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Science Subject Leaders Resource File

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Science SL Resource File

This, and subsequent resource files have been designed specifically to support the work of subject leaders in Primary Schools who have responsibility for any of the following subjects: Art & Design; Computing; Design & Technology; English; Geography; History; Mathematics; MfL; Music; PE; PSHE and Science. The structure of each resource file follows the same format:

To support the work of a subject leader, there is a subject specific work-book for you to keep a record of all of the actions you have taken as well as the impact / outcome of those actions.

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Science Subject Leaders Work-Book

Part A: Resource pack for Subject Leaders of: Science

Links:
Science Association

- Association of Science Education

https://www.ase.org.uk
(Membership for: School £149 / annum - Individual £95 / annum)

- Science Museum

www.sciencemuseum.org.uk

- Primary Science Quality Mark

http://www.psqm.org.uk/what-is-psqm

- STEM

http://www.stem.org.uk

Resources

- Great science leadership at primary school (Welcome Trust)

https://welcome.ac.uk/sites/default/great-science-subject-leadership-welcome.pdf

- Developing great science subject leadership: great ideas for primary science from schools that value science

https://www.stem.org.uk/resources/elibrary/resource/229368/developing-great-science-subject-leadership-great-ideas-primary

- Primary Science Leaders Survival Guide

http://www.ase.org.uk/news/ase-news/primary-survival-guide/

The scientific area of learning and experience is concerned with increasing pupils' knowledge and understanding of the natural world and the world as modified by human beings, and with developing skills and competencies associated with science as a process of enquiry. These include observing, selecting from the observations whatever is important, framing hypotheses, devising and conducting experiments, communicating in oral and symbolic forms and applying the knowledge and understanding gained to new situations.

Pupils need to be taught to organise the data gathered through observation and investigation conducted by themselves and others. They should look for relationships or patterns and try to explain them. They should be encouraged to seek alternative explanations, to select those which seem most probable and to test them by experiments.

Pupils should be encouraged to handle objects, to observe phenomena, to talk about these and to take part in enquiries through which skills related to science as a process can be developed.

The emphasis should be on considering real problems.

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Science Programmes of Study for KS1 & 2

Purpose of study
A high-quality science education provides the foundations for understanding the world through the specific disciplines of biology, chemistry and physics. Science has changed our lives and is vital to the world's future prosperity, and all pupils should be taught essential aspects of the knowledge, methods, processes and uses of science. Through building up a body of key foundational knowledge and concepts, pupils should be encouraged to recognise the power of rational explanation and develop a sense of excitement and curiosity about natural phenomena. They should be encouraged to understand how science can be used to explain what is occurring, predict how things will behave, and analyse causes.

Aims
The national curriculum for science aims to ensure that all pupils:
♣ develop scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics
♣ develop understanding of the nature, processes and methods of science through different types of science enquiries that help them to answer scientific questions about the world around them
♣ are equipped with the scientific knowledge required to understand the uses and implications of science, today and for the future.

In order to achieve this, pupils need to work as successful scientists. This requires them to have the necessary skills for scientific enquiry. These skills should build upon opportunities for them to play, explore, create and engage in active learning.
It is important that there is a progression of the scientific skills that pupils are to develop throughout school. This ensures that they are not simply repeating the same skills again and again. As your pupils progress through school, they need to be able to use progressively more challenging skills to tackle the scientific problems they encounter.
To guarantee this happens, enquiry skills need to be carefully planned for.

*To support this please see this excellent resource '**Working Scientifically in the Primary Classroom'**. This has been produced by The Centre for Industry: Education Collaboration, and the original is available from**:***
http://www.ciec.org.uk/resources/working-scientifically.html

Scientific knowledge and conceptual understanding
The programmes of study describe a sequence of knowledge and concepts. While it is important that pupils make progress, it is also vitally important that they develop secure understanding of each key block of knowledge and concepts in order to progress to the next stage. Insecure, superficial understanding will not allow genuine progression: pupils may struggle at key points of transition (such as between primary and secondary school), build up serious misconceptions, and/or have significant difficulties in understanding higher-order

content. Pupils should be able to describe associated processes and key characteristics in common language, but they should also be familiar with, and use, technical terminology accurately and precisely. They should build up an extended specialist vocabulary. They should also apply their mathematical knowledge to their understanding of science, including collecting, presenting and analysing data. The social and economic implications of science are important but, generally, they are taught most appropriately within the wider school curriculum: teachers will wish to use different contexts to maximise their pupils' engagement with and motivation to study science.

The nature, processes and methods of science
'Working scientifically' specifies the understanding of the nature, processes and methods of science for each year group. It should not be taught as a separate strand. The notes and guidance give examples of how 'working scientifically' might be embedded within the content of biology, chemistry and physics, focusing on the key features of scientific enquiry, so that pupils learn to use a variety of approaches to answer relevant scientific questions. These types of scientific enquiry should include: observing over time; pattern seeking; identifying, classifying and grouping; comparative and fair testing (controlled investigations); and researching using secondary sources. Pupils should seek answers to questions through collecting, analysing and presenting data. 'Working scientifically' will be developed further at key stages 3 and 4, once pupils have built up sufficient understanding of science to engage meaningfully in more sophisticated discussion of experimental design and control. Spoken language The national curriculum for science reflects the importance of spoken language in pupils' development across the whole curriculum – cognitively, socially and linguistically. The quality and variety of language that pupils hear and speak are key factors in developing their scientific vocabulary and articulating scientific concepts clearly and precisely. They must be assisted in making their thinking clear, both to themselves and others, and teachers should ensure that pupils build secure foundations by using discussion to probe and remedy their misconceptions. School curriculum The programmes of study for science are set out year-by-year for key stages 1 and 2. Schools are, however, only required to teach the relevant programme of study by the end of the key stage. Within each key stage, schools therefore have the flexibility to introduce content earlier or later than set out in the programme of study. In addition, schools can introduce key stage content during an earlier key stage if appropriate. All schools are also required to set out their school curriculum for science on a year-by-year basis and make this information available online.

Key Stage 1:
The principal focus of science teaching in key stage 1 is to enable pupils to experience and observe phenomena, looking more closely at the natural and humanly-constructed world around them. They should be encouraged to be curious and ask questions about what they notice. They should be helped to develop their understanding of scientific ideas by using different types of scientific enquiry to answer their own questions, including observing changes over a period of time, noticing patterns, grouping and classifying things, carrying out simple comparative tests, and finding things out using secondary sources of information. They should begin to use simple scientific language to talk about what they have found out and communicate their ideas to a range of audiences in a variety of ways. Most of the learning about science should be done through the use of first-hand practical experiences, but there should also be some use of appropriate secondary sources, such as books, photographs and videos. 'Working scientifically' is described separately in the programme of study, but must always be taught through and clearly related to the teaching of substantive science content in the programme of study. Throughout the notes and guidance, examples show how scientific methods and skills might be

linked to specific elements of the content. Pupils should read and spell scientific vocabulary at a level consistent with their increasing word reading and spelling knowledge at key stage 1.

Key stage 1 programme of study – years 1 and 2

Working scientifically

Statutory requirements During years 1 and 2, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content:

- ♣ asking simple questions and recognising that they can be answered in different ways
- ♣ observing closely, using simple equipment
- ♣ performing simple tests
- ♣ identifying and classifying
- ♣ using their observations and ideas to suggest answers to questions
- ♣ gathering and recording data to help in answering questions.

Year 1 programme of study

Plants: Statutory requirements

Pupils should be taught to:

- ♣ identify and name a variety of common wild and garden plants, including deciduous and evergreen trees
- ♣ identify and describe the basic structure of a variety of common flowering plants, including trees.

Animals, including humans: Statutory requirements

Pupils should be taught to:

- ♣ identify and name a variety of common animals including fish, amphibians, reptiles, birds and mammals
- ♣ identify and name a variety of common animals that are carnivores, herbivores and omnivores
- ♣ describe and compare the structure of a variety of common animals (fish, amphibians, reptiles, birds and mammals, including pets)
- ♣ identify, name, draw and label the basic parts of the human body and say which part of the body is associated with each sense.

Everyday materials: Statutory requirements

Pupils should be taught to:

- ♣ distinguish between an object and the material from which it is made
- ♣ identify and name a variety of everyday materials, including wood, plastic, glass, metal, water, and rock
- ♣ describe the simple physical properties of a variety of everyday materials
- ♣ compare and group together a variety of everyday materials on the basis of their simple physical properties.

Seasonal changes: Statutory requirements

Pupils should be taught to:

- ♣ observe changes across the four seasons
- ♣ observe and describe weather associated with the seasons and how day length varies.

Year 2 programme of study

Living things and their habitats: Statutory requirements

Pupils should be taught to:

♣ explore and compare the differences between things that are living, dead, and things that have never been alive

♣ identify that most living things live in habitats to which they are suited and describe how different habitats provide for the basic needs of different kinds of animals and plants, and how they depend on each other

♣ identify and name a variety of plants and animals in their habitats, including microhabitats

♣ describe how animals obtain their food from plants and other animals, using the idea of a simple food chain, and identify and name different sources of food.

