# Improving Primary Science
## Guidance Report

Education
Endowment
Foundation

## About the Education Endowment Foundation

The Education Endowment Foundation (EEF) is an independent charity dedicated to breaking the link between family income and educational achievement. We do this by supporting schools, colleges, and early years settings to improve teaching and learning through better use of evidence.


## Acknowledgements

The authors would like to thank the many researchers and practitioners who provided support and feedback on drafts of this guidance. In particular, we would like to thank the guidance panel, review team, and user testing group.

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# Contents

# Foreword

**Professor Becky Francis**

CEO, Education Endowment Foundation

High quality science teaching builds pupils' curiosity and critical thinking, helping them to develop a coherent understanding of the world around them. Primary science teaching plays a crucial role in shaping pupils' attitudes toward the subject, nurturing participation that can support future pathways into science, technology, engineering, and mathematics (STEM) fields.

Much like the other core subject areas of the national curriculum, in science, there is a stubborn gap in attainment between socio-economically disadvantaged pupils and their classmates. This gap is also reflected in pupils' participation in science, with those from disadvantaged backgrounds far less likely to progress to further study in science subjects when it is no longer compulsory.

It is crucial that early science teaching empowers all pupils, regardless of their background, to engage fully with science learning, equipping them with the knowledge and skills they need to access opportunities later in life.

This guidance report provides six practical recommendations, underpinned by high quality evidence, about how to make meaningful improvements to primary science teaching. It is designed to help practitioners build on their existing expertise with a view to supporting them to close the attainment gap and cultivate positive pupil attitudes towards science.

We hope that it supports teachers, science subject leads, and senior leaders to reflect on their current practice so that they are able to recognise which approaches may better support learning and implement them effectively in their school.

## What does this guidance cover?

This guidance report focuses on primary science teaching and is relevant to the teaching of all pupils between the ages of five to 11. Early years is not included in this guidance as it can be subject to different priorities, expected approaches, and areas of learning. Effective approaches for improving secondary science are provided in a separate EEF guidance report, which provides practical recommendations for teaching pupils between the ages of 11 and 16.

## What evidence underpins the guidance?

The recommendations in this report have been drawn from a systematic review of the best available international evidence and in consultation with a panel of expert practitioners and academics. Much of the research on primary science teaching remains limited but this guidance offers recommendations about what we can learn from the evidence. The two primary sources are:

**A systematic review of the evidence on primary science teaching** co-led by Judith Bennett and Lynda Dunlop at the University of York Science Education Group, in collaboration with UCL Institute of Education: the team analysed the evidence on primary science teaching interventions published from 2007 to 2021 and consulted with 31 teachers from 21 schools to frame the scope of outcomes and approaches most important to capture in the review.

**The expertise of a guidance panel** —the recommendations draw on the expertise of academics and current practitioners: these include Lynne Bianchi, Marianne Cutler, Sarah Earle, Ali Eley, Amy Halsall, Nadia Moustapha, Louise Parks, Ben Rogers, and Jane Turner.

Evidence has also been drawn from the wider suite of EEF guidance reports where appropriate—which are further underpinned by systematic reviews of the evidence—and the EEF's Teaching and Learning Toolkit. Insights into current practice have been drawn from a wide range of available recent research. A full list of references can be found at the end of this report.

## Who is this guidance for?

This guidance is aimed at science leads, class teachers, headteachers, and other staff with leadership responsibility in primary schools. Science leads are well placed to leverage the recommendations to support the professional development of colleagues. However, senior leaders have responsibility for managing change across a school so attempts to implement these recommendations are more likely to be successful if they are involved.

Science teaching also involves English and mathematics and there is value in collaborating with leads in these subjects to better support science teaching. Additional audiences who may find the guidance relevant include governors, parents, programme developers, policymakers, and education researchers.

# Introduction

## What is primary science?

While primary science has the potential to be broad ranging in scope, for this guidance report we focus on science as defined in the national curriculum,[1] which includes the teaching of:

- scientific knowledge and concepts across biology, chemistry, and physics;
- the nature, processes, methods, and skills of science to answer scientific questions; and
- the application and implications of science in the wider world, presently and in the future.

Teaching science in primary school isn't solely about achieving strong attainment outcomes: many teachers will understand the joy of sparking pupils' curiosity and motivating them to explore a subject more deeply. This guidance considers both attainment and attitudinal outcomes in science.

Primary science teaching is also about ensuring that opportunities in science remain accessible to pupils from all backgrounds—should they wish to take them—now, and as they get older. We are all—in the broadest sense—scientists, but high-quality teaching at an early age does much to support pupil attainment that can facilitate a pathway towards further study in science,[2] and foster aspirations to be scientists.

## Reading this guidance report

Each recommendation begins with an illustrative scenario that outlines a possible challenge faced by teachers before posing questions to consider while reading the recommendation. The recommendations feature models, worked examples, and scenarios of what might work in the classroom. These seek to contextualise the evidence and provide suggestions of what should be considered or how the approach could be delivered in practice.

While a wide range of research was identified, not every specific classroom approach has been rigorously evaluated in an English setting. These suggestions, therefore, offer techniques and approaches for what might work in the classroom based on our interpretation of the evidence and our panel's expertise. The recommendations should be considered together; however, you should also reflect on how they align with your school's specific circumstances and implement them accordingly using your own professional judgement.

## Summary of recommendations

| | |
|---|---|
| **01**<br>**Develop pupils' scientific vocabulary** | Identify science-specific vocabulary.<br>Explicitly teach new vocabulary and its meaning, creating opportunities for repeated engagement and use over time. |
| **02**<br>**Encourage pupils to explain their thinking, whether verbally or in written form** | Create a collaborative learning environment.<br>Capitalise on the power of dialogue.<br>Cultivate reasoning and justification. |
| **03**<br>**Guide pupils to work scientifically** | Explicitly teach the knowledge and skills required to work scientifically, guiding pupils to apply this in practice, with opportunities for discussion and reflection. |
| **04**<br>**Relate new learning to relevant, real-world contexts** | Consider real-world contexts.<br>Engage with science concepts supported by virtual models. |
| **05**<br>**Use assessment to support learning and responsive teaching** | Plan teaching that builds on existing knowledge and experiences.<br>Monitor pupils' learning to inform responsive teaching, feedback, and next steps.<br>Summarise what pupils have learned against planned criteria. |
| **06**<br>**Strengthen science teaching through effective professional development, as part of an implementation process** | Use a range of information to identify development priorities and professional learning needs.<br>Consider factors of high quality professional development to plan or evaluate provision.<br>Reflect on senior leadership support at the strategic to classroom level. |

# Develop pupils' scientific vocabulary

*The following vignette presents a common challenge in primary science teaching.*

Ms Armstrong, a Year 4 teacher, has been teaching her class about digestion. After their lunch break, she asks the pupils to discuss the journey of the food they have just eaten through their body. She provides a diagram of the digestive system on the board for reference and poses the question: 'Where does our lunch go, and why?'

While the pupils are engaged in conversation and actively listening to each other, they frequently use informal terms like 'throat' and 'tummy' instead of employing scientific language such as 'oesophagus', 'stomach', and 'intestine'. Some pupils get the large intestine and small intestine the wrong way around and others use the word 'stomach' to refer to the digestive system as a whole.

**Ms Armstrong wonders about the following:**

- How can I support my pupils to use scientific language to describe their ideas?
- How can I scaffold their discussions and incorporate approaches to enhance their understanding of digestion?
- How can I make links that promote meaningful understanding while staying focused on the scientific concepts being taught?

## Why it's important

Scientific vocabulary can often be confusing and abstract, making it difficult for pupils to fully understand and use. Everyday words can suddenly have new meanings when used in a science context. For example, the word 'force' is used in everyday language to indicate an action undertaken with great effort or to be made to do something you don't want to do. In the world of science, a force represents pushes and pulls that can make things move, stop, or change shape. You can't see a force—which may make it harder to understand—though you can feel or observe its effects.

Supporting pupils to develop scientific vocabulary can help them to actively participate in science learning and effectively communicate their understanding. Pupils may be able to better engage with new concepts because they are familiar with the words used to describe them.[3] This is valuable for all pupils, but particularly pupils with English as an Additional Language (EAL).[4]

**"If they don't have that key scientific vocabulary, and they can't use it and have a discussion around it, then they'll face more challenges."**

**Primary teacher,**
Review on practice.[5]

## How to implement this recommendation

Explicitly teaching science-specific vocabulary can help pupils learn scientific words and understand that some everyday words have a different meaning in science. Opportunities to build pupils' scientific vocabulary and understanding can be introduced through spoken language, reading, and writing.

