* Ensure that children realise that as they have suggested each of these variables might affect the height of the shadow puppet, in a fair test only ***one*** of them can be changed – if more than one variable was changed, it wouldn't be clear which one was affecting the results.

- Ask children: *'If we change the height of the puppet and measure the height of the shadow produced, what will our question be?'*

  Model using the two sticky notes to frame a question to investigate:

How does the Height of puppet affect the Height of shadow produced (mm/cm) ?

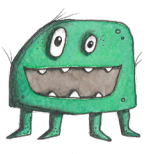


- Practise setting up other fair tests and phrasing questions to investigate, changing something other than the height of the puppet: for example, distance between the puppet and the light source.

- Repeat this until you feel that the class knows the procedure.

- Review the main points, including:
  - When setting up a fair test, you need to identify what you are changing, what you are measuring and what you are keeping the same.
  - You only change one variable at a time.
  - All other things that might make a difference should stay the same.
  - Your question to investigate should include what you are changing and what you are measuring.

You may need to be prepared for children to suggest variables that **you know will not affect the outcome, e.g. the material puppet is made from, or the light source. Will you let them find out for themselves? If the material that the puppet is made from or light source is changed, the enquiry becomes a comparative test.*

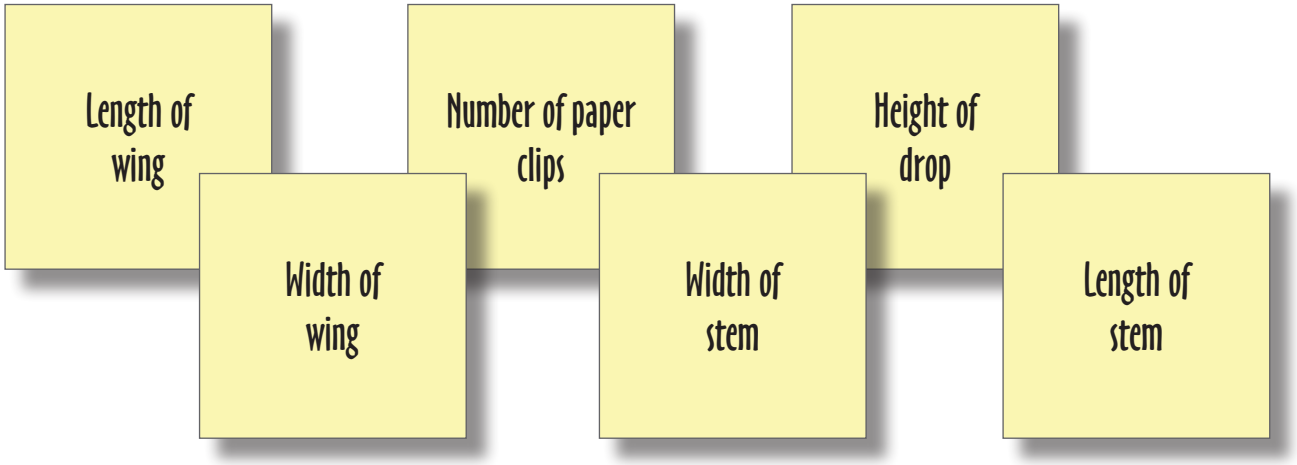


Strategy – The sticky label approach

Paper Spinners: Fair Test example

What to do

- Show the children a paper spinner falling to the ground. Allow them to make one of their own and observe it falling.
- Put children into small groups and ask them to consider ideas in response to the general question 'What might affect the time a paper spinner takes to fall to the ground?'
- Take in responses from the groups, record on sticky-labels and stick them onto the board, for example:



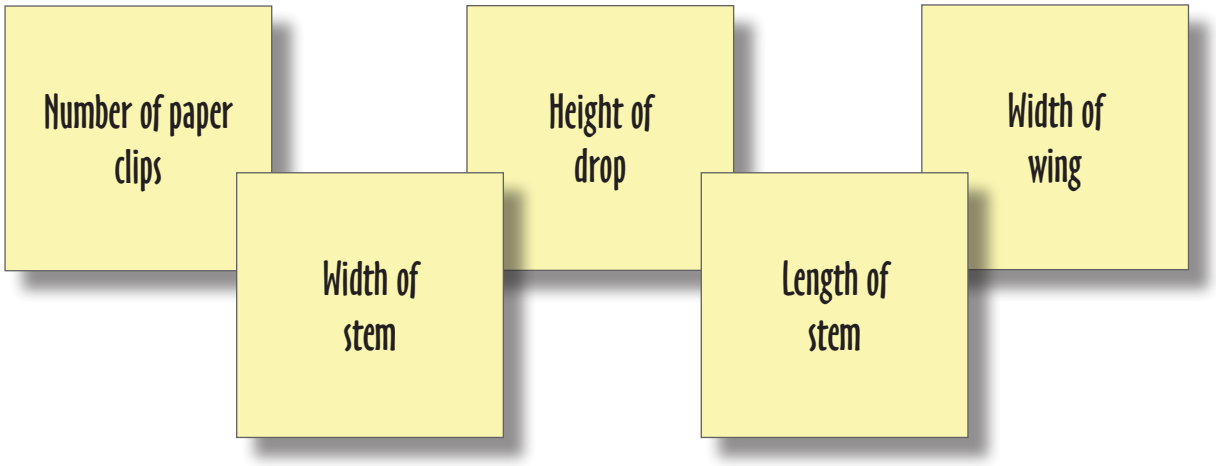
- Tell children that these are all things we could change in an investigation.
- Discuss how they would measure the effect of changing one of these; in this case, it would be the time it takes the paper spinner to fall, which would be measured in seconds.
- Write this on another sticky label of a **different colour**, to indicate that this is different from those above.

- Take one example from the '*What might affect the time it takes a paper spinner to fall?'* sticky labels*, e.g. the length of wing, and show children how to set up a fair test by moving the sticky labels onto the **Planning Sheet** as follows:

We will change:

We will measure or observe the effect on:

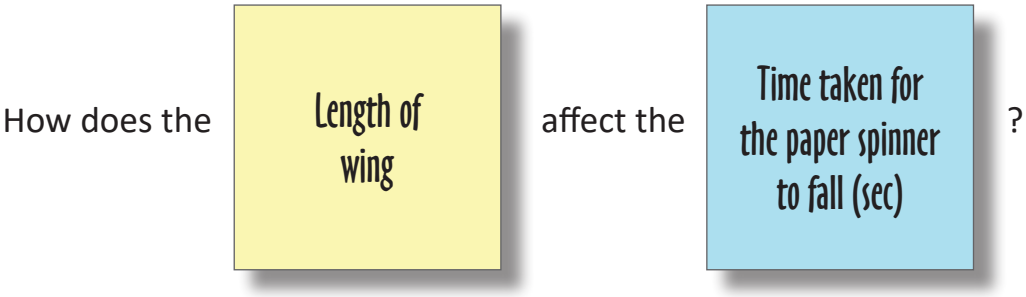
We will keep these things the same:



- Look at the *'We will keep these things the same'* sticky notes. Ask children: *'Why do we have to keep these things the same?'*. Ensure that children realise that, as they have suggested each of these variables might affect the time taken for a paper spinner to fall, in a fair test only ***one*** of them can be changed – if more than one variable was changed, it wouldn't be clear which one was affecting the results.

- Ask children: *'If we change the length of the wing and measure the time it takes for the paper spinner to fall, what will our question be?'*

  Model transferring the two sticky notes to frame a question to investigate:

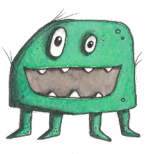


- Practise setting up other fair tests and phrasing questions to investigate, changing something other than the height of the length of wing: for example, height of drop.

- Repeat this until you feel that the class knows the procedure.