Plants: Statutory requirements

Pupils should be taught to:

♣ observe and describe how seeds and bulbs grow into mature plants

♣ find out and describe how plants need water, light and a suitable temperature to grow and stay healthy.

Animals, including humans: Statutory requirements

Pupils should be taught to:

♣ notice that animals, including humans, have offspring which grow into adults

♣ find out about and describe the basic needs of animals, including humans, for survival (water, food and air)

♣ describe the importance for humans of exercise, eating the right amounts of different types of food, and hygiene.

Uses of everyday materials: Statutory requirements

Pupils should be taught to:

♣ identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses

♣ find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.

Lower key stage 2 – years 3 and 4

The principal focus of science teaching in lower key stage 2 is to enable pupils to broaden their scientific view of the world around them.

They should do this through exploring, talking about, testing and developing ideas about everyday phenomena and the relationships between living things and familiar environments, and by beginning to develop their ideas about functions, relationships and interactions. They should ask their own questions about what they observe and make some decisions about which types of scientific enquiry are likely to be the best ways of answering them, including observing changes over time, noticing patterns, grouping and classifying things, carrying out simple comparative and fair tests and finding things out using secondary sources of information. They should draw simple conclusions and use some scientific language, first, to talk about and, later, to write about what they have found out. 'Working scientifically' is described separately at the beginning of the programme of study, but must always be taught through and clearly related to substantive science content in the programme of study. Throughout the notes and guidance, examples show how scientific methods and skills might be linked to specific elements of the content. Pupils should read and spell scientific vocabulary correctly and with confidence, using their growing word reading and spelling knowledge.

Lower key stage 2 programme of study

Working scientifically:Statutory requirements

During years 3 and 4, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content:

♣ asking relevant questions and using different types of scientific enquiries to answer them

♣ setting up simple practical enquiries, comparative and fair tests

♣ making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers

♣ gathering, recording, classifying and presenting data in a variety of ways to help in answering questions

♣ recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables

♣ reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions

♣ using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions

♣ identifying differences, similarities or changes related to simple scientific ideas and processes

♣ using straightforward scientific evidence to answer questions or to support their findings.

Year 3 programme of study

Plants: Statutory requirements

Pupils should be taught to:

♣ identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves and flowers

♣ explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant

♣ investigate the way in which water is transported within plants

♣ explore the part that flowers play in the life cycle of flowering plants, including pollination, seed formation and seed dispersal.

Animals, including humans: Statutory requirements

Pupils should be taught to:

♣ identify that animals, including humans, need the right types and amount of nutrition, and that they cannot make their own food; they get nutrition from what they eat

♣ identify that humans and some other animals have skeletons and muscles for support, protection and movement.

Rocks: Statutory requirements

Pupils should be taught to:

♣ compare and group together different kinds of rocks on the basis of their appearance and simple physical properties

♣ describe in simple terms how fossils are formed when things that have lived are trapped within rock

♣ recognise that soils are made from rocks and organic matter.

Light: Statutory requirements
Pupils should be taught to:
♣ recognise that they need light in order to see things and that dark is the absence of light
♣ notice that light is reflected from surfaces
♣ recognise that light from the sun can be dangerous and that there are ways to protect their eyes
♣ recognise that shadows are formed when the light from a light source is blocked by an opaque object
♣ find patterns in the way that the size of shadows change.

Forces and magnets: Statutory requirements
Pupils should be taught to:
♣ compare how things move on different surfaces
♣ notice that some forces need contact between two objects, but magnetic forces can act at a distance
♣ observe how magnets attract or repel each other and attract some materials and not others
♣ compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials
♣ describe magnets as having two poles
♣ predict whether two magnets will attract or repel each other, depending on which poles are facing.

Year 4 programme of study
Living things and their habitats: Statutory requirements
Pupils should be taught to:
♣ recognise that living things can be grouped in a variety of ways
♣ explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment
♣ recognise that environments can change and that this can sometimes pose dangers to living things.

Animals, including humans: Statutory requirements
Pupils should be taught to:
♣ describe the simple functions of the basic parts of the digestive system in humans
♣ identify the different types of teeth in humans and their simple functions
♣ construct and interpret a variety of food chains, identifying producers, predators and prey.

States of matter: Statutory requirements
Pupils should be taught to:
♣ compare and group materials together, according to whether they are solids, liquids or gases
♣ observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C)
♣ identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature.

Sound: Statutory requirements
Pupils should be taught to:
♣ identify how sounds are made, associating some of them with something vibrating
♣ recognise that vibrations from sounds travel through a medium to the ear

♣ find patterns between the pitch of a sound and features of the object that produced it
♣ find patterns between the volume of a sound and the strength of the vibrations that produced it
♣ recognise that sounds get fainter as the distance from the sound source increases.

Electricity: Statutory requirements
Pupils should be taught to:
♣ identify common appliances that run on electricity
♣ construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers
♣ identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery
♣ recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit
♣ recognise some common conductors and insulators, and associate metals with being good conductors.

Upper key stage 2 – years 5 and 6

The principal focus of science teaching in upper key stage 2 is to enable pupils to develop a deeper understanding of a wide range of scientific ideas. They should do this through exploring and talking about their ideas; asking their own questions about scientific phenomena; and analysing functions, relationships and interactions more systematically. At upper key stage 2, they should encounter more abstract ideas and begin to recognise how these ideas help them to understand and predict how the world operates. They should also begin to recognise that scientific ideas change and develop over time. They should select the most appropriate ways to answer science questions using different types of scientific enquiry, including observing changes over different periods of time, noticing patterns, grouping and classifying things, carrying out comparative and fair tests and finding things out using a wide range of secondary sources of information. Pupils should draw conclusions based on their data and observations, use evidence to justify their ideas, and use their scientific knowledge and understanding to explain their findings. 'Working and thinking scientifically' is described separately at the beginning of the programme of study, but must always be taught through and clearly related to substantive science content in the programme of study. Throughout the notes and guidance, examples show how scientific methods and skills might be linked to specific elements of the content. Pupils should read, spell and pronounce scientific vocabulary correctly.

Upper key stage 2 programme of study
Working scientifically: Statutory requirements
During years 5 and 6, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content:
♣ planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary
♣ taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate
♣ recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs
♣ using test results to make predictions to set up further comparative and fair tests
♣ reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations

♣ identifying scientific evidence that has been used to support or refute ideas or arguments.

Living things and their habitats: Statutory requirements
Pupils should be taught to:
♣ describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird
♣ describe the life process of reproduction in some plants and animals.

Animals, including humans: Statutory requirements
Pupils should be taught to:
♣ describe the changes as humans develop to old age.

Properties and changes of materials Statutory requirements
Pupils should be taught to:
♣ compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets
♣ know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution
♣ use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating
♣ give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic
♣ demonstrate that dissolving, mixing and changes of state are reversible changes
♣ explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Earth and space: Statutory requirements
Pupils should be taught to:
♣ describe the movement of the Earth, and other planets, relative to the Sun in the solar system
♣ describe the movement of the Moon relative to the Earth
♣ describe the Sun, Earth and Moon as approximately spherical bodies
♣ use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky.

Forces: Statutory requirements
Pupils should be taught to:
♣ explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object
♣ identify the effects of air resistance, water resistance and friction, that act between moving surfaces
♣ recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Year 6 programme of study
Living things and their habitats: Statutory requirements
Pupils should be taught to:
♣ describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including microorganisms, plants and animals

♣ give reasons for classifying plants and animals based on specific characteristics.

Animals including humans: Statutory requirements
Pupils should be taught to:
♣ identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood
♣ recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function
♣ describe the ways in which nutrients and water are transported within animals, including humans.

Evolution and inheritance: Statutory requirements
Pupils should be taught to:
♣ recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago
♣ recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents
♣ identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution.

Light: Statutory requirements
Pupils should be taught to:
♣ recognise that light appears to travel in straight lines
♣ use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye
♣ explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes
♣ use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them.

Electricity: Statutory requirements
Pupils should be taught to:
♣ associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit
♣ compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches
♣ use recognised symbols when representing a simple circuit in a diagram.