- 1.a. Identify science specific vocabulary.
- 1.b. Explicitly teach new words and their meaning, creating opportunities for repeated engagement and use over time.

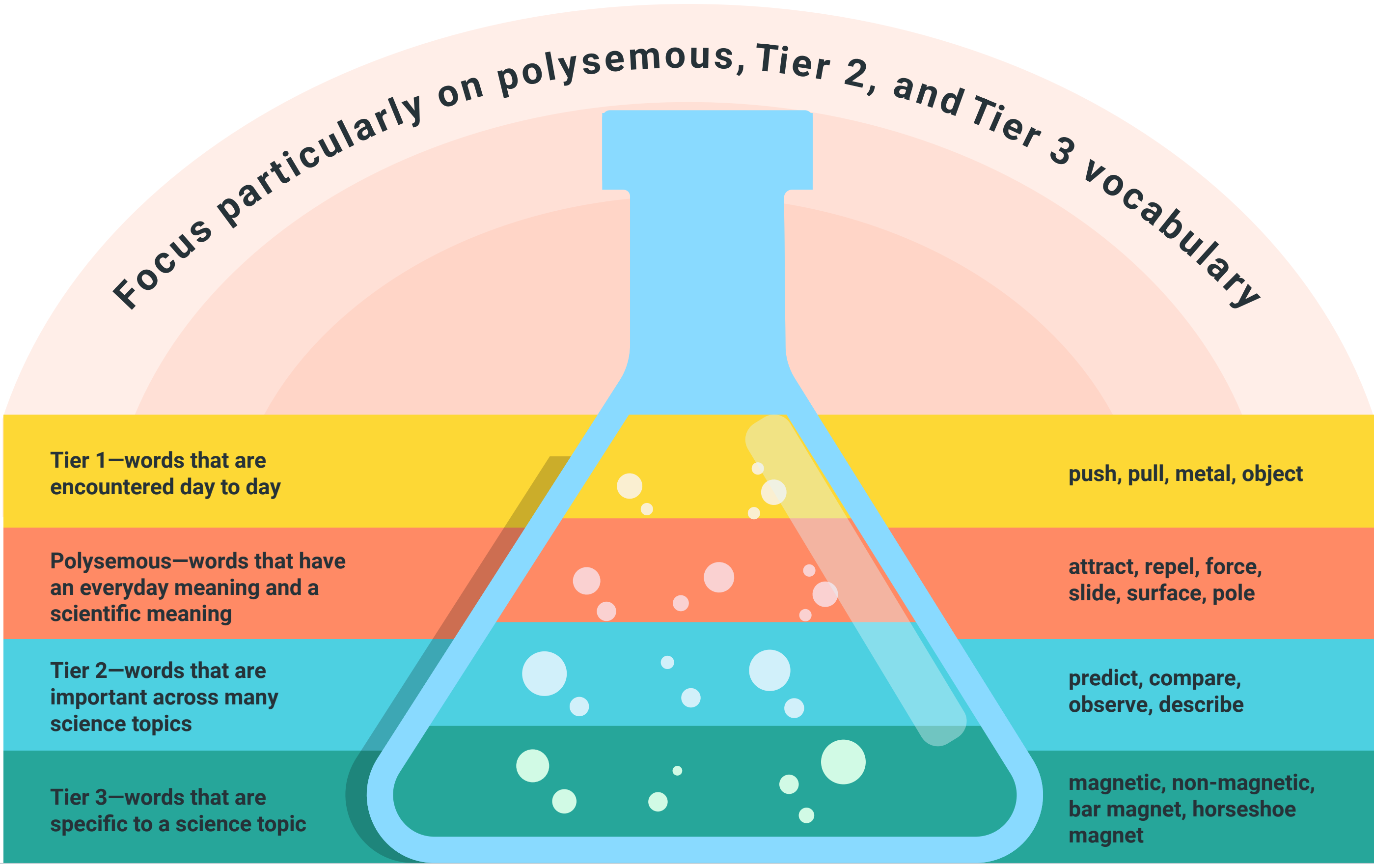
# 01 Develop pupils' scientific vocabulary

## 1a. Identify science specific vocabulary

Research shows that explicitly teaching scientific vocabulary is a useful strategy to help pupils learn.[6] When deciding on which words to explicitly teach, consider the breadth of vocabulary and background knowledge needed to fully access the science being taught.[7] It can be useful to group the words into different priority areas in the curriculum, focusing on:

- words that have an everyday meaning and a scientific meaning (polysemous words) to help address any confusion;
- words that are important across science topics (Tier 2 vocabulary); and
- words that are specific to the topic (Tier 3 vocabulary).[8]

The types of words and their grouping will depend on the topic being taught and the prior knowledge of your pupils. Below is an example of vocabulary used when discussing forces and magnets—remember to include science investigation words like 'test' or 'table' too.



## 1b. Explicitly teach new words and their meaning, creating opportunities for repeated engagement and use over time

When teaching new vocabulary, plan when and how you will introduce new words and definitions, ensuring they link directly to the content being taught, and build on prior knowledge.[9]

Support pupils to learn new vocabulary and its meaning by creating opportunities to repeatedly engage with the words and use them in different scenarios.[10] The following four strategies help to integrate new vocabulary into teaching.

### Model the use of the new word in context

Use the word in a sentence and provide a clear, pupil-friendly definition or explanation of its meaning.

**Pupil (with a pair of bar magnets):**
"When I put the red ends together, they push away, but a red and a blue go together.

**Teacher:**
"Yes, these magnets use red to show the **north pole**, and blue to show the **south pole**. When opposite poles are put next to each other they **attract**—which means they pull towards each other—but if the same poles are put next to each other they **repel**—which means they push away."

### Create context for words that need to be learned

Connect scientific language to related concepts to make it meaningful for pupils.

In the example to the right, Mr Davies wants his Year 1 pupils to classify different animals by what they eat. But first he wants to introduce some key vocabulary—'herbivore', 'carnivore', 'omnivore'. He draws on pupils' existing knowledge of rabbits and their first-hand experience of seeing them on the school playing field to help create context.


**Mr Davies** [showing a picture of a rabbit]: 'Has anyone seen a rabbit in real life?'

**Some pupils say they have seen them on the playing field from far away and a couple have pet rabbits.**

**Mr Davies:** 'Does anyone know what rabbits like to eat?'

**Suggestions are put forward by the class and it's agreed that rabbits like things like grass, which is why they are on the field, but the pupils who have pet rabbits answer that they feed them cucumber and lettuce.**

**Mr Davies:** 'The things you've all mentioned are all plants. Rabbits only eat plants. We have a name for animals that only eat plants; we call them herbivores. It's easy to remember because it starts with 'herb', and herbs are plants! Can anyone think of any other **herbivores?'**

**Mr Davies then goes on to show and discuss carnivores (using examples like spiders) and omnivores (using examples like blackbirds).**

# Develop pupils' scientific vocabulary

## Expose pupils to new vocabulary across all literacy activities

Provide multiple opportunities to revisit and engage with scientific vocabulary over time. This aims to help pupils see how the vocabulary is used and they can actively use the new vocabulary themselves to reinforce their learning and support recall.[11]

## Use vocabulary approaches that promote rich language connections

Use vocabulary approaches that promote rich language connections and help pupils understand the relationships between words and concepts.[12] Visual aids combined with image creation, such as drawing pictures or diagrams, can help pupils understand the meaning of a new words.[13] Strategies such as discussing the origin of words (etymology) or the structure of words (morphology), like Mr Davies does above, are also used in practice.[14]

## Bringing it together

Satisfy yourself that your pupils are not only learning the vocabulary but can use it accurately and understand the concept well enough to apply it in different contexts.

Reflecting on the opening vignette, what approaches could Ms Armstrong have taken when teaching about digestion? How could she have incorporated them into her lesson plan?

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# Encourage pupils to explain their thinking, whether verbally or in written form

*The following vignette presents a challenge identified in primary science teaching.*

Mr Nayeni knows that discussion can be an effective way for pupils to share their understanding and develop their thinking. He'd like to try and build in more time for in-class discussion; however, he's uncertain about the best approach.

In a previous attempt to discuss the impact of diet and exercise on health, the class veered off-topic, losing focus. Furthermore, a few pupils were upset due to personal comments made by others. He felt that the process became counterproductive and he wants to avoid this happening again.

**Mr Nayeni seeks answers to the following questions:**

- How can I keep pupils focused on the topic?
- How can I structure the task to foster scientific understanding through dialogue?
- What measures can I put in place to minimise potential upset caused by controversial topics?
- How can I assess the effectiveness of dialogue in enhancing understanding?