- Review the main points, including:
  - When setting up a fair test, you need to identify what you are changing (independent variable), what you are measuring (dependent variable) and what you are keeping the same (control variables).
  - You only change one variable at a time.
  - All other things that might make a difference should stay the same.
  - Your question to investigate should include what you are changing and what you are measuring.

**This would be a good time to discuss which variables would be relatively easy to change in a classroom situation and which would be harder to change, e.g. changing height of drop might be difficult in one-storey schools.*



Strategy – The sticky label approach

Balloon Rocket: Comparative Test example

What to do

- Show the children a balloon rocket travelling along string and a range of different strings.
- Tell the children that, in this investigation, they will be finding out which is the best string for a balloon rocket.
- Discuss how they would measure which is the best string. In this case, it could be the one that allows the balloon rocket to travel the fastest, which would be measured in seconds, or the one that allows the balloon rocket to travel the furthest, which would be measured in centimetres*.
- Write the suggestions on sticky labels.

Time taken to travel one metre (sec)

Distance travelled (cm)

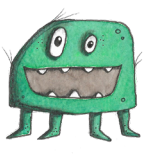
- Put children into small groups and ask them to consider ideas in response to the general question *'Apart from the type of string, what else might affect how well the balloon rocket travels?'*
- Take in responses from the groups and record on sticky labels of a different colour from the ones before. Stick them onto the board, for example:

Material of tube

Amount balloon is inflated

Length of tube

Balloon type



- Tell children that we will need to keep these the same. Ask children, *'Why do we have to keep these things the same?'*. Ensure that children realise that, as they have suggested each of these variables might affect how well the balloon rocket travels, in a comparative test only ***one*** of them can be changed – if more than one variable was changed, it wouldn't be clear which one was affecting the results.

- Show children how to set up a comparative test by moving the sticky labels onto the **Planning Sheet** as follows:

We will change:

Type of string

We will measure or observe the effect on:

Distance travelled (cm)

We will keep these things the same:

Material of tube

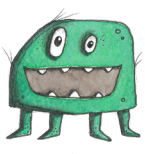
Amount balloon is inflated

Length of tube**

Balloon type

- Model using the two sticky notes to frame a question to investigate:

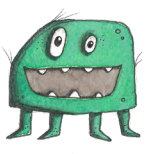
How does the Type of string affect the Distance travelled (cm) ?



- Review the main points, including:
  - When setting up a comparative test, you need to identify what you are changing (independent variable), what you are measuring (dependent variable) and what you are keeping the same (control variables).
  - You only change one variable at a time.
  - All other things that might make a difference should stay the same.
  - Your question to investigate should include what you are changing and what you are measuring.

**This would be a good time to discuss which variables would be relatively easy to measure effectively in a classroom situation and which would be more difficult, e.g. measuring how quickly a balloon rocket travels one metre might be too quick to measure effectively.*