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Part B: Subject leaders audit: Science

Task	Notes	Completed	Date
Am I clear about the N.C. Aims for Science?			
Have I checked out the subject association website to identify resources for: * Me, as the subject leader * Teachers / assistants			
Have I completed an audit of my own K, S & U against these aims?			
Have I identified sources to support me in my own subject knowledge?			
Have I written a statement of Intent for Science?			
In writing the statement of Intent, did I refer to paragraph 179 of D-D Resource 1?			
Re: Para: 179, do I have a written response for each of the 5 bullet points?			
Has this statement been approved by HT / SLT / all staff?			
Have I developed a monitoring calendar so that I am able to build up an accurate and up-to-date overview of the www/ebi in T, L & A for Science?			
Have I clarified with my line manager what good / better T, L & A in Science ‘looks’ like? (and hence what is not yet ‘good’ enough)			
Supplementary questions:			
How long have I been the subject leader for Science, and what			

support (CPD) have I received either internally or externally?			
What resources do I use to support me as a subject leader?			
How have I designed the Science curriculum?			
What am I trying to achieve through the Science curriculum?			
What scheme of learning does the school follow (published or your own)?			
How is this subject taught, and why?			
How do children progress in this subject from one year to the next? *(Remember that **progress is knowing more, remembering more and being able to do more**.)*			
How do you ensure that pupils retain their subject knowledge?			
How do you ensure that pupils with SEND (as well as those entitled to Pupil Premium) benefit from the curriculum in this subject?			
What would you expect an inspector to see when they visit Science lessons and speak to the pupils?			
How do teachers clarify any misconceptions by pupils?			
What links are made between Science and other subjects does – can you give an example of where this works particularly well?			
Can you tell of any examples where you have supported other teachers / assistants in subject X and the impact that this has had on their teaching / pupils' learning?			

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Part C: Progression in Science: exemplar

NC Aims	How science works (Scientific enquiry)	Organisms, their behaviour and the environment	Materials, their properties and the earth	Energy, forces and space
EYFS	Use all their senses in hands-on exploration of natural materials. Explore collections of materials with similar and/or different properties. Talk about what they see, using a wide vocabulary. Understand the effect of changing seasons on the natural world around them.	Plant seeds and care for growing plants. Understand the key features of the life cycle of a plant and an animal. Begin to understand the need to respect and care for the natural environment and all living things.	Explore and talk about different forces they can feel. Talk about the differences between materials and changes they notice.	
A	Pupils respond to prompts to suggest practical ways to find answers to questions. They make observations about features of objects, living things and events. They communicate their findings in ways such as talking about their work in everyday terms, or through drawings or by completing pictograms.	Pupils use their knowledge related to organisms, their behaviour and the environment to recognise, identify and describe a range of common plants, animals and natural events. They name and describe external parts or features of plants, such as leaf colour; humans, such as head, arm; and other animals, such as coat colour. They use that evidence to identify plants or animals and make links between science and everyday objects and experiences.	Pupils use their knowledge related to materials, their properties and the Earth, to recognise, and describe some common materials, and their sensory properties, such as the texture and appearance of soils. They communicate their descriptions and observations in terms of these properties. They recognise evidence that has been used to answer a question such as identifying similar materials and make links between science and everyday objects and experiences such as waterproof materials being used to keep things dry.	Pupils use their knowledge related to energy, forces and space to describe some changes in light, sound or movement, that result from actions, such as those caused by pushing and pulling objects or switching on an electrical circuit. They recognise that light and sound come from a variety of sources, such as the Sun or a musical instrument. They recognise evidence that has been used to answer a question, such as how a musical instrument makes a noise, and make links between science and everyday objects and experiences such as the Sun being a light source.
B	Pupils respond to suggestions and make their own suggestions, with help, about how to collect relevant data and answer questions. They find information by using texts, with help.	Pupils use their knowledge related to organisms, their behaviour and the environment to describe plants and animals, the places they are found and the basic conditions they need in order to survive.	Pupils use their knowledge related to materials, their properties and the Earth to identify a range of common materials and some of their properties. They recognise, and describe similarities	Pupils use their knowledge related to energy, forces and space to recognise, describe and compare a range of properties and effects of light, sound, forces, and electricity, such as the ways in which devices work in different

	They follow direct instructions in order to stay safe. They make observations and measurements to compare living things, objects and events, using equipment provided for them. They record findings using prepared tables and communicate observations using scientific vocabulary. They say whether what happened was what they expected and, when prompted, suggest different ways they could have done things.	They recognise and describe similarities and differences between the plants, humans and other animals they observe, using these to sort them into groups. They use questions based on their own ideas and evidence such as finding different types of plants and animals in different places. They identify science in everyday contexts and say whether it is helpful, for example ways of growing vegetables for food.	and differences between the materials they observe, using these to sort them into groups. They recognise and describe ways in which some materials are changed by heating or cooling or by processes such as bending or stretching. They suggest answers to questions, such as the best material to reflect light, based on their own ideas and evidence. They identify science in everyday contexts and say whether it is helpful, for example ice melting.	electrical circuits, the brightness or colour of lights, the loudness of sounds or the speed or direction of different objects. They suggest answers to questions such as which sound is loudest based on their own ideas and evidence. They identify science in everyday contexts and say whether it is helpful, for example electricity in domestic appliances.
C	Pupils respond to suggestions and put forward their own ideas about how to investigate an idea or find answers to questions. They recognise why it is important to collect data to investigate ideas and answer questions, and use texts to find information. They begin to recognise risks with help. They make relevant observations and measure quantities, such as length or mass, selecting and using a range of simple equipment. They carry out fair tests with some help, recognising and explaining what makes them fair. They record findings in a variety of ways, including tables or charts. They give explanations for observations and for patterns in measurements they have made and recorded. They communicate in a scientific way what they have found out and suggest improvements in their work.	Pupils use knowledge and understanding of organisms, their behaviour and the environment, such as the basic life processes of growth and reproduction, to describe similarities, differences and changes in the plants, animals, and non-living things they observe. They use simple scientific ideas with evidence they have collected to give explanations of their observations, linking cause and effect, for example lack of light or water affecting plant growth and the ways in which animals or plants are suited to their environments. They recognise and explain the purpose of a variety of scientific and technological developments in their everyday lives, for example medicines helping people get better when they are ill.	Pupils use knowledge and understanding of materials, their properties and the Earth to sort materials into groups in a variety of ways, according to their properties. They explain the ways in which some materials are suited to specific purposes such as glass for windows or copper for electrical cables. They classify changes in materials as reversible, such as water freezing, and non-reversible, such as baking of cakes. They use simple scientific ideas with evidence they have collected to give explanations of their observations, linking cause and effect, for example the evaporation of water. They recognise and explain the purpose of a variety of scientific and technological developments in their everyday lives, for example sustainable packaging.	Pupils use their knowledge and understanding of energy, forces and space to link cause and effect in their observations of the properties and effects of light, sound, forces, and electricity, such as a bulb failing to light because of a break in an electrical circuit, or a push or pull changing the speed or direction of a moving object. They begin to make generalisations such as sounds getting fainter the further the listener is from the source. They use simple scientific ideas with evidence they have collected to give explanations of their observations, linking cause and effect, for example using a switch to turn off a light bulb in an electrical circuit. They recognise and explain the purpose of a variety of scientific and technological developments in their everyday lives, for example streamlining and air resistance.

D	Pupils decide on an appropriate approach, including using a fair test to answer a question, and select suitable equipment and information from that provided. They select and use methods that are adequate for the task. Following instructions, they take action to control obvious risks to themselves. They make a series of observations and measurements and vary one factor while keeping others the same. They record their observations, comparisons and measurements using tables and bar charts and begin to plot points to form simple graphs. They interpret data containing positive and negative numbers. They begin to relate their conclusions to patterns in data, including graphs, and to scientific knowledge and understanding. They communicate their conclusions using appropriate scientific language. They suggest improvements in their work, giving reasons.	Pupils describe some processes and phenomena related to organisms, their behaviour and the environment, drawing on scientific knowledge and understanding and using appropriate terminology, for example using food chains to describe feeding relationships between plants and animals in a habitat. They recognise that evidence can support or refute scientific ideas, such as in the identification and grouping of living things. They recognise some applications and implications of science, such as the use of predators to control pest populations.	Pupils describe some processes and phenomena related to materials, their properties and the Earth, drawing on scientific knowledge and understanding and using appropriate terminology, for example separation methods. They recognise that evidence can support or refute scientific ideas, such as the classification of reactions as reversible and irreversible. They recognise some applications and implications of science, such as the safe use of acids and alkalis.	Pupils describe some processes and phenomena related to energy, forces and space, drawing on scientific knowledge and understanding and using appropriate terminology, for example the observed position of the sun in the sky over the course of a day. They recognise that evidence can support or refute scientific ideas, such as sounds being heard through a variety of materials. They recognise some applications and implications of science, such as the use of electrical components to make electrical devices.
E	Pupils decide appropriate approaches to a range of tasks, including selecting sources of information and apparatus. They select and use methods to obtain data systematically. They recognise hazard symbols and make, and act on, simple suggestions to control obvious risks to themselves and others. They use line graphs to present data, interpret numerical data and draw conclusions from them. They analyse findings to	Pupils describe processes and phenomena related to organisms, their behaviour and the environment, drawing on abstract ideas and using appropriate terminology, for example the main functions of plant and animal organs and how these functions are essential. They explain processes and phenomena, in more than one step or using a model, such as the main stages of the life cycles of humans and flowering plants. They apply and use knowledge and understanding in	Pupils describe processes and phenomena related to materials, their properties and the Earth, drawing on abstract ideas and using appropriate terminology, for example the weathering of rocks. They explain processes and phenomena, in more than one step or using a model, such as the deposition of sediments and their formation into rocks. They apply and use knowledge and understanding in familiar contexts, such as identifying changes of state. They recognise that both	Pupils describe processes and phenomena related to energy, forces and space, drawing on abstract ideas and using appropriate terminology, for example ‘balanced forces’. They explain processes and phenomena, in more than one step or using a model, such as the length of a day or a year. They apply and use knowledge and understanding in familiar contexts. They recognise that both evidence and creative thinking contribute to the development of scientific