## Why it's important

Strategies that encourage pupils to make their thinking explicit can create opportunities for pupils to recall, organise, and express their thoughts and ideas, refine their understanding, and think scientifically.[15] There is some evidence to suggest that this is particularly beneficial for pupils from socio-economically disadvantaged backgrounds.[16]

## How to implement this recommendation

A way to encourage pupils to make their thinking explicit is by engaging in high quality discussion.[17] Writing is another way to elicit pupils' thoughts,[18] however, we focus on the spoken word here as it means that pupils aren't hindered by limitations in their reading or writing skills.

**Encourage pupils to make their thinking explicit:**

- 2a. Create a collaborative learning environment
- 2b. Capitalise on the power of dialogue
- 2c. Cultivate reasoning and justification

## 2a. Create a collaborative learning environment

Well-structured collaborative learning approaches, such as paired and small group work, offer a great opportunity for discussion during which pupils can make their thinking explicit.[19] Collaborative learning approaches paired with well-designed tasks that integrate talk demonstrate the greatest impact.[20] However, the impact can vary so it is important to get the detail right, starting with a collaborative environment.

### Talk behaviours

Support the development of listening skills where needed, such as how to actively listen and reflect on what has been said, take turns to contribute, and respect others' views and ideas.

### Expectation setting

Establish clear expectations around participation. This could be done by modelling the kind of behaviours you are expecting, how you ask for clarification, and how you listen. Another approach from practice is to have pupils establish their own shared rules in class.

### Task design

Think about how you can design tasks to encourage collaboration. For instance, you could consider group sizes of no more than five, and how you will scaffold the involvement of lower prior attaining pupils.

### An example from the classroom:

**'To support lower-attaining pupils' engagement, I provide opportunities to build understanding of scientific approaches through an accessible, non-scientific context where they can use their general talk skills. For example, to learn the scientific approach of 'linking evidence to an idea' I might ask pupils to justify ideas like 'I think … white chocolate … is my favourite because … it is really sweet!', where there is no right or wrong answer. Once they can do this comfortably, I can then move pupils on to applying the same concept in a scientific context where they also need to justify their idea using more science-specific content.'**

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# Encourage pupils to explain their thinking, whether verbally or in written form

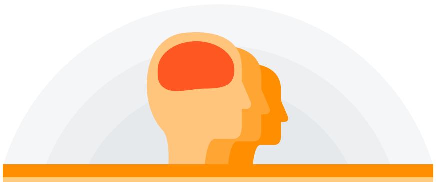
## 2b. Capitalise on the power of dialogue

Dialogue between the teacher and pupils, and between pupils, can provide opportunities to articulate thinking and make explicit a shared understanding. When planned and structured, dialogue may support pupils to integrate new ideas with their current knowledge, identify gaps in their understanding, and reorganise their thoughts to consolidate their learning.[21]

**To support high-quality dialogue:**

**Plan key questions and discussion points in advance**

Open ended questions, which encourage pupils to explain, reason, or argue, can be particularly helpful. For example, 'How did you …?', 'Why does this …?', and 'What makes you think that …?', 'What do you mean by that …?'



**Use strategic follow-up questions to guide dialogue**

Support pupils to build on their responses and those of their peers to provide the detail you are looking for: 'Can anyone think of another reason?', 'Does anyone agree? Why might that be the case?'

**Balance teacher and pupil voice**

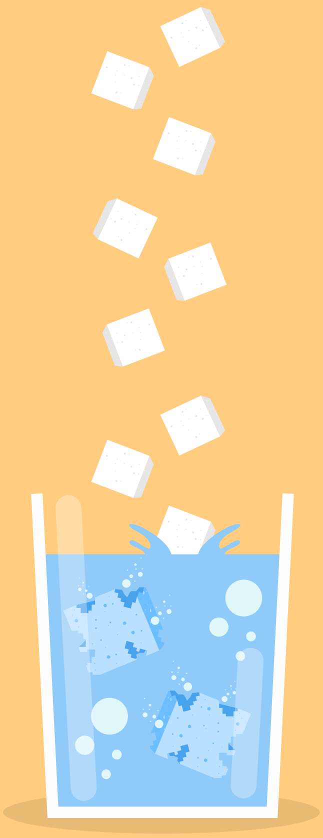
Ensure that you are giving pupils opportunities to share their thoughts as well as providing yours. If you find yourself wanting to fill the silence, remember pupils need wait time to develop their thinking before responding—pausing for five seconds can help pupils to think over their answer.

# Encourage pupils to explain their thinking, whether verbally or in written form

## Power of dialogue

Mrs Matthews has been teaching her Year 5 pupils about properties and changes of materials. She wants to tackle the concept of dissolving. She organises pupils into trios and explains the task. Each group is given beakers of water and packets of sugar. The pupils add the sugar to the water, and they watch what happens.

Mrs Matthews wants the class to discuss what they have observed. She decides to stimulate dialogue through careful questioning:



**Mrs Matthews:** 'Okay class, I've got a question for you and I'm going to give you a few minutes to discuss it in your groups. What do you think has happened to the sugar?'

**Mrs Matthews joins one group, listening carefully to their discussions.**

**Mrs Matthews:** 'So, what do you think has happened to the sugar?'

**Abdul:** 'The sugar has got all mixed up with the water so you can't see it anymore.'

**Sasha:** 'It has disappeared.'

**Mrs Matthews:** 'You have two different ideas. Has the sugar mixed up with the water or has it disappeared?'

**Evie:** 'I think the sugar has dissolved.'

**Abdul:** 'Oh yes, it has dissolved! That is what I meant!'

**Mrs Matthews:** 'Excellent use of the word 'dissolve'. Can you expand and explain what 'dissolve' means?'

**Abdul:** 'When the sugar dissolves, it looks like it has disappeared but it just mixed up with the water to make it transparent. That's why it looks like you can't see it anymore.'

**Sasha:** 'The sugar has broken into small pieces and spread throughout the water.'

**Mrs Matthews:** 'Can anyone tell me what the transparent liquid is called?'

**Evie:** 'The liquid is called the solution. It is one of our key words on our knowledge organiser!'

**Mrs Matthews:** 'Great work team for remembering and using scientific words accurately. Does anyone know anything else about dissolving sugar in water?'

**Sasha:** 'My mum drinks tea and I know that sugar dissolves quicker when it is put in boiling hot water.'

**Evie:** 'Sugar is soluble because it dissolves.'

**Abdul:** 'Yes, that's right: sugar is soluble. But some things are insoluble.'

**Mrs Matthews gains feedback from the class and together they clarify what dissolving means including the term 'solution'.**

Mrs Matthews asks the class follow-up questions to guide further discussion.

- What else could be soluble in water? If we tried it, how would we know?
- How could we see the pieces of sugar again?
- Can you think of substances that will not dissolve in water? How could we test it?

## 2c. Cultivate reasoning and justification

As pupils progress through primary school they are encouraged to be curious, make observations, ask questions, and increasingly support their ideas and thinking with explanation and evidence.[22] Strategies which may cultivate reasoning and justification include the following.

**Explain**

Pupils explain their thinking through discussions with peers, in pairs or small groups, interactions with teachers, or in written form.

> Pupils observe a torch illuminating an object resulting in a shadow cast on a wall. They are prompted to predict and explain the potential changes to the shadow if the object is moved closer to the torch. They are given the sentence stem, 'I predict _____ because _____.'

**Discuss**

Pupils then engage in group or whole-class discussion facilitated by the teacher. This allows pupils to call on their own understanding, listen to new information and perspectives, and consider how this relates to theirs.

> Pupils observe the effects of moving the torch. A whole-class discussion is facilitated by the teacher using questions to encourage the sharing of diverse ideas and explanations from pupils: 'What do we notice about the shadow?', 'What else has happened to the shadow?', 'Why do we think this is the case?', 'How could we make the shadow smaller again?', 'What would happen if we used a transparent object?'...

**Re-explain**

Pupils are given the opportunity to review and update their thinking after the discussion.

> Pupils have the chance to modify and enhance their predictions and explanations. Afterwards, pupils write an explanation in their exercise books. The class could also write a shared prediction and explanation after a discussion, record it orally using an electronic tablet, or end on 'think, pair, share' discussions.

Example modified from Chang et al, 2021.[23]

## 'Odd one out' [24]

Pupils are shown three to four images related to a particular topic, such as three different autumnal leaves, related to learning about seasonal changes. There is no clear odd one out. Pupils are asked to discuss and explain which one they think is the odd one out and why. This creates the opportunity to explore pupils' ideas and reasoning. Using this strategy at the start of a topic could also help inform what pupils already know and expose preconceptions.[a]

[a] Preconceptions are pre-conceived ideas pupils may have about the world.