*** If children choose to change this variable, it will be a fair test, not a comparative test.*

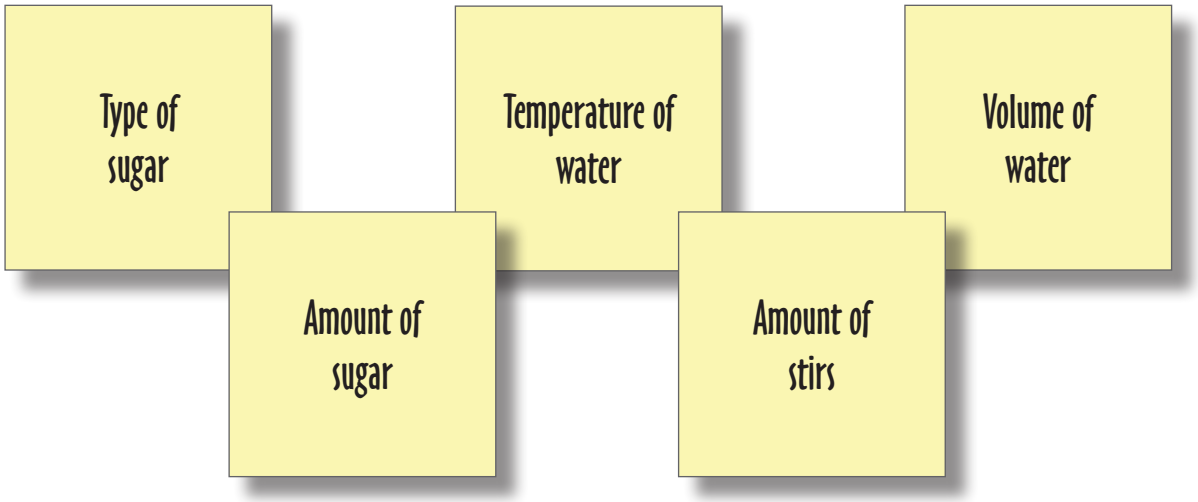


Strategy – The sticky label approach

Dissolving Sugar: Comparative Test example

What to do

- Introduce the context by stirring a spoonful of sugar into hot water and asking the children to describe what happens.
- Show the children a selection of different types of sugar. Tell children that in this investigation they will be finding out which type of sugar dissolves the quickest.
- Put children into small groups and ask them to consider ideas in response to the general question *'Apart from the type of sugar, what else might affect how quickly sugar dissolves?'*
- Take in responses from the groups, record on sticky labels and stick them onto the board, for example:



- Tell children that we will need to keep these the same. Ask children: *'Why do we have to keep these things the same?'* Ensure that children realise that, as they have suggested each of these variables might affect how quickly the sugar dissolves, in a comparative test only ***one*** variable can be changed – if more than one variable was changed, it wouldn't be clear which one was affecting the results.
- Discuss how they would measure the effect of changing the type of sugar; in this case, it would be by timing how long the sugar took to dissolve.

- Write this on another sticky label of a ***different colour***, to indicate that this is different from those above.

Time taken for sugar to dissolve (seconds)

- Show children how to set up a comparative test by moving the sticky labels onto the **Planning Sheet** as follows:

We will change:

Type of sugar

We will measure or observe the effect on:

Time taken for sugar to dissolve (seconds)

We will keep these things the same:

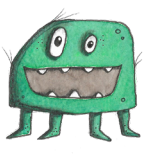
Temperature of water

Volume of water

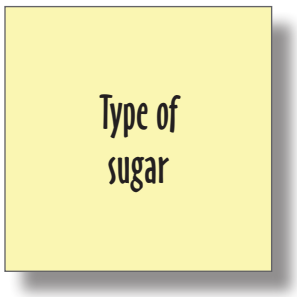
Amount of sugar

Amount of stirs

- Look at the *'We will keep these things the same'* sticky notes. Ask children: *'If we change the type of sugar and measure the time it takes for the sugar to dissolve, what will our question be?'*



- Model using the two sticky notes to frame a question to investigate:

How does the 

affect the 

?

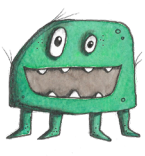
- Review the main points, including:
  - When setting up a comparative test, you need to identify what you are changing, what you are measuring and what you are keeping the same.
  - You only change one variable at a time.
  - All other things that might make a difference should stay the same.
  - Your question to investigate should include what you are changing and what you are measuring.

The sticky label approach can also be used to guide children through making a prediction and setting up a table for the results of their investigation by transferring their chosen sticky notes.

The **Prediction Sheet** helps children to keep their focus on what they are changing and what they are measuring as they write what they think will happen.

The sticky notes can then be transferred to the **Results Table Sheet** to help children create a table with correct column headings in which to record their results.