	draw scientific conclusions that are consistent with the evidence. They communicate these using scientific and mathematical conventions and terminology. They evaluate their working methods to make practical suggestions for improvements.	familiar contexts, such as different organisms being found in different habitats because of differences in environmental factors. They recognise that both evidence and creative thinking contribute to the development of scientific ideas, such as the classification of living things. They describe applications and implications of science, such as solving some of the health problems that arise when organ damage occurs.	evidence and creative thinking contribute to the development of scientific ideas, such as basing separation methods for mixtures on physical and chemical properties. They describe applications and implications of science, such as the uses of metals based on their specific properties or the benefits and drawbacks of the use of fossil fuels.	ideas, such as objects being seen when light from them enters the eye. They describe applications and implications of science, such as the ways sound can be produced and controlled, for example in musical instruments.
F	Pupils identify an appropriate approach in investigatory work, selecting and using sources of information, scientific knowledge and understanding. They select and use methods to collect adequate data for the task, measuring with precision, using instruments with fine scale divisions, and identify the need to repeat measurements and observations. They recognise a range of familiar risks and take action to control them. They record data and features effectively, choosing scales for graphs and diagrams. They analyse findings to draw conclusions that are consistent with the evidence and use scientific knowledge and understanding to explain them and account for any inconsistencies in the evidence. They manipulate numerical data to make valid comparisons and draw valid conclusions. They communicate qualitative and quantitative data	Pupils describe processes and phenomena related to organisms, their behaviour and the environment, using abstract ideas and appropriate terminology, for example simple cell structure and function. They take account of a number of factors or use abstract ideas or models in their explanations of processes and phenomena, such as environmental factors affecting the distribution of organisms in habitats. They apply and use knowledge and understanding in unfamiliar contexts, such as a food web in a habitat. They describe some evidence for some accepted scientific ideas, such as the causes of variation between living things. They explain the importance of some applications and implications of science, such as the use of selective breeding.	Pupils describe processes and phenomena related to materials, their properties and the Earth, using abstract ideas and appropriate terminology, for example the particle model applied to solids, liquids and gases. They take account of a number of factors or use abstract ideas or models in their explanations of processes and phenomena, such as word equations. They apply and use knowledge and understanding in unfamiliar contexts, such as relating changes of state to energy transfers in a range of contexts such as the formation of igneous rocks. They describe some evidence for some accepted scientific ideas, such as the patterns in the reactions of acids with metals and the reactions of a variety of substances with oxygen. They explain the importance of some applications and implications of science, such as the production of new materials with specific desirable properties.	Pupils describe processes and phenomena related to energy, forces and space, using abstract ideas and appropriate terminology, for example electric current as a way of transferring energy. They take account of a number of factors in their explanations of processes and phenomena, for example in the relative brightness of stars and planets. They also use abstract ideas or models, for example sustainable energy sources and the refraction of light. They apply and use knowledge and understanding in unfamiliar contexts. They describe some evidence for some accepted scientific ideas, such as the transfer of energy by light, sound or electricity, and the refraction and dispersion of light. They explain the importance of some applications and implications of science, such as the responsible use of unsustainable sources of energy.

	effectively, using scientific conventions and terminology. They evaluate evidence, making reasoned suggestions about how their working methods could be improved.			
G	Pupils plan appropriate approaches and procedures, by synthesising information from a range of sources and identifying key factors in complex contexts and in which variables cannot readily be controlled. They select and use methods to obtain reliable data, including making systematic observations and measurements with precision, using a range of apparatus. They recognise the need for a risk assessment and consult appropriate sources of information, which they follow. They record data in graphs, using lines of best fit. They analyse findings to draw conclusions that are consistent with the evidence and use scientific knowledge and understanding to explain these conclusions and identify possible limitations in primary and secondary data. They use quantitative relationships between variables. They communicate effectively, using a wide range of scientific and technical conventions and terminology, including symbols and flow diagrams. They begin to consider whether the data they have collected are sufficient for the conclusions they have drawn.	Pupils describe a wide range of processes and phenomena related to organisms, their behaviour and the environment, using abstract ideas and appropriate terminology and sequencing a number of points, for example respiration and photosynthesis, or pyramids of biomass. They make links between different areas of science in their explanations. They apply and use more abstract knowledge and understanding, in a range of contexts, such as inherited and environmental variation. They explain how evidence supports some accepted scientific ideas, such as the structure and function of cells. They explain, using abstract ideas where appropriate, the importance of some applications and implications of science, such as the uses of cells in stem cell research.	Pupils describe a wide range of processes and phenomena related to materials, their properties and the Earth, using abstract ideas and appropriate terminology and sequencing a number of points, for example the rock cycle. They make links between different areas of science in their explanations, such as between the nature and behaviour of materials and their particles. They apply and use more abstract knowledge and understanding, in a range of contexts, such as the particle model of matter, and symbols and formulae for elements and compounds. They explain how evidence supports some accepted scientific ideas, such as the reactivity series of metals. They explain, using abstract ideas where appropriate, the importance of some applications and implications of science, such as the need to consider the availability of resources, and environmental effects, in the production of energy and materials.	Pupils describe a wide range of processes and phenomena related to energy, forces and space, using abstract ideas and appropriate terminology and sequencing a number of points, for example how energy is transferred by radiation or by conduction. They make links between different areas of science in their explanations, such as between electricity and magnetism. They apply and use more abstract knowledge and understanding in a range of contexts, such as the appearance of objects in different colours of light. They explain how evidence supports some accepted scientific ideas, such as the role of gravitational attraction in determining the motion of bodies in the solar system. They explain, using abstract ideas where appropriate, the importance of some applications and implications of science, such as the uses of electromagnets.

Part D: Initial subject self-evaluation proforma   Date:

This is a basic self-evaluation proforma in order for the subject leader to gain a brief overview of strengths and areas for improvement possibly prior to undertaking a more comprehensive review and monitoring process.

Summary
The key strengths in:
Teaching, learning & assessment in Science are:
The Science Curriculum are:
The main areas we need to develop in:
Teaching, learning & assessment in Science are:
The Science curriculum are:

Signed: …………………………………..   **Date:** ………………………………….

A P Associates
educational consultants

Part E: Best practice as identified by Ofsted

In this section, I make reference to:

- **Ei:** Finding the optimum: the science subject report(Ofsted February 2023) https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2
- **Eii:** the Ofsted Research Review Report for Science (July 2021) https://www.gov.uk/government/publications/research-review-series-music/research-review-series-music#fn:22
- **Eii:** the last 'triennial' report (2011) the Ofsted wrote about MfL in Primary & Secondary schools This report provides numerous examples of what were described as best practice in teaching & learning in Science (2011) in primary schools. They provide excellent examples for sharing out amongst class teachers as well as for subject leaders to audit their school's provision against.

Part Ei: Finding the optimum: the science subject report (Ofsted February 2023)
https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2

Executive summary
Science helps us to answer our biggest questions and to meet our most basic needs: from explaining the deepest mysteries of the universe to the structure of elementary particles that form atoms. The findings of science have fundamentally shaped every aspect of our world. Science drives innovation, creating new knowledge to help us solve current and future problems. All young people are entitled to a high-quality science education, to the curiosity it engenders and the understanding and the opportunity it brings.

The report evaluates the common strengths and weaknesses of science in the schools inspected and considers the challenges that science faces. This evidence was gathered by His Majesty's Inspectors as part of routine inspections. The report builds on the 2021 Ofsted science research review. The report is split into findings in primary schools and those in secondary schools, and includes evidence from Reception classes and sixth forms. Within each of these sections, we talk about:

- aspects of the curriculum
- pedagogy
- assessment
- the way schools are organised
- the impact of this on what pupils learn

Overall, this report identifies some significant strengths in school science education and recommends ways that school and subject leaders can ensure that all pupils leave school with an authentic understanding of science, as both a tradition of enquiry and a set of connected but distinct ideas that explain the world we live in.

It is important to note that we evaluate schools against the criteria in the school inspection handbooks. Findings from this report will not be used as a 'tick list' by inspectors when they are inspecting schools: we know that there are many different ways that schools can put together and teach a high-quality science curriculum.

Key terms used in this report

Knowledge in science
Throughout this report, we use the same terminology to describe scientific knowledge as we did in our science research review. These are not terms that Ofsted necessarily expects pupils or teachers to use during inspections. Rather, we use them here to recognise these 2 important aspects of science in which pupils need to build their understanding throughout their time at school.

- **Substantive knowledge**: refers to the established knowledge produced by science, for example, the parts of a flower or the names of planets in our solar system. This is referred to as 'scientific knowledge' and 'conceptual understanding' in the national curriculum.
- **Disciplinary knowledge**: refers to what pupils learn about how to establish and refine scientific knowledge, for example by carrying out practical procedures. By identifying and sequencing this knowledge, it is possible to plan in the curriculum for how pupils will get better at working scientifically throughout their time at school.