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# Encourage pupils to explain their thinking, whether verbally or in written form


Example adapted from Naylor, S. (2014) [25]

## 'Concept cartoons'

Concept cartoons are cartoon-style drawings that put forward a range of viewpoints about the science involved in everyday situations.[26] Cartoon characters discuss their viewpoints around a science concept, which include common misconceptions.[b] Pupils reflect on what they think of the characters' viewpoints and explain their reasoning.

[b] Misconceptions are an incorrect belief that doesn't align with current known scientific understanding. For example, a common misconception in relation to evolution is that an individual can evolve within their own lifetime.

## Bringing it together

The strategies described are structured to encourage overt thinking in targeted ways: to cultivate a shared understanding of a concept, to encourage scientific justification, and to explore ideas.[27]

Looking back at the vignette at the beginning of this recommendation, what strategies would you suggest Mr Nayeni try with his class? How could he apply them?

# Guide pupils to work scientifically

The following vignette presents a challenge encountered in primary science teaching.

Mr Sharp wants his pupils to apply their scientific skills to observe and record what happens to the brightness of a bulb when the number and voltage of cells is altered. He is excited as he has recently discovered a free app which measures light brightness using a tablet's camera. He wants the pupils to set up circuits with different numbers of cells or cells of different voltage and take accurate measurements of the brightness of the bulb each time using this new app. He asks the pupils to record the data to discuss later.

The pupils enthusiastically work in their groups to set up circuits, changing the number or voltage of cells each time. They measure the brightness of the bulb, but some groups have trouble getting accurate readings as they think the daylight from the classroom window is affecting how the app works. Pupils spend time closing the blinds, reorganising where they work in the classroom, or using card to block exterior light.

Mr Sharp asks the pupils what they have found out. They enjoyed the task, spending a lot of time setting up the circuits and trying to capture light readings using the new technology but, due to time constraints, they approached their recording in several ways and the charts they have drawn vary in relevance and accuracy due to the large value readings. Not all pupils are clear what the readings are telling them and haven't made the link between the number of cells and the bulb brightness.

**Mr Sharp wonders:**

- What did the pupils learn in this activity? Was it what he wanted them to learn? If not, does the task still have value?
- How could Mr Sharp plan this lesson differently so that it is more purposeful and focused for pupils? How should he adapt his teaching?

## Why it's important

Working scientifically integrates science content knowledge with an understanding of the nature, processes, and methods of science.[28] Combining these different aspects to work scientifically can be challenging for both teachers and pupils.

For example, when measuring temperature, pupils may need to consider how to read a thermometer, recall what the reading was, write it down in a chart, think about the standardised unit to use, and then … what did the teacher say we do next? As a result, it can be easy to get lost in the task without achieving a deeper understanding of the learning objectives.[29] Guiding pupils to work scientifically has the potential to improve their ability to think like scientists and support them to understand challenging concepts.[30]

**"In the past there has been a danger of activities being done without the learning being there and the pupils don't remember … I just think sometimes, 'Oh, it's really exciting; we'll do this to kick it off', but the pupils don't know what they're doing so it's lost really."**

**Primary teacher,**
Research on practice

## How to implement this recommendation

The seven-step model on the following page provides a useful framework to support pupils towards becoming independent scientists who can work scientifically by: [31]

- **explicitly teaching** the knowledge, skills, and processes required to work scientifically;
- guiding pupils to **apply this in practice; and**
- incorporating opportunities for **discussion and reflection.**[32]

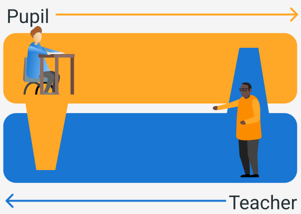
The seven steps can be implemented across a series of lessons or a topic. Although the stages are in sequence, in practice there will be some integration and iteration: for example, you may need to check more frequently whether pupils have understood what you have taught them for particularly tricky topics, and opportunities for discussion and reflection could be integrated throughout. With all practical work, ensure you reference safety and good practice advice, such as ASE Be Safe, or CLEAPSS guidance.

Adapted from Quiqley et al. (2021).[33]

## 3a. Explicitly teach the knowledge and skills required to work scientifically, with opportunities for practice and discussion

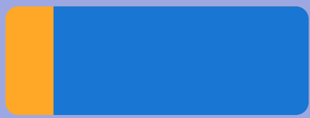
This seven-step model is a scaffolding framework to deliberately shift responsibility for learning from teacher to the pupil.

The orange part of the bar represents the pupil and the blue part represents the teacher input.




### 1. Activating prior knowledge

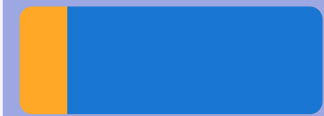
Pupil/Teacher



**Link new learning to prior knowledge.** Identify what pupils already know, what you have taught previously, and what pupils need to know to access the lesson. This can inform the pace of the lesson and what you need to cover.

### 2. Explicit strategy instruction

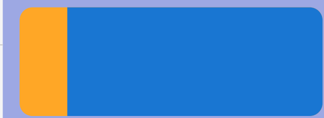
Pupil/Teacher



**Explicitly teach the knowledge, skills, and processes required to work scientifically.** Be clear what the learning intentions are. Address common preconceptions before they become embedded as pupils' own explanations for phenomena may differ from scientific explanations.

### 3. Modelling of learned strategy

Pupil/Teacher



**Modelling.** Build understanding through demonstrations, modelling expected behaviour or thinking, providing examples, partially worked examples, or non-examples (which show what it isn't).

### 4. Memorisation of strategy

Pupil/Teacher

**Memorisation.** Check to see if pupils have understood. For example, low stakes quizzes (ensuring you see or hear a range of answers to inform next steps) can help check pupils' understanding of a particular strategy to work scientifically.

### 5. Guided practice

Pupil/Teacher

**Guided practice.** Introduce practical work to reinforce learning, encourage recall, or deepen understanding while developing skills to work scientifically. Ensure you have a clear idea of the learning outcomes of the practical work and how you will know this has been achieved.

### 6. Independent practice

Pupil/Teacher

**Independent practice.** As pupils build their knowledge and expertise, the type of support you provide should be gradually reduced so that pupils can work more independently.

### 7. Structured reflection

Pupil/Teacher

**Discuss and reflect.** Provide opportunities for pupils to summarise what they've learned and receive feedback. 'Does the conclusion make sense? Why? What improvements could you make?'

## **Teaching a fair test** - a worked example

Mrs Rice has planned to teach her pupils about fair tests. She sets up an invalid and valid test in front of her pupils to teach what a fair test is and isn't. While implementing the test she explicitly teaches the concepts of variables and a fair test. She makes this interactive, asking pupils to identify which variables stayed the same and which were changed. Mrs Rice reflects on the conclusions of the approach to a fair test with her class, supporting her pupils to discuss how the two tests differed, the key parts of a fair test, and why they are important.

In the next lesson, Mrs Rice quickly demonstrates a fair test, including a deliberate mistake. Once the groups of pupils have discussed why this was not a fair test, they are steered through planning and setting up their own tests using a series of 'driving questions', which create opportunities for Mrs Rice to see what her pupils have understood and to correct any misconceptions—What variables will you change? Why? What variables will stay the same? Why? What are you going to measure? Why is this important?

Example inspired from Di Mauro et al. (2016).[34]

A comprehensive, step by step example using the seven-step model approach can be found in the additional tools accompanying this guidance. The case study below highlights how curriculum planning can support linking new learning to prior knowledge, building on the development of scientific skills.

## **Link new learning to prior knowledge** - a case study

Paradigm Trust is a multi-academy trust comprising five primary schools, a secondary school, and a special school located in Ipswich and Tower Hamlets. Within the trust, each school has a science lead who has contributed to the development of the Early Years Foundation Stage (EYFS) to Key Stage 3 science curriculum.

The curriculum is underpinned by two progression documents. The first maps the progression of content knowledge from the EYFS to Key Stage 3 covering topics such as forces, habitats, and properties of materials. The second is a disciplinary map that outlines the expected progress of pupils in understanding 'how science works' and the practical skills and techniques they should develop.

Medium-term plans are designed to enable pupils to develop their subject knowledge in contexts they are already familiar with, as described on the next page.