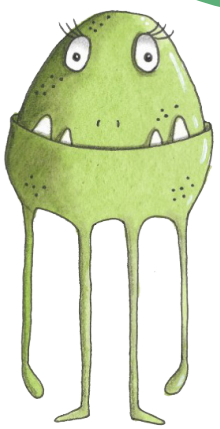
For guidance on how the table can be converted into a graph, see Unit 6.



Planning Sheet for the sticky label approach

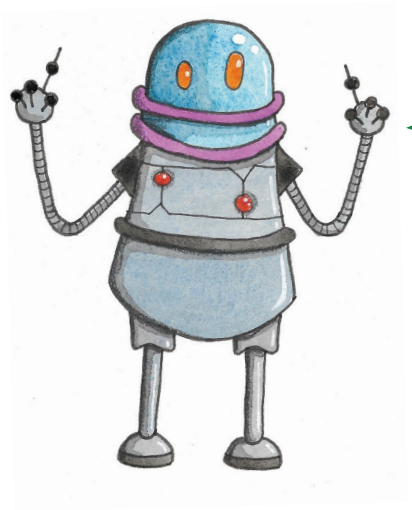
We will change:

Once you have chosen what you will change, don't forget that you need to keep everything else that might affect the results the same



We will measure or observe:

We will keep these things the same:



Does your question include what you are changing and what you are measuring or observing?

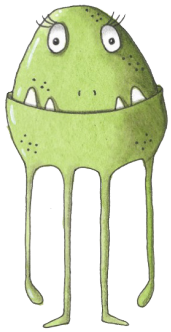
Our question:

How does _____ affect the _____ ?

Prediction Sheet for the sticky label approach

When we change this . . .

. . . what will happen to this?



Use the questions here to make sure that your prediction includes what you are changing and what you are measuring

I predict that _____

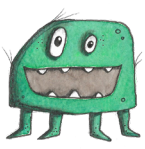
_____

_____

because _____

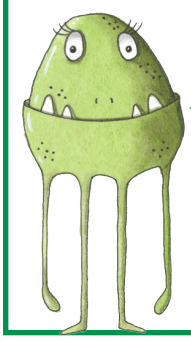
_____

_____

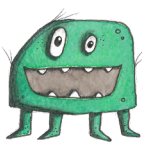


Results Table for the sticky label approach

What we changed	What we measured/observed



Use this table to record what you found out

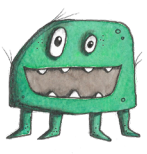


Moving from guided activity to independent planning of fair and comparative tests

As children become more familiar with the sticky label approach, there are opportunities for them to become more independent in planning, gradually moving away from guided, whole-class discussions of possible variables and questions with the whole class planning the same investigation.

After the discussions around the initial general questions about what might affect *'x'* and subsequent completing of sticky labels as a class, allow children to manipulate the sticky notes to plan a question to investigate – including what they will change, what they will measure and what they will keep the same. By copying the class-generated sticky notes, this could also be completed independently in groups before sharing and evaluating as a class. Following this, children should be asked to complete each step independently, e.g. What could we change?, followed by a class discussion to check understanding before proceeding to the next step.

Ultimately, children should be working independently in groups through the whole process, with each group investigating their own questions.



Types of scientific enquiry

Fair test

A fair test is an investigation in which one variable is changed and the effect that this change has on something else is measured or observed, giving children the opportunity to explore relationships between variables.

In a fair test, the variable that is being changed can be counted or measured. For example, temperature of water, height of ramp, number of cells.

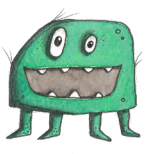
By changing one variable and keeping everything else the same, it allows the person conducting the investigation to know that no other variable has affected the results and to establish a causal relationship, i.e. If I change x it will affect y in this way.

For example, does the water temperature affect how quickly sugar dissolves?

In this investigation, the temperature of the water is changed, the time taken for sugar to dissolve is measured and everything else – amount of sugar, type of sugar, amount of water, container, etc. – is kept the same. Therefore, it is reasonable to conclude that any changes in the time taken for the sugar to dissolve are as a direct result of the change in the water temperature.