Practical work

We are aware that primary and secondary school teachers talk about practical work in science using different terms. For clarity, this report defines practical work as: ‘any teaching and learning activity which at some point involves the students in observing or manipulating the objects and materials they are studying’. Practical work in this report can refer to a teacher demonstration or a hands-on practical activity for students.

Main findings

- Most pupils, including those with special educational needs and/or disabilities (SEND), studied a science curriculum that was at least as ambitious as the national curriculum. These curriculums were mainly focused on developing, over time, pupils' knowledge of substantive concepts such as 'habitat', 'force' and 'material'.

- Where science was strong, pupils had learned detailed and connected knowledge of the curriculum, and remembered what they had learned previously. In a significant minority of schools, pupils were not developing secure knowledge of science. Often, in these schools, the focus was on covering the content, rather than ensuring it was learned, or completing practical activities.

- There were a small minority of primary schools where pupils went for entire half terms without learning science. This is a concern because science is a core subject of the national curriculum, and pupils benefit from regular opportunities to revisit and build on their knowledge so that it is not forgotten.

- Some pupils came out of lockdown with significant gaps in their scientific knowledge, and COVID-19 prevented primary and secondary colleagues from working together to support pupils' transition.

- Leaders' plans to develop pupils' disciplinary knowledge were usually much less developed than their plans to develop pupils' substantive knowledge. In general, not enough consideration was given to identifying the disciplinary knowledge, including concepts, that are needed to work scientifically. This limited how effectively leaders could plan a curriculum for pupils to get better at working scientifically over time. Too often, the focus was simply on identifying practical activities for pupils to complete.

- There were large differences in the amount of practical work taking place in schools. For example, pupils in primary school were much more likely to take part in hands-on practical activities than pupils in secondary school. In all schools that we visited, teachers rarely used demonstrations.

- Across primary and secondary schools, some pupils did not have sufficient opportunities to practise and consolidate what they learned before moving on to new content. This meant they did not remember key content taught previously. In some schools, there was an over-reliance on pupils catching up when the content was repeated later in the curriculum, rather than ensuring it was learned first time. Often this happened when teachers were expected to teach too much content in a short time. This was more common in secondary schools.

- Overall. most leaders saw their school science curriculum as a description of what pupils needed to know and do. They had planned the curriculum carefully so that pupils studied content in a logical order. However, leaders generally did not see the curriculum as something that could make learning science easier. For example, very few leaders had planned their science curriculum to take account of what pupils learned in mathematics, and rarely did science curriculums help pupils to avoid misconceptions.

- In some schools, leaders planned the science curriculum to build on what pupils had learned in the previous phase of education. However, in some secondary schools it was incorrectly assumed that pupils learned little science in primary school. This led to some content being unnecessarily repeated in Year 7 and beyond.

- Children were generally introduced to a range of interesting phenomena in Reception. However, in some primary schools, the knowledge of the natural world that children were expected to learn in Reception was not clear enough. Often this was when curriculums simply identified general topic areas or activities for children to complete. This limited how effectively children were prepared for learning science in Year 1.

- Teachers generally had secure subject knowledge. Clear explanations from teachers, alongside carefully selected teaching activities, supported the learning of specific content and played a key role in helping pupils to learn science. Teachers who had strong subject knowledge were able to bring into the lesson wider knowledge from across the science curriculum. This helped pupils to make connections between scientific concepts.

- However, teachers rarely drew on evidence-based, subject-specific approaches when teaching science. Very few schools had a clear plan of how teachers' knowledge of science, and how to teach it, was developed over time through continuing professional development (CPD).

- In most schools, subject leaders played a crucial role in developing school science curriculums and supporting teachers to teach them. However, not all subject leaders had access to dedicated leadership time and subject leadership training. This is a concern, given their central role in ensuring good-quality teaching in their subject.

- During the period when we were gathering evidence, schools were facing many challenges because of COVID-19. Despite these challenges, many subject leaders were improving and developing their school's science curriculum. Sometimes, this was because leaders wanted to address gaps in pupils' knowledge that were caused by science being taught remotely during the pandemic.

- In some schools, assessment as learning was sometimes taking place at the expense of assessment for learning. Some pupils were asked to recall knowledge that they had not successfully learned first time around.

- Generally, assessment in science did not check whether pupils had remembered what they had learned in previous years. This was a particular concern in some primary schools, where generalised judgements at the end of a piece of learning were being made against age-related expectations, but what these grades represented in relation to the curriculum was not clear.

- In some schools, there was not enough focus on checking whether pupils had learned the disciplinary knowledge that is needed to work scientifically. These schools only focused on checking that pupils had learned substantive knowledge. This was more common in primary schools.

Discussion of the main findings

Where science was strong in the primary and secondary schools that we visited, pupils had learned detailed and connected knowledge of the curriculum, and remembered what they had learned previously. In these schools, leaders and teachers were clear about the purpose of any teaching activity or specific content choice. They explained scientific ideas clearly and used assessment carefully to check what pupils had learned. This included disciplinary knowledge (knowledge of how to work scientifically) as well as substantive knowledge (established factual knowledge).

In schools where science was strong, leaders generally saw the purpose of a curriculum as more than just a description of what pupils needed to know and do. They saw the curriculum as a 'path' that can make learning science easier. For example, leaders planned the science curriculum to take account of what pupils learned in mathematics, or made sure that pupils had enough time to learn the most important content in a way that they could remember it. In the best cases, leaders saw this path as provisional, so that the curriculum could be refined and developed in ways that would improve it, year on year.

In a significant minority of schools visited, pupils were not developing secure knowledge of science. Often, in these schools, the focus was on covering content or completing practical activities. In both cases, the curriculum goal, that is what pupils needed to learn and remember, got lost. This led to pupils studying science, often for long periods of time, without developing sufficient substantive and disciplinary knowledge. Teaching was not planned to ensure that what pupils learned next was related to what they already knew, so that they could build connected knowledge. In these schools, we also found that teachers' assessment rarely checked knowledge that pupils had learned in previous years.

We found that primary and secondary schools had different priorities in science. In primary schools, for example, there was much more emphasis on pupils carrying out different types of scientific enquiry and encountering scientific phenomena and the objects they were learning about. In contrast, the focus in most secondary schools was on developing pupils' substantive knowledge. There is also evidence from the schools we visited that many pupils in secondary school spend too much time studying content that they have already learned in primary school.

Although there was a greater emphasis on practical work in primary schools, across both primary and secondary, plans to develop pupils' substantive knowledge were much more developed than the plans to develop pupils' disciplinary knowledge. Often, this was because leaders had not sufficiently considered the kind of knowledge that pupils need in order to be able to work scientifically or carry out practical work generally. Too often in primary and KS3 the focus was on simply selecting practical activities for pupils to complete. The apparent differences in practices between primary and secondary science may cause challenges for pupils moving from primary to secondary school.

Inspectors regularly found considerable differences in how well teachers taught the curriculum. Very few teachers used approaches that were based on evidence or that were specific to science. Other than for physics or practical work where leaders had identified a training need, few schools had developed a systematic plan of how to develop teachers' knowledge of science and how to teach it.

Overall, the evidence gathered as part of this report identifies some significant strengths in relation to science education in England’s schools. This is particularly encouraging considering the significant impact that the pandemic has had, and continues to have, on pupils, teachers and leaders and the wider science education community. However, there is still more to do to make sure that curriculum, pedagogy, assessment and school systems all work together to create the most favourable, or ‘optimum’, conditions for learning science. Although many pupils leave school with a secure knowledge of science and working scientifically, there are still too many pupils who do not.

Recommendations

Curriculum

Schools should:

- ensure that the curriculum is specific about the knowledge that children in Reception should learn about understanding the world. This knowledge should connect with what pupils go on to learn in Year 1 science.

Q: Can you share an example(s) demonstrating what specific scientific knowledge children in YR need to learn and how this will be developed when they enter Y1?

- ensure that enough time is built into the curriculum for pupils to learn and remember key knowledge. It is important that pupils are helped to see how this knowledge connects with what they already know about science, so that they build connected knowledge.

Q: Can you provide an example (or two) of how pupils learning from one science unit is built upon from past and in subsequent units?

- ensure that the curriculum identifies and sequences the disciplinary knowledge that pupils need to work scientifically. This should not be limited to learning about scientific techniques, data analysis or fair tests. It should include developing their knowledge of all areas of working scientifically, including different types of scientific enquiry, such as pattern seeking, and concepts such as evidence and accuracy.

Q: Do you have curriculum plans which demonstrate how pupils learning in science will develop both their disciplinary knowledge as well as the skills of working scientifically?

- ensure that all pupils have enough opportunities to take part in high-quality practical work that has a clear purpose in relation to the curriculum.

Q: Do your curriculum plans show the progression in practical scientific skills that pupils will develop topic by topic and year by year?

- ensure that the science curriculum is planned to take account of what pupils learn, particularly in mathematics.

Q: Have you some examples from the science curriculum plans that show links and connections with those of mathematics and do you have evidence from any monitoring that demonstrates that impact / benefits to pupils from these?