03
# Guide pupils to work scientifically

For example, in Key Stage 1, when pupils begin to learn about comparative tests, they use the context of growing plants, leveraging their existing knowledge and independently practising skills such as measuring water volume, plant height, and recording observations.

| | Discrete skill | | | |
|---|---|---|---|---|
| | **Measuring length and height** | **Measuring volume** | **Measuring temperature** | **Recording data and observations** |
| **Years 1 and 2** | Using a ruler to measure whole centimetres | Using measuring cups/ spoons and bottles with easy-to-read scales (e.g. 100ml, 200ml, 300ml) | | Using simple tables and tallies. Recording numerical and descriptive data |
| **Years 3 and 4** | Using a ruler to measure millimetres | Using measuring bottles/jugs with scales with divisions | Using simple digital thermometers and data loggers | Presenting data in simple charts and tables |
| **Years 5 and 6** | Choosing the most appropriate scale and measuring instrument for a task (e.g. tape measure) | Using measuring cylinders with accuracy and precision | Using digital thermometers (1 decimal place) and data loggers | Choosing appropriate tables and charts to record, present and analyse data. Pupils will calculated changes, averages and simple ratios (e.g. speed) |

## Bringing it together

In the opening vignette of this recommendation Mr Sharp found that pupils were highly engaged but many hadn't learnt what he was intending to teach them. How could he use the strategies suggested above to make the practical work more purposeful?

# 04
# Link science learning to relevant, real-world contexts

Mr Hayes wants to engage his pupils in science so that they are inspired and curious to find out more about the world. His Year 5 class has been focusing on the topic of forces and he wants to make the subject as relevant and meaningful to his pupils as possible.

He heard one of his pupils discuss how he rides his bicycle to school and thought this would be a great way to introduce pupils to the topic of friction. He uses this idea to create a scenario where the pupils must explain what happens to make a bicycle stop moving. However, some of the pupils have never used a bicycle before so the concept of bicycle brakes is unfamiliar to them, others start insisting that a scooter is much more fun than a bicycle, and others feel sad because they don't have a bicycle at home and have never had the chance to ride one. Overall, the scenario didn't have the effect he intended leading Mr Hayes to contemplate a number of questions.

**Mr Hayes wonders:**

- How can I ensure that all of my pupils can engage with the real-world contexts I integrate into my teaching?
- How can I create learning opportunities that are memorable for the right reasons?
- Could I have done anything before, during, or after the scenario to better support learning?

## Why it's important

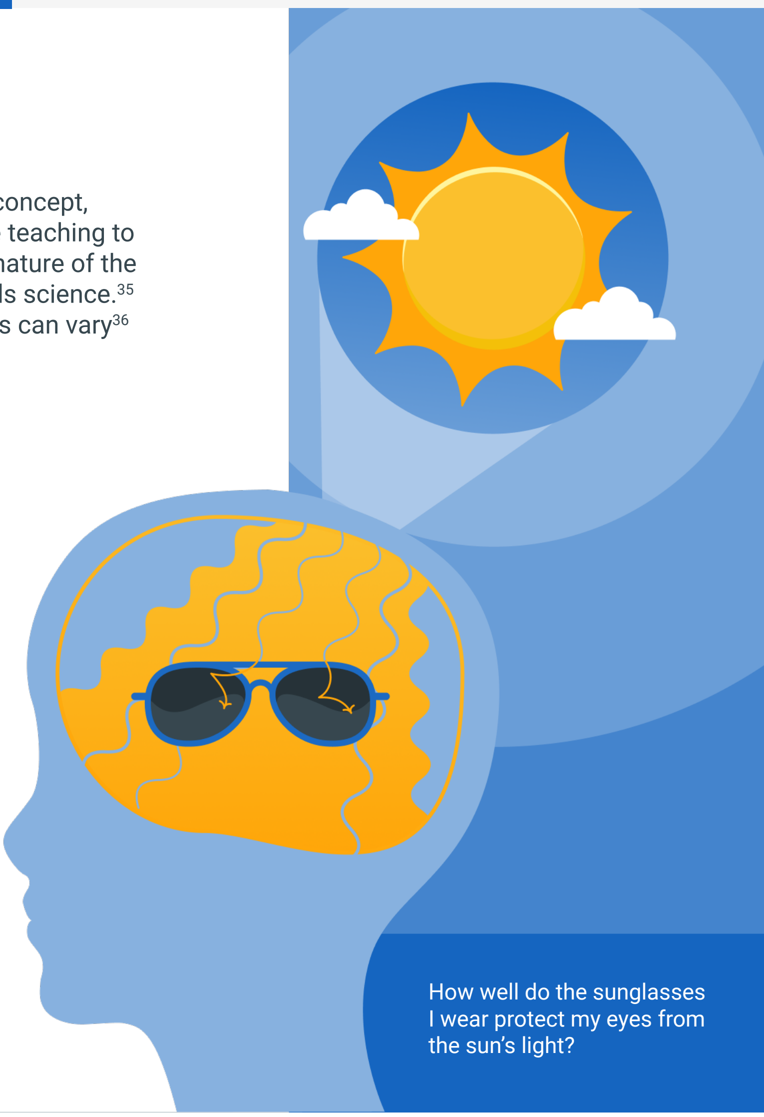
A 'real-world context' refers to the application or relevance of a concept, idea, or skill in the practical, everyday world. Connecting science teaching to meaningful and tangible scenarios or examples that reflect the nature of the real world can enhance science attainment and attitudes towards science.[35] However, the benefits for disadvantaged or lower-attaining pupils can vary[36] so it is important that it is implemented well.

## How to implement this recommendation

Relevant real-world scenarios can be introduced through in-class teaching,[37] outside of the classroom,[38] and by using virtual models.[39] Ensure that your real-world context appropriately supports explanations of the science you want to teach, that it links closely to in-class learning, and fits into long term curriculum planning.

**You might draw on approaches which provide opportunities for the integration of meaningful scenarios:**

- 4a. Consider real-world contexts
- 4b. Engage with science concepts, supported by virtual models



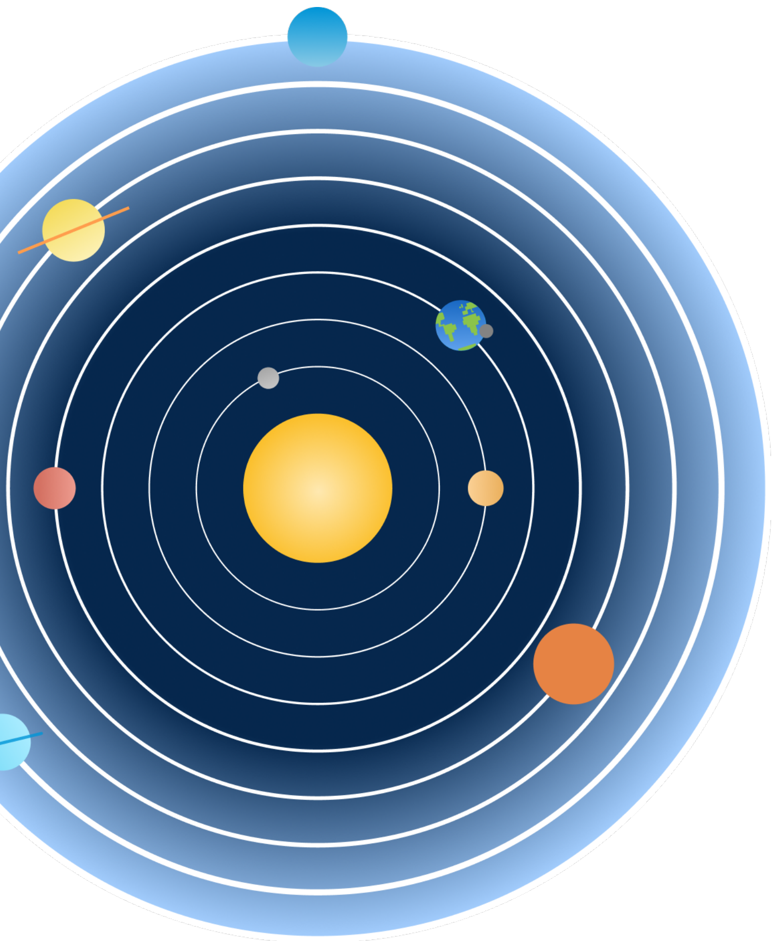
## 4a. Consider real-world contexts

Use applications of science and real-world contexts that support pupils to develop an understanding of science, demonstrate its purpose, and show its relevance to them by connecting it to pupils' experiences, the local context, or wider contexts. Plan your teaching so that the context adds substantively to learning and is accessible to all pupils.[40] Weigh up the balance of time, cost, and engagement value alongside the key learning objectives the context supports.