To conduct a fair test, children will need to develop the following core working scientifically skills:

- Identifying variables – what we change (independent variable), what we measure or observe (dependent variable) and what we keep the same (control variables).
- Asking a question that identifies what will be changed and what will be measured or observed.
- Describing the investigation, making clear what will be changed, what will be measured or observed.
- Choosing the range, interval and number of independent variables.
- Making a prediction.
- Deciding if repeat readings are required (sometimes, in circumstances when it is likely that children would get different results, e.g. Does the wing length affect how long it takes for a paper spinner to fall?).
- Recording their results in an appropriate format.
- Presenting their results in an appropriate format (sometimes, often a table will suffice).
- Describing relationships or patterns noticed.
- Suggesting explanations for patterns.
- Evaluating whether the test was fair.
- Evaluating whether the measurements were reliable.
- Evaluating whether their results are repeatable.
- Evaluating the evidence.



Comparative test

A comparative test is a particular type of fair test. It is also an investigation in which one variable is changed and the effect on something else is measured or observed, giving children the opportunity to explore relationships between variables. However, in a comparative test, the variable that is being changed is a category: for example, the type of sugar, the colour of a car, the type of material. It is not expressed in digits.

For example, which material is best for muffling sound in ear defenders?

In this investigation, the material is changed, the level of sound is measured and everything else – the distance from the sound, the object used to produce the sound, the volume of the sound, how the level of sound is measured, etc. – is kept the same. Therefore, it is reasonable to assume that any changes to the level of sound measured is a direct result of the type of material being used.

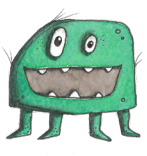
In some comparative tests, results may be gathered over a period of time.

To conduct a comparative test, children will need to develop the following core working scientifically skills:

- Identifying variables – what we change (independent variable), what we measure or observe (dependent variable) and what we keep the same (control variables).
- Asking a question that identifies what will be changed and what will be measured or observed.
- Describing the investigation, making clear what will be changed, what will be measured or observed.
- Choosing the range and number of independent variables.
- Making a prediction.
- Deciding if repeat readings are required (sometimes, in circumstances when it is likely that children would get different results, e.g. Which type of exercise has the greatest effect on our pulse rate?).
- Recording their results in an appropriate format.
- Presenting their results in an appropriate format (sometimes, often a table will suffice).
- Describing relationships or patterns noticed (sometimes, e.g. a relationship might be noticed when investigating which type of sugar dissolves the fastest).
- Suggesting explanations for patterns (sometimes, see above).
- Evaluating whether the test was fair.
- Evaluating whether the measurements were reliable.
- Evaluating whether their results are repeatable.
- Evaluating the evidence.

Identifying and classifying

For these investigations, children make careful and relevant observations and/or measurements, looking for similarities and differences to help them sort things into groups, make connections and name things.



Identifying: this uses similarities and differences in characteristics to name something. For example, what is this animal called? What trees are growing on our field?

Grouping: this uses similarities and differences in characteristics to organise things into groups. For example, how can we group the foods that we eat? Which materials are magnetic?

Classifying: this is deciding, based on specific characteristics, to which group a living thing belongs. For example, is a worm an insect? To which group of plants does moss belong?

Results for identifying, grouping and classifying can be collected by first-hand observing or measuring, or by researching data from secondary sources.

To identify or classify, children will need to develop the following core working scientifically skills:

Identifying:

- Creating an identification key.

Grouping and classifying:

- Asking a question to investigate.
- Describing the investigation, making it clear what will be observed and/or measured (sometimes, e.g. Are there different types of woodlice on our school grounds?).
- Deciding on the size of samples to be observed or measured (sometimes, e.g. Are all electrical conductors also attracted to a magnet?).
- Recording their results in an appropriate format.
- Presenting their results in an appropriate format.
- Describing results.