Pedagogy and assessment

School should:

- ensure that, during explanations, teachers regularly connect new learning to what pupils have already learned. This includes showing pupils how knowledge from different areas of the curriculum connects.

Q: Can you provide an example (or two) of how pupils learning from one science unit is built upon in subsequent units? In addition do you have any evidence from monitoring that this is a routine part of pupils learning in science?

- ensure that pupils have a secure knowledge of what has been taught, before moving on to more content. This should include checking whether pupils have specific misconceptions.

Q: How are you ensuring that all teachers know precisely what pupils need to be able to learn / understand in each science unit and ensure that they are set tasks / challenges which enables them to demonstrate this?

- ensure that appropriate teaching and learning approaches are selected for specific content.

Q: Can you share any examples of where you have received CPD to enhance your own understanding of best practice in terms of teaching and learning related to specific science content and what has been the impact of this on pupils' learning?

- ensure that assessment checks whether pupils remember the substantive and disciplinary knowledge they have learned in previous years. This includes checking that they can use their substantive and disciplinary knowledge to select, plan and carry out different types of relevant scientific enquiry.

Q: How are you ensuring that all teachers know precisely what pupils need to be able to learn / understand in each science unit (both substantive and disciplinary knowldge) and ensure that they are set tasks / challenges which enables them to demonstrate this?

Systems ay subject and school level

Schools should:

- create a systematic and continuous approach to developing the science expertise of staff and leaders. This should align with the school's curriculum and take account of any specific needs and expertise.

Q: How are you intending to ensure that all teachers know precisely what pupils need to learn / understand in each unit?

- support subject leaders to prioritise curriculum time for teaching key scientific knowledge. In some schools, the focus is on making sure that pupils learn and remember what has been taught, so that they develop increasingly sophisticated and connected scientific knowledge. However, too many subject leaders and teachers feel pressured to cover content and move on.

Q: Can you share any examples of where you have received CPD to enhance your own understanding of key scientific knowledge and what CPD are you delivering / directing colleagues to in order to enhance their own science subject knowledge.

Part Eii: Research review series: Science (April 2021)
https://www.gov.uk/government/publications/research-review-series-science/research-review-series-science

The report identifies a number of features which it states as: *'High-quality science education may have the following features":*

For the subject leader – it 'may' prove beneficial to work through each theme: e.g. Curriculum progression; organising knowldge etc one at a time, assessing your school's own practice against what Ofsted have identified in this report. ***(see pages xx - xx below)***

High-quality science education may have the following features

Curriculum progression: what it means to get better at science:

- *The curriculum is planned to build increasingly sophisticated knowledge of the products (substantive knowledge) and practices (disciplinary knowledge) of science.*
- *Disciplinary knowledge (identified in the 'working scientifically' sections of the national curriculum) comprises knowledge of concepts as well as procedures.*
- *When pupils develop their disciplinary knowledge, they learn about the diverse ways that science generates and grows knowledge through scientific enquiry. This is not reduced to a single scientific method or taken to mean just data collection.*
- *The curriculum outlines how disciplinary knowledge advances over time and teaches pupils about the similarities and differences between each science.*
- *Pupils are not expected to acquire disciplinary knowledge simply as a by-product of taking part in practical activities. Disciplinary knowledge is taught.*
- *Scientific processes such as observation, classification or identifying variables are always taught in relation to specific substantive knowledge. They are not seen as generalisable skills.*

Organised knowledge within the curriculum:

- *In the early years, pupils are introduced to a wide-ranging vocabulary that categorises and describes the natural world. These words are not too technical but provide the 'seeds' for developing scientific concepts that will be built on in later years.*
- *Attainment targets, specification points and the EYFS educational programmes are broken down into their component knowledge.*
- *Substantive knowledge is sequenced so that pupils build their knowledge of important concepts such as photosynthesis, magnetism and substance throughout their time at school.*
- *Knowledge is sequenced to make the deep structure of the scientific disciplines explicit. This allows teachers and pupils to see how knowledge is connected.*
- *Disciplinary knowledge is sequenced to take account of:*

    - *its hierarchical structure*
    - *the best substantive contexts in which to teach it.*
- *Once disciplinary knowledge is introduced, it is used and developed in a range of different substantive contexts.*
- *Planning for progression takes account of what is taught in other subjects. For example, the science curriculum should be coherent with what is taught in mathematics. Where there are differences, these are made explicit to pupils and teachers.*

Other curricular considerations:

- *Sufficient curriculum time is allocated for pupils to embed what they have learned in long-term memory through extensive practice before moving on to new content.*
- *The component knowledge pupils need in order to read, write, represent and talk science is identified and sequenced.*
- *Curriculum plans consider how component knowledge introduced at one point in time influences future learning. This ensures that knowledge builds incrementally from pupils' prior knowledge and so pupils' misconceptions are less likely.*
- *The curriculum anticipates where pupils are likely to hold misconceptions. These are explicitly addressed, and pupils learn how the misconception is different to the scientific idea.*
- *Pupils know when and why models and rules can be used in science, which includes knowing what they can and cannot be used for.*

Curriculum materials:

- *Online resources match what the curriculum is intending pupils to learn and are not a source of errors/misconceptions.*
- *If science kits are used, they help achieve the curriculum intent and the activities themselves do not become the curricular goal.*
- *High-quality textbooks are used as an important resource for learning and teaching science.*

Practical work:

- *The curriculum is sequenced so that pupils have the necessary disciplinary and substantive knowledge to carry out practical work successfully and learn from it.*
- *The purpose of practical work is clear in relation to curriculum content so that practical activities can be set up and managed to develop pupils' disciplinary and/or substantive knowledge.*
- *Practical activities form part of a wider instructional sequence that gives pupils time to connect theory to observation.*
- *Pupils are not expected to learn disciplinary knowledge only through taking part in practical work – disciplinary knowledge should be taught using the most effective methods.*
- *Pupils encounter the full range of objects and phenomena they are studying through both laboratory and fieldwork. These encounters should take pupils*

beyond their everyday experiences to develop a sense of wonder and curiosity about the material world.

Pedagogy: the teaching of science:

- *Activities are carefully chosen so that they match specific curriculum intent.*
- *Teachers use systematic teaching approaches, where learning is scaffolded using carefully sequenced explanations, models, analogies and other representations to help pupils to acquire, organise and remember scientific knowledge.*
- *Teaching takes account of the limited working-memory capacity of their pupils when planning lessons.*
- *Pupils are not expected to arrive at scientific explanations by themselves without sufficient prior knowledge.*
- *Systematic approaches, alongside carefully selected texts, are used to teach the most important vocabulary in science.*
- *Pupils have regular opportunities in the early years and primary classrooms to learn vocabulary through story and non-fiction books, rhymes, songs and oral rehearsal.*

Assessment:

- *Teachers and pupils are clear on the purpose of assessment. There is clarity about what is being assessed.*
- *Assessment is not overly burdensome on teachers' time in relation to marking, recording or feedback.*
- *Feedback is focused on the science content and not on generic features. Teachers have sufficient subject knowledge to be able to do this.*
- *Pupils regularly retrieve knowledge from memory to help them remember and organise their knowledge. This is coupled with feedback. Teachers think carefully about what pupils are being asked to retrieve and whether this prioritises the most important content.*
- *Overuse of external assessment items, such as GCSE or A-level questions, is avoided because this narrows the curriculum and leads to superficial progress that does not prepare pupils for further study.*
- *Systems are in place to support teachers to make accurate decisions when assessing pupils' work. This includes supporting primary teachers with statutory teacher assessment of science at key stages 1 and 2.*

Systems at subject and school level:

- *Teachers, teaching assistants and technicians have access to high-quality subject-specific CPD to develop subject knowledge and pedagogical content knowledge. This is aligned to the curriculum.*
- *In primary schools, there is at least one teacher who specialises in teaching science and science leaders have dedicated leadership time.*
- *Science teachers engage with subject associations, and take responsibility, with support from the school, for developing their own subject knowledge throughout their career.*

- *Early-stage teachers in particular have timetables that allow them to develop expertise in one science and that do not give them too many key stages to teach.*
- *Timetables allocate appropriate teaching time to science, reflecting its status as a core subject in the national curriculum. There are particular concerns that pupils in some primary schools are not receiving sufficient curriculum time to learn science.*
- *Pupils have access to sufficient practical resources to take part in demanding practical work, either independently or in appropriately sized groups that enable first-hand experiences.*

Conclusion

This review has explored a range of evidence relating to high-quality science education. It has drawn on research from many different countries and organisations. It also builds from the same research base that underpins the EIF.

In this conclusion, we have identified some general principles. Each principle is not restricted to a specific area of science education, such as curriculum, pedagogy, assessment or school systems. Rather, we have chosen them because evidence presented in this review suggests that they play a central role in influencing many aspects of science education that lay the foundation for subject quality.