| | |
|---|---|
| 01<br>What is it I want pupils to know/ understand/do? | A Year 4 teacher considers using a local green area as a relevant real-world context with the aim of supporting her pupils to:<br>**know** there's a variety of living things in their local environment, which can be grouped in different ways;<br>**understand** how to use classification keys to identify and name a variety of living things; and<br>**observe** invertebrates carefully in their local environment, identifying them using a classification key. |
| 02<br>Does the context support this? How? | The context forms part of a lesson sequence on living things and their habitats.<br>The area has a variety of habitats which host invertebrates, including snails and slugs, worms, spiders, and insects. Pupils can directly engage with their local environment to apply their knowledge of classification keys in a meaningful context. Pupils are able to see that the science they are learning is relevant to everyday life and that science is 'everywhere'. |
| 03<br>Are there potential challenges with this context, such as a risk of unfamiliarity, segregation, or misunderstanding for some pupils? | Challenges may include:<br>• a wider physical area over which to manage pupil learning;<br>• pupils may not find a variety of invertebrates on the day to use the classification keys;<br>• there are several elements for pupils to manage: the outdoor environment, group work, the classification key, and recording of findings; and<br>• ethical and health considerations when handling invertebrates. |
| 04<br>When and how should I introduce the key concepts, processes, or skills I'm trying to teach in relation to the context (pre-teach, during, after)? | The teacher ensures pupils are prepared and familiar with the concepts and skills they are required to apply in the real-world context through the sequence of lessons before and scaffolding in place during, to ensure all pupils can engage with the learning.<br>Preceding teaching includes learning of key vocabulary, understanding the purpose of a classification key and practising how to use one, and the importance of caring for the environment.<br>Teaching during includes observation of pupil's practice, regularly asking pupils questions that focus on identification, reinforcing observation, classification, and grouping using the classification key. |
| 05<br>What connections does this context have with the wider curriculum (science and beyond)? How can I make these connections explicit? | The teacher explicitly connects their current science lessons to pupils' previous learning, including comparing the differences between things that are living, dead, and things that have never been alive, and using simple keys in the classroom. |
| 06<br>How can I consolidate learning from the context? | Learning in-context is linked back to the learning in the classroom and followed up: pupils discuss the range of invertebrates they found using their recording sheets. The teacher reviews any difficulties they had in classifying any of the invertebrates and facilitates discussion about some invertebrates looking different in different stages of life cycles. |

One of the aims of primary science is for pupils to understand the uses and implications of science, today and in the future.[41] Taking the learning outside of the classroom in the example on the previous page is one of several strategies to integrate real-world relevance in primary science lessons. Other real-world examples drawn from practice include:

- How is friction relevant to sports and athletic performance? Pupils might investigate how equipment in real life, such as goalie gloves, cricket bats, and tennis rackets, are specially designed for maximum grip.
- How well do the sunglasses I wear protect my eyes from the sun's light? Pupils might build skills to use data loggers and measure how much light is blocked by different lenses, including linking to real-life official safety standards.
- Does the food I eat provide a nutritious and balanced diet? Pupils might use food packaging to learn more about how food is classified in real life based on its nutritional value.



## 4b. Engage with science concepts, supported by virtual models

Scientific phenomena can sometimes be complex and hard to visualise. A model is a way of representing these concepts in a simplified and accessible way to make it easier to comprehend, such as a model of the digestive system or water cycle.[42] Virtual models relate to the real world by making an abstract idea, concept, or process visible.

A virtual model can take many forms ranging from simulations of the real thing, analogies, illustrations, examples, and educational gameplay.[43] These can be used to support teaching concepts, such as demonstrating the relationship between the movement of the sun, earth, and moon in the solar system using online 3D models, or constructing a gear or pulley system online, observing the impact of changing the number of pulleys or size and number of cogs.

When identifying whether a virtual model might support your teaching, it can be helpful to think about the following prompts - described on the next page.

04

# Link science learning to relevant, real-world contexts

**Does the virtual model accurately represent the scientific concept being taught?**

Does a virtual model of the solar system show the relative sizes of the planets? Or the distances between them? Or both? If not, how else can you convey these scales to pupils?

**What are the limitations of the virtual model?**

Where does the model fail and no longer accurately represent reality? Can you discuss these boundaries to avoid creating misconceptions? For example, models of the heart often show oxygenated blood as red and deoxygenated blood as blue.

**Does the virtual model offer clear, visually appealing, and relatable representations of the concept making it accessible to pupils?**

Does the model make an abstract, complex idea easier to understand and visualise? Are the labels clear? Is information provided pitched at the right level?

**Does the virtual model provide interactivity and engagement for pupils?**

Can pupils change features and parameters to explore what happens? Is it a simulation or an animation? Which is most appropriate for what you are teaching?

Adapted from EEF Secondary Science guidance report.[44]

## Bringing it together

When applying this recommendation, think about how you can maximise the potential of the real-world context to support and reinforce learning goals, increasing the opportunity for curriculum relevance. Revisiting the vignette at the start of this recommendation, what do you think Mr Hayes could do next time to improve pupil learning?

05

# Use assessment to support learning and responsive teaching

*The following vignette presents a challenge that might be encountered in primary science teaching.*

Mrs Thompson, a Year 6 teacher, feels she is struggling with assessment in science. In maths, she's been using short multiple-choice quizzes (with mini whiteboards) during lessons, and regular end of unit assessment questions, with great success. However, the same approach doesn't seem to be working so well in science. Pupils seem to perform well in the short multiple-choice quizzes (on content knowledge) but they really struggle with end-of-topic assessments where they must apply their knowledge. Overall, she's not confident her assessments are that useful.

**Prompted by her concerns, Mrs Thompson ponders:**

- Is my end of topic assessment an accurate reflection of the curriculum covered? Is it allowing pupils to fully show their understanding? Is it a good use of time?
- How can I effectively assess what pupils have learned through working scientifically?
- Should I change anything in my approach to teaching based on the assessment results?

## Why it's important

Assessment in science is useful for both pupils and teachers. For pupils, it can support them to take ownership of their learning, respond to feedback, and aim towards learning goals.[45] For teachers, assessment can help identify pupils' knowledge and experience at the start of a topic, inform responsive teaching, and the planning of next steps.[46]

## How to implement this recommendation

- 5a. Plan teaching that builds on existing knowledge and experiences
- 5b. Monitor pupils' learning to inform responsive teaching, feedback, and next steps
- 5c. Summarise what pupils have learned against planned criteria

## 5a. Plan teaching that builds on existing knowledge and experiences

Assessment undertaken both before and during a topic has been shown to support science attainment and self-efficacy (your confidence in your ability to do well in science).[47] When undertaken before a topic, 'diagnostic assessment' can be a valuable tool to uncover pupils' pre-existing ideas and understanding, so that planning can be adjusted to support learning more effectively.[48] This could include spending more time securing foundational knowledge before moving on to new learning or covering complex content that is new to pupils in smaller stages so that it is more manageable.[49]

There are several techniques to elicit current knowledge and understanding at the start of a topic, which can be completed as a whole class, in small-groups, or individually in relation to the topic to be learned. The 'recognise, reveal, and respond' process outlined below highlights useful suggestions from practice.

| | |
|---|---|
| **Recognise what you want to assess**<br>Reading around or discussing with colleagues the common preconceptions and misconceptions for any upcoming science topic can help you plan your diagnostic assessment. Anticipating preconceptions and misconceptions can help you to spot them, take account of them, and respond to them. | Common misconceptions<br>All light objects float; all heavy objects will sink.<br>The human body contains blood, food, and waste. The stomach is in the area of our tummy button or naval. |
| **Reveal their understanding**<br>Mind map (with/without physical/pictorial/video prompts) of knowledge related to the topic of focus.<br>Big question answers—pupils answer conceptually challenging questions such as, 'What are the properties of a liquid?'<br>Odd one out—pupils discuss 3–4 pictures or objects, explaining which is the odd one out and why.<br>Positive, minus, interesting—pupils discuss positive, minus, and interesting aspects of a scenario statement.<br>Concept cartoons—explained in Recommendation 2.<br>Card sorts—including images, words, and definitions.<br>Label/construct a diagram<br>Explain a prediction<br>Given the answer—what is the question?<br>Talk for just a minute on …<br>True/false statements | Given a range of objects, can pupils predict (with reasons) whether they will float or sink? How will they record their ideas?<br>Given the outline of a human body, ask pupils to draw/label how food travels through our bodies. Note: use of a 3D skeleton could reinforce this misconception as it demonstrates the 'empty space'. |
| **Respond in your planning**<br>Is key vocabulary creating a barrier for understanding?<br>Would memorisation strategies be helpful?<br>Are there links with previous learning you want to make explicit?<br>Is there prior knowledge you want to activate?<br>Could the same diagnostic assessment be repeated later (during or after the topic) to show changes in learning? | If the misconception is present, simply demonstrate a collection of items, e.g. a small nail that will sink, a full can of drink that will float. Plan how this could be revisited when the forces topic comes up again or you are exploring properties of materials.<br>Explicit teaching of location/role of major organs in the body and how they link. Key vocabulary reinforced. |

## 5b. Monitor pupils’ learning to inform responsive teaching, feedback, and next steps

Assessment can also be planned into lessons to inform how pupils are learning and to adjust instruction to ensure that learning moves forward.[50] This type of assessment is often called ‘formative assessment’, which aims to help teachers and pupils recognise learning gaps and decide how best to close them during a topic.[51] It is important to have a clear idea of what learning you want your pupils to achieve so that you can effectively assess their progress against this and respond appropriately.[52]

### Clarify, share, and understand learning intentions and success criteria

Be clear about what success in the task would look like and share the learning intentions of the lesson so that everyone has a clear idea of what they are aiming for. Engaging with clear guidelines for success means teachers, pupils, and peers can make better informed judgements on learning progress.[53]

### Elicit evidence of learning

Elicit evidence of learning to help assess whether the learning aims are being achieved. You can use this information to decide what needs to be done next to move learning forwards.[54] Suggestions from practice include quick checks of understanding such as a few key questions from the teacher,[55] multiple-choice questions that include common misconceptions and distractor answers,[56] and listening in to pupils as they work. You might also use more structured discussions, assessment, or peer- and self-assessment.