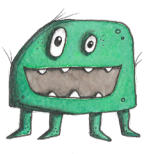
Observing over time

For these investigations, children observe and/or measure changes in living things, materials and physical processes over a period of time. The changes could take place in seconds, minutes, hours, days, weeks or even months. Observations or measurements should be made at regular intervals.

For example, how does this tree change throughout the year? What happens when I heat water? How does my shadow change over the day?*

To conduct an observation over time investigation, children will need to develop the following core working scientifically skills:

- Describing the investigation, making it clear what will be observed or measured, how often it will be observed or measured, and how long it will be observed or measured for.
- Deciding on the frequency of observations or measurements and the timeframe over which these occur.
- Making a prediction.
- Recording their results in an appropriate format.
- Presenting their results in an appropriate format.
- Describing their results.
- Evaluating the evidence.



Pattern-seeking

Pattern-seeking investigations often begin with a question about a possible link between two variables.

For example, is there a link between what we eat for breakfast and how fast we can run? Are foods that are high in energy also high in sugar? Do bigger seeds germinate more quickly?

In these investigations, there are usually variables that cannot easily be controlled for either practical or ethical reasons, For example, when looking for a link between what we eat for breakfast and how fast we can run, it would be impossible to control the amount of sleep that we had the night before, the amount of energy already used that day before the investigation, the overall health on the day, etc., even if the investigation only considered the same child over several days.

Results for pattern-seeking enquiries can be collected by first-hand observing or measuring, or by researching data from secondary sources.

Sometimes, pupils will identify a direct relationship between two variables that might be a possible causal relationship, for example, more woodlice are usually found in damp, dark places than in light, dry places. However, in pattern-seeking, it is very important that children understand that a direct relationship between two variables does not always mean that a causal relationship exists. Two variables can be related to each other without either variable directly affecting or causing the other. An example of this could be a relationship between a child's handspan and their shoe size. Children might conclude that 'in our class, the children with the largest handspans have the biggest feet'. This might be true, but the children with the biggest feet do not have the largest handspans because they have the biggest feet, and their feet aren't the biggest because they have the largest handspans.

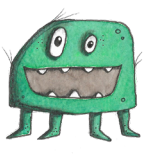
To conduct a pattern-seeking investigation, children will need to develop the following core working scientifically skills:

- Asking a question that identifies what will be measured and/or observed.
- Describing the investigation, making it clear what will be observed and/or measured.
- Deciding on the size of samples to be observed or measured.
- Recording their results in an appropriate format.
- Presenting their results in an appropriate format (sometimes, a table will suffice).
- Describing relationships or patterns noticed.
- Suggesting explanations for patterns.
- Evaluating the evidence.

Research using secondary sources

When it is impossible or unsafe to answer questions using hands-on investigations for either practical or ethical reasons, children will need to use secondary sources such as books, videos, visits, interviews, questionnaires or websites.

For example, what are the different ways in which seeds are dispersed? How have our ideas about gravity changed over time? What is the melting point of gold?



Sometimes, pattern-seeking investigations and identifying and classifying will require children to conduct research using secondary sources.

For example, do bigger animals have longer gestational periods (pattern-seeking)? Is there a link between the circumference of a planet and the time that it takes to orbit the Sun (pattern-seeking)?

What is the name of this plant (identifying)? To which animal group does a platypus belong (classifying)?

To conduct research using secondary sources, children will need to develop the following core working scientifically skills:

- Asking a question that identifies what will be researched.
- Describing the investigation, making it clear what will be researched (sometimes, e.g. Does the size of a mammal affect the length of its gestation period?).
- Deciding on the size or range of samples to be researched (sometimes, as above).
- Recording results.
- Presenting their results in an appropriate format (sometimes, often notes will suffice).
- Describing relationships or patterns noticed (sometimes, e.g. Is there a link between an animal's diet and the shape of their teeth?).
- Suggesting explanations for patterns (sometimes, as above).
- Evaluating the evidence.