The first principle concerns the nature of the scientific discipline itself. **A high-quality science education is rooted in an authentic understanding of what science is.** This recognises science as a discipline of enquiry, underpinned by substantive and disciplinary knowledge, that seeks to explain the material world. Importantly, this requires that pupils learn about the differences between each science. This includes learning about the diversity of approaches used to establish knowledge in science and knowing that there is not one scientific method. When the discipline is not well understood, evidence shows that this leads to superficial curriculum thinking and ineffective pedagogical approaches. Often, these focus on developing ill-defined skills. They also confuse scientific enquiry as a curricular goal with enquiry-based teaching approaches. Without a strong sense of the discipline, it is also easy for high-stakes assessment, either through its absence or presence, to distort what is taught.

The second principle extends from the first. It reflects the important status of scientific concepts, and the relationships between them, as building blocks of scientific knowledge. **A high-quality science curriculum prioritises pupils building knowledge of key concepts in a meaningful way that reflects how knowledge is organised in the scientific disciplines.** This starts in the early years. Importantly, this assumes there is enough curriculum time to teach science. Evidence shows that this is not always the case.

Historically, science education has looked mainly to pedagogy to address the difficulties pupils face learning science. However, as seen throughout this review, by changing what pupils learn it is possible to prevent some of these difficulties from arising in the first place. For example, the effectiveness of practical work can be increased by making sure that pupils have the necessary prior knowledge to learn from the activity. Similarly, by changing what pupils learn, and when, the likelihood of misconceptions forming can be reduced. The science curriculum is therefore more than a description of the journey towards expertise. It is also the means by which to get there. **This means that science curriculums should be planned to take account of the function of knowledge in relation to future learning.**

Together, these 3 principles show that a high-quality science education carefully balances several competing priorities/tensions. For example:

- pupils learn that science is a body of established knowledge but is also a discipline of enquiry
- complex concepts and procedures must be broken down into simpler parts, but knowledge must not become fragmented or divorced from the subject discipline
- curriculum is distinct from pedagogy, but what you learn is influenced by how you learn it

To navigate these tensions successfully, teachers and subject leaders require in-depth knowledge of science and how to teach it, as well as an understanding of how pupils learn. Building teachers' knowledge is therefore a central plank of high-quality science education. The evidence in this review suggests that this knowledge should be developed in relation to the curriculum that is taught.

Part Eii: Best practice as identified by Ofsted (2013)

The last time Ofsted reported specifically on Science (2013) they stated that:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/379164/Maintaining_20curiosity_20a_20survey_20into_20science_20education_20in_20schools.pdf

Primary schools should:

- ensure that pupils are engaged in scientific enquiry, including practical work, and are developing enquiry skills. They should be providing a balanced programme of science education for all year groups that develops science knowledge and understanding and has a significant focus on developing skills
- make provision for effective continuing professional development to support and extend teachers' knowledge, understanding and skills in science and their confidence in teaching it
- invest in developing the role of the science coordinator to provide effective, sustained leadership in the subject and promote improvements in teaching and learning.

Good progress and standards were most often associated with:

- good leadership and management
- effective continuing professional development
- the improved use of assessment
- a clear focus on science work that included a significant component of scientific enquiry and investigation.

Recognising the outstanding
This section of the report exemplifies outstanding science lessons. The text is taken from inspectors' direct observations of lessons and the examples cover a range of topics and year groups.

Primary example 1: Reception class
During their time sitting on the carpet, the teacher engages the children in describing the mini-beasts they had seen in their investigation of the school's grounds. In pairs the children talk about their mini-beasts and then share their ideas with the whole class.
The teacher brings the teaching assistants into the conversation and they remind the children of their experiences. This helps them to arrive at an understanding of the wide range of living things in their environment. A sense of ownership and care for the environment is generated.

The teacher shows a video of a butterfly and its way of life. The presentation is interactive on the whiteboard and teacher skilfully uses questions and the children's answers to establish what was alive during the observation and the characteristics of living things. The children's level of interest and engagement is very high

The teaching is animated and enthusiastic and the teacher has a detailed knowledge of the needs of individual children. She shows the class the caterpillars that they observed during the previous week and the children can see how much they have grown. Careful prompts from the teacher are effective in helping the children cooperatively to relate the characteristics of living things to their observations of the caterpillars. During this time the teacher works with individuals or small groups to promote further thought to extend their learning. The teaching assistants are similarly engaged in a purposeful way.

A session of summarising questions and answers leads to pupils demonstrating the caterpillar/butterfly life cycle to reinforce their knowledge and understanding. A child is dressed in a cagoule to represent the ‘skin’ of the caterpillar and is then wrapped in toilet paper to represent the cocoon. When the pupil breaks out of the cocoon the back of the costume shows the wings of the butterfly. To reinforce the learning, the teacher then takes on the role of the child and the pupils become the teacher in explaining the life cycle of the butterfly.

Key features
* High levels of engagement
* Vigilance from the teacher in monitoring progress
* Very good use of guided discussion between children
* Very effective questioning to elicit ideas, to engage pupils and check understanding
* Very clear progression of ideas; a very well-planned sequence of learning
* Good individual intervention and extension
* Very effective class management, including the deployment of teaching assistants.

Primary example 2: Year 3
The lesson begins with an effective question and answer session in which pupils describe what they know about light. This clarifies the pupils’ understanding of key vocabulary such as ‘translucent’, ‘opaque’ and ‘transparent’. There are high levels of response, application and attention.

The teacher uses a penguin puppet to ask about shadows of objects in relation to an overhead projector, discussing size, shape, position and clarity. The pupils have recently been learning about energy and how the environment can be harmed by the poor management of energy. A pupil comments on the heat from the overhead projector and the teacher takes the opportunity to consolidate the pupils’ thinking on energy and conservation; not wasting electricity; noise and heat as waste energy from such devices; and the dangers of overheating by poor use.

More discussion follows on what can be seen or not seen in a shadow, and talk of shades of grey, not just black and white, shows that light is dispersed in the atmosphere. The pupils then move around a series of well-planned and well-resourced activities at different stations in the room. Pupils’ levels of application and good collaboration are very high. The teacher is very effective at monitoring progress and managing activities so that all the pupils visit all the work stations, consolidating and extending their knowledge and understanding of light.

Key features
* very good classroom management, combined with very good relationships, result in high levels of application
* effective explanations
* excellent questions used to check understanding, promote thinking sand engage pupils
* very careful and effective development of vocabulary and its accurate use
* the creation of a positive environment for learning science

Primary example 3: Year 5
Pupils collaborate well on an investigative task about friction. They are working on the question, 'Which is the best shoe for gripping the floor?' Pupils have been planning their investigation, taking decisions on what to measure, the equipment needed and the procedures they will carry out. The teacher has worked with the teaching assistant to plan and anticipate the range of activities that might be proposed. The assessment strategy for the activity was also agreed with the teaching assistant. The teacher and the teaching assistant have considered the 'knowledge and understanding' content of the activity and the science skills, such as the consideration of variables and the need for accurate measurement. The pupils work in groups of four and discuss their plans.

Discussions with pupils show that they understand fair testing clearly and can describe why they chose to carry out the investigation in the way they planned. Their attitudes to science work are very positive. They cite 'doing practical' as one of the things they enjoy most. They have considered the different surfaces on which they do not want the shoe to slip. They demonstrate their understanding of the need for accuracy and the purpose of repeating procedures and measurements to raise reliability. They choose a scale for measurement that will be most appropriate and they agree on their roles in the procedure.

Overall, the groups investigate a good range of variables and measurements and the outcomes are shared effectively with others. The process is very well managed by the teacher. A plenary discussion demonstrates the pupils' good and developing knowledge and understanding of forces, friction, surface area, changing mass to change force, and the range of variables considered.

Key features
* a very well-planned lesson in which the teaching assistant was fully aware of lesson objectives and assessment goals
* teacher vigilant in monitoring progress
* excellent collaboration; pupils take on roles and work constructively with each other
* pupils were taking decisions rationally and with understanding of scientific enquiry
* pupils were planning confidently and were selecting appropriate equipment; they were not simply following instructions: they knew what they were doing and why
* very good assessment procedures, coordinated between teacher and teaching assistant
* procedures carried out accurately: the pupils understood the need to repeat measurements and calculate averages to make the findings more reliable
* a very effective plenary session, in which the pupils were learning from each other's work, leading to good understanding of the range of knowledge elicited by this practical work.

Primary example 4: Year 6
The pupils' behaviour is excellent, they are engaged well. The teacher teaches enthusiastically and confidently through a well-planned lesson. She uses ICT effectively to illustrate a view of the future as she sets the scene to learn about evolution. The simulation shows the world in five million years' time.

She uses questions and answers well, with many of the questions directed at individuals for specific reasons: keeping attention, building self-confidence, encouraging, and checking understanding. She explores ideas such as plate tectonics through the effective ICT presentation. Evolution and adaptations are talked about with high levels of interaction with pupils. They make suggestions and answer questions confidently.

Pupils then carry out a ‘beak experiment’ very successfully. They use forceps of different shapes as model beaks to tackle four different samples of living things: small seeds, walnuts, apples, worms. They work in groups and their enjoyment of the activity is very evident. They discuss spontaneously how the shape of the beak affects what they can do with it and hence affirm the ideas of adaptation, the shape of the beak affecting how successful they were at feeding on particular food items.