### Reflect on any teaching adjustments

Reflect on any teaching adjustments that may be needed to help pupils better meet the success criteria or learn from the feedback you need to provide. Guidance on how to provide this feedback can be found in the EEF’s Teacher Feedback to Improve Pupil Learning guidance report.
Assessment takes time, so whichever approach you take, ensure that it will help inform responsive teaching, feedback, and next steps.[58]

**Example from practice**

Working scientifically requires carefully designed tasks to elicit evidence of pupils’ learning as it is often delivered through discussion or ‘doing’. A method that might make this more manageable is to plan your lessons focusing your attention on one skill at a time as part of a whole investigation.[57] Skills include: ask questions/predict, plan, set-up, observe and measure, record, interpret and report, and conclude. By planning to focus more teaching time on a particular skill and recording the skill in a way appropriate for the task, you can ensure there is time to elicit evidence of learning. For example, you might spend more time probing the planning aspects of an investigation when focusing on fair tests. Over time, you can ensure you have covered all skills across a range of approaches to working scientifically.

## 5c. Summarise what pupils have learned against planned criteria

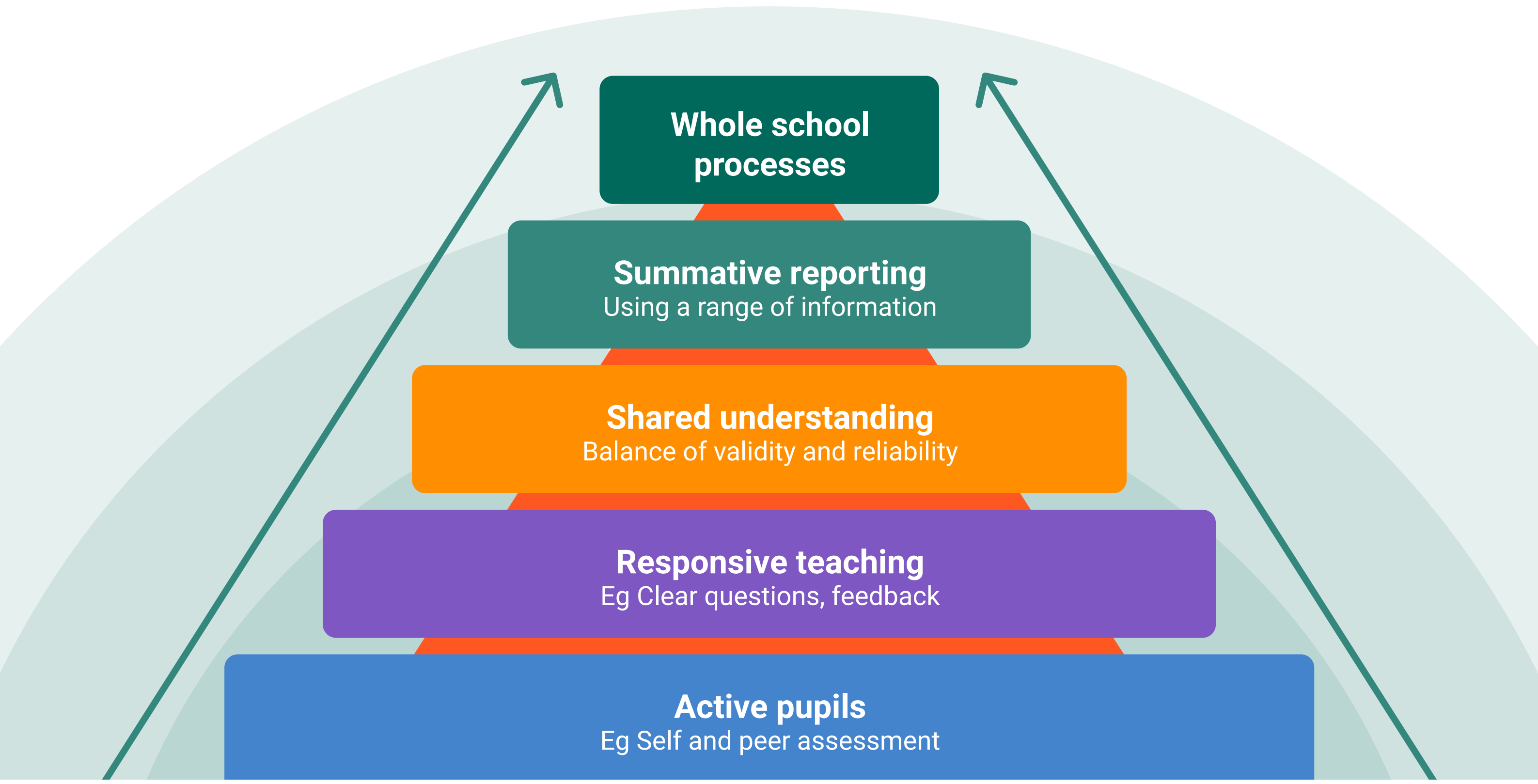
Although there is limited research on effective approaches to assessment in primary science, the Teacher Assessment in Primary Science (TAPS) project is a rigorously evaluated approach that has demonstrated a positive impact on pupils' learning of two months' additional progress.[59]

TAPS uses information from formative assessment, collected over time, to inform summative reporting which evaluates pupils' overall understanding at the end of a unit, term, or year. The approach can be summarised using its pyramid tool, which provides a framework to help schools evaluate and develop their primary science assessment processes using a 'formative to summative' model of assessment across the school.

The approach to assessment builds from the base of the pyramid, upwards. The foundation includes 'active pupils' and 'responsive teaching', which encapsulate TAPS' principles of assessment to support learning; these include clear learning objectives or success criteria, the use of questioning, feedback, and next steps, and peer and self-assessment.

Moving up, 'shared understanding' aims to enhance reliability of assessment (consistency of judgements) by discussing and comparing pupil outcomes and judgements with colleagues, supported by planned criteria and exemplars. A range of methods are used to summarise pupils' knowledge and understanding.

At the top of the pyramid, 'summative reporting' and 'whole school processes' aim to support a reliable and valid (reflective of planned learning) summary of learning by collating evidence about pupils' skills, knowledge, and understanding from formative assessment and wider class activities, which can be summarised for different reporting purposes.



# Use assessment to support learning and responsive teaching

## Hillside Primary School, Stoke-on-Trent - a case study

At Hillside Primary School, teachers employ diverse assessment methods in science to support their summative judgements of pupils. They plan various approaches for assessing and recording science knowledge throughout the unit. Examples include:

**Year 5: pupils create videos explaining day and night using a globe and torch.**

**Year 4: pupils make playdough models of teeth, matching them to name, function, and purpose, and capturing photographs.**

**Year 2: pupils create mini videos with the Chatterpix app, explaining material suitability for specific purposes.**

**Year 6: pupils use annotated photographs of shadows to explain related processes.**

Teachers use the pupils' work, observations, teacher notes, and written tasks to inform summative assessments. This inclusive approach allows all pupils to excel in science, irrespective of their English proficiency. It fosters depth of understanding and engagement by relieving the pressure to rely solely on writing.

When making summative judgements, teachers collate evidence from unit lessons and determine if it sufficiently demonstrates expected-level attainment. Moderation meetings are conducted, where staff compare individual books, floor books, observation notes, and formative assessment sheets with examples of 'working at' from the Pan London Assessment Network (PLAN) materials. This collaborative process ensures validation of teacher assessments by other staff, including the science lead.