Finally, pupils watch a video of an evolving lizard that lives on the salt flats, catching flies on its frills and so on. Pupils not only enjoy the video but they readily identify the key features of the lizard and how these help it to survive in that environment.

Key features
* A very well prepared lesson
* Very confident and enthusiastic teaching
* A well-sequenced series of activities that engaged pupils effectively
* Imaginative practical work that built skills, knowledge and understanding effectively
* Very good-quality resources including well-researched and relevant video clips.

From satisfactory to good and beyond

The following examples are descriptions of satisfactory science lessons. Suggestions are made about how the lesson might be improved to raise the quality to at least good.

Primary example 1: Reception Class

The teacher begins to outline the activities for the morning. During their time sitting on the carpet, the children are restless and their attention is only satisfactory. The range of activities is quite prescribed and there is little evidence of the teacher using suggestions the children make. There are two teaching assistants who do little to encourage the children’s engagement with what the teacher is explaining.

The class splits into different activity groups: work on floating and sinking, use of computer programs, and water play, filling plastic bottles and plastic containers of different shapes and sizes. The experiences are well-planned but not carried out fully in practice. The teaching assistants are not taking a full part in the learning activities but tend to child-mind and concentrate on mopping up water spills and so on. The children are active and engaged for much of the time. In the main, they are focused on the tasks they have been set. They are learning but the pace is only moderate. There is some good development of language because the teacher interacts with the children during their activities. There is no plenary work by the teacher in the groups, so the learning is not shared as well as it might be.

Areas for improvement

* The session needed more structured interaction between the adults and children. The children naturally enjoyed the exploration activity but the interaction with adults to talk about what was happening and to encourage more focused observations was limited.
* The teaching assistants should have been better briefed, so that they had a clear understanding of their role in promoting learning and were able to raise the quality of the learning by more effective intervention. Their limited contribution was the weakest feature of the session.
* Developing the children’s language should have been a priority for all the adults in the class. This was proceeding well for the children who had the teacher’s attention but the teaching

assistants were under-deployed in this area and did not engage children as much as they could have done.
* The children's ideas and suggestions could have been better exploited. Opportunities to evaluate and build on their ideas could have had a positive impact on promoting their engagement and guiding learning.

Primary example 2: Year 2

At the start of the lesson, many pupils respond to the teacher's question and answer session but not all pay good attention. Vocabulary such as 'photosynthesis' arises but there is no overt checking of understanding by the teacher. Clearly, some pupils have used the word and associate it with plants making food from sunshine. For some their understanding is not secure and this is not recognised or challenged by the teacher. During the questions and answers, the teacher describes the roots 'taking up food'. This is inaccurate and can lead to misconceptions, as it is water and minerals/nutrients that are taken from the soil by the roots. Pupils' attitudes are good and most are keen to answer the teacher's questions. The notion of fair testing is understood by many and their responses to questions, expressed in their own language, indicate good understanding.

There is an ICT display of seasonal pictures with different forms and stages of life, which provides a rolling presentation of living things and growth.

The class is organised into groups efficiently and the teacher uses ICT effectively to set out procedures and instructions for the work to be done. She elicits their ideas well but does not respond effectively to a couple of the more inventive ideas that she was not expecting. The pupils set up apparatus to investigate water absorption, but the equipment provided is not well-matched to the activity; for example, one-litre jugs are used for measuring 100ml. Spillages and inaccuracies are not challenged and nor are the pupils spotting the problem that this poses. The teacher's main concern seems to be to complete the activity, and there is insufficient focus on the quality of the practical work and the refining of the pupils' thinking. They enjoy the work and behave responsibly, even if the accuracy and the pace of learning are only satisfactory.

Areas for improvement

* The lesson would have been more effective if the teacher had had a clearer understanding of what the pupils already knew or did not know about plants and the way that they make food. Assessment for learning techniques could have informed her of areas of misunderstanding, as could initial discussions between pupils, working in pairs or small groups.
* Although it is challenging to do so, the teacher needed to ensure that she used scientific terms accurately. Consulting the science coordinator before each unit of work to check the key vocabulary and its meaning is an effective way of doing this. Some schemes of work have key words highlighted to alert teachers to their accurate use. The problems in science can often involve words where the common meaning is different from the more precise scientific usage.
* The practical equipment used should have been appropriate to the task, allowing pupils to make sufficiently accurate measurements.
* The teacher herself clearly did not have an adequate understanding of the need for accuracy.

Primary example 3: Year 4/5

The pupils are working on planning an investigation of materials suitable for making a model ship. The work is set within a theme involving Tudor ships. The teacher leads a class discussion on fair testing, changing variables and measuring. This goes on for too long and pupils begin to lose interest.

The class is split into groups depending on their attainment. The different groups have different questions to tackle related to the strength, flexibility and floating properties of the materials. The pupils are using a standard planning sheet to provide focus and minimise the language required to plan their work. When the pupils move on to their own planning, many find it difficult, particularly in setting up a fair test.

The materials provided include a cardboard cereal box, a foil tray, a length of wood, cardboard tubes, felt and other materials. All these are of different sizes and shapes and no means is provided of cutting the materials to the same shape and size. Some pupils are puzzled by this and teacher passes over the questions they ask about it. The teaching assistant does some very good work with a group of low-attaining pupils by asking pertinent questions and giving clear guidance to move their ideas along. The teacher circulates around the groups, checking on their progress but a few groups struggle to come up with a plan for an investigation they can undertake. The teacher's lack of direction does not help the pupils to make suitable progress and it allows some less-committed pupils to wander off-task.

Areas for improvement

* The lesson illustrated the challenge of combining science and design and technology. * A lack of understanding of this combination led to inappropriate materials and equipment being deployed in a task that frustrated pupils. The science learning objectives needed to be clearer.
* A better approach to the notion of fair testing would have been to start with a well-structured class discussion in order to pick off issues one by one, to develop a common understanding of the challenge and identify a number of strategies to tackle the problem. The provision of different questions to different groups, with the assumption that a fair test could be applied to them all, showed a misunderstanding of the subject's demands.
* Although the teaching assistant's contribution to the pupils she worked with was good, this was on her own initiative. The whole class could have benefited from support being better allocated across the different groups.
* The pupils needed more judicious use of instruction and direction when they were unclear about how to proceed. This would have helped their confidence and made it possible for them to work more constructively. The teacher's withholding of direction and her lack of response to questions were not effective in getting pupils to think.

Primary example 4: Year 6

The theme of the lesson is the rate at which a solid dissolves. The teacher asks the pupils to put their ideas about the variables involved on sticky notes and to place them on laminated cards, in groups, to see how many and what types of variables are identified. Some confusion begins as the pupils start work. Out of the six groups, two have not understood the challenge and are reinforcing misunderstanding through their discussions with one another. Teaching assistants had watched the initial 'start up' but do not challenge the misunderstandings sufficiently and it is some time before the teacher gets round to all six groups.

The pupils are well-motivated and keen to take on the task. They have satisfactory practical skills. There is confusion among some of them as to what they are to measure; some are measuring the independent variable rather than the dependent variable. The idea behind the practical work is sound and simple, but the execution is weaker than it could be because the teacher and teaching assistants are not tuning pupils into the work with sufficient clarity, and intervention is limited by the inefficient deployment of the teaching assistants.

While learning is progressing satisfactorily, the rate could be quicker. The phrasing of the questions to investigate is difficult for some pupils and the teaching assistants become more active in helping pupils to clarify their ideas and language as the lesson proceeds. The teacher refers to dissolving, inaccurately, as a change of state. Some pupils decide to measure how much sugar is added to the water by measuring the volume of sugar. The teacher uses ‘volume’ in talking to these pupils while with others she refers correctly to the ‘mass’ of sugar, and pupils set about measuring the sugar by using electronic scales. Some pupils do not understand what the difference is between mass and volume and this also leads to some confusion.

Areas for improvement

* The teacher could have taken more time to clarify the pupils’ thinking about and understanding of the task before they started on it.
* A whole-class session of question and answer would have clarified pupils’ prior knowledge and understanding. This would have helped the teacher to determine how well individuals understood. She could then have worked with the weaker pupils to promote their understanding while encouraging the higher attainers to ‘get on with it’.
* The teaching assistants should have been briefed more clearly about the lesson’s learning priorities. They were under-deployed initially, although they eventually focused appropriately on groups and individuals who were struggling with organising language, ideas and equipment.
* The teacher’s inaccurate use of some scientific vocabulary could have been a stumbling block to effective learning. Whenever practicable, teachers should check their own understanding, for example with the science leader.

Part F: Science: Quality of Education – Good (in old money[1])
Ofsted produced this guidance to support their subject specific reviews (Eii above)

Achievement (which is now (2021) termed as Impact)
■ Pupils regularly work independently, often taking the initiative in individual work and when working with others.
■ They show confidence and competence in the full range of stage-appropriate practical work, including planning and carrying out science investigations in groups or individually.
■ Pupils use their scientific knowledge and understanding well in most situations to give accurate explanations or