## Bringing it together

Assessment should be viewed as a tool for improving teaching and learning rather than simply measuring outcomes. It's how you, your pupils, and your school respond to this information that is important.

Returning to the vignette at the start of this recommendation, what would you advise Mrs Thompson to do? How could the recommendations above help her and her pupils?

## 06
# Strengthen science teaching through effective professional development, as part of an implementation process

*The following vignette presents a challenge encountered by a science lead.*

Mrs Kasongo, a Year 1 teacher and the school science lead, sits surrounded by feedback forms from her colleagues. Teachers have expressed difficulties around teaching certain science topics, revealing worries about subject understanding and possibly confidence too. Mrs Kasongo's heart sinks as she sifts through the concerns—evolution, electricity, working scientifically …

She believes every teacher can do an excellent job of teaching science with proper guidance but faced with so many potential areas to support, she is uncertain about what to do next.

Mrs Kasongo reflects on her own professional development experiences: they focused on broader teaching strategies rather than subject-specific content. She feels a little overwhelmed, knowing her decisions could shape not only her colleagues' teaching but the scientific education of their young pupils.

**Mrs Kasongo wonders:**

- How should I develop an implementation plan which supports high quality science teaching?
- How can I bridge the gap between general teaching skills and subject-specific knowledge in science? Would subject-specific professional development courses benefit teachers?
- How can I monitor and evaluate the impact of these professional development initiatives on teaching and learning outcomes?

## Why it's important

Teaching is a continuous process of development: everyone has the potential to become a better teacher. Providing opportunities for science-specific professional development can harness this potential, which—with the right conditions—can translate into positive science outcomes for pupils.[60] Professional development is defined in this guidance as structured and facilitated activity for teachers intended to increase their teaching ability[61] and includes developing curriculum plans, systems for assessment, and monitoring processes.

Science leads are key drivers in bringing about change in science teaching,[62] however, without sustained senior leadership buy-in, which supports professional development—including the time and resourcing required—they are less likely to succeed.[63]

Implementation is defined as making, and acting on, evidence-informed decisions. Professional development is one strategy as part of a broader implementation effort to improve teaching quality.

## How to implement this recommendation

- 6a. Use a range of information to identify development priorities and professional learning needs[65]
- 6b. Consider key features of high quality professional development to plan or evaluate provision[66]
- 6c. Reflect on senior leadership support from the strategic to the classroom level[67]

**In 2019/2020, 57% of science leaders received professional development for science leadership or school development, and 61% had dedicated management time.[64]**

06

# Strengthen science teaching through effective professional development, as part of an implementation process

## 6a. Use a range of information to identify development priorities and professional learning needs

Science leads can play an important role in supporting the professional development of science teaching across a school. This may include identifying and accessing high quality and relevant training as well as providing a range of internal support such as staff training, co-planning and teaching, moderation of assessment, and the sharing of resources and sources of information.

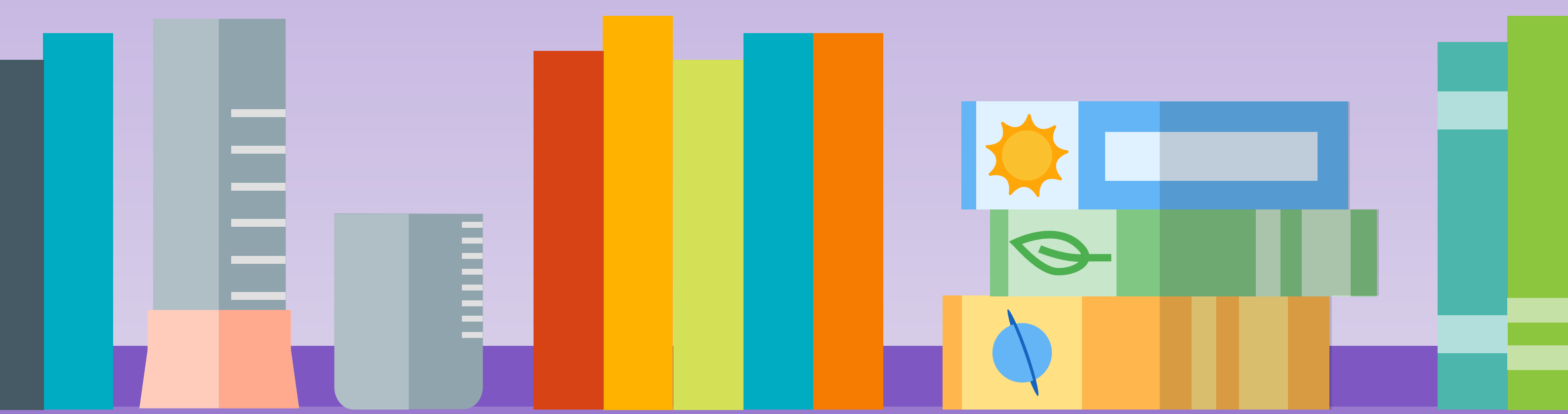
The range and extent of support a science lead may need to provide could be wide in scope, however, it needs to be manageable.

It is important not to try and support everything at once. Prioritise what is most impactful and specify a tight area of focus for improvement that is amenable to change.[68]

**To identify areas in science teaching most in need of improvement, and the type of information you need to inform your decisions, it may help to answer the following questions:**

1. Which areas of pupils' science learning need strengthening? What evidence is there for these?
2. Which aspects of science teaching are teachers finding most challenging? Is this reflected in pupils' learning?
3. Are teachers using assessment effectively in science lessons? How is this impacting teaching?
4. Do teaching plans and content support delivery of a well-sequenced curriculum?
5. Which areas of improvement will be most impactful to pupils' learning?
6. Does the support required for this align with senior leadership strategic goals or the school development plan?

Information to support decision making should be collected from a variety of sources, on an ongoing basis. This could include drawing on existing school monitoring processes such as curriculum planning documents, lesson observations, school development plans, teacher surveys, and professional development feedback.[69] Once you have identified a priority, consider where you want to get to and what is required to achieve this. Monitoring information can then be used to observe progress and inform future support.



## 6b. Consider key features of high quality professional development to plan or evaluate provision

Science leads need to be able to judge the quality and relevance of sources of professional learning. What are the indicators of high-quality professional learning? What evidence is this based on? Is it relevant to address your needs and those of the school? Could it be addressed with internal or external support?

There are several commercially available professional development programmes to support primary science. Some have been rigorously evaluated—including Focus4TAPS, Primary Science Quality Mark, and Thinking, Doing, Talking Science—however, many other available professional development programmes have not.

While independent evaluations provide accessible information on the likely impact of a programme, when this is not available it can be useful to reflect on the features of high quality professional development to the right. More guidance can be found in the EEF's Effective Professional Development guidance report, and through this video.

**High quality professional development should:**

- **build knowledge**—consider the amount of information that can be reasonably handled in one go and revisit learning to support recall of the approach or topic;
- **motivate staff**—empower teachers to set their own goals to achieve as an outcome of the training and demonstrate a robust supporting evidence-base so they can trust it; once implemented, positive reinforcement can encourage continuation;
- **develop teaching techniques**—show teachers how to integrate the approach into their practice using modelling, rehearsal, peer support, and delivery, with feedback, to hone technique; and
- **embed practice**—support purposeful plans and accountability, to use techniques, monitor progress, and reinforce implementation, so it becomes second nature.[70]

**A Balanced Approach to Professional Development**

### Sources of professional development include:

- Reach Out CPD
- STEM Learning
- The Association for Science Education
- Primary Science Teaching Trust
- The Odgen Trust
- Royal Society of Chemistry
- British Science Association

# Strengthen science teaching through effective professional development, as part of an implementation process

## 6c. Reflect on senior leadership support from the strategic to the classroom level

The foundations for good implementation of professional development include a leadership and school ethos which supports it. Without this, there is a risk any improvements become an 'add-on' task for science leads and teachers to tackle on top of their day to day work, or changes simply aren't sustained because competing priorities impact any initial enthusiasm.[71]

**Ways in which a science lead can be supported are:**

- science is included in the school development plan;
- science features on the school's professional development plan;
- science leads have appropriate time to fulfil their leader role;
- science leads are able to access science-specific professional development to support their role; and
- systems and processes empower science leaders to support teachers and monitor need.

The guidance report Putting Evidence to Work: A School's Guide to Implementation provides advice to help develop effective plans for implementation, which could support improvements in science teaching and enable science leads and teachers to prioritise improvements. Senior leaders, science leads, and teachers could consider who around them could help make change happen, and how they could positively support implementation.

### Bringing it together

The opening vignette in this recommendation will feel familiar to many science leads. What should Mrs Kasongo prioritise to best support pupils' science learning? How could she use these recommendations?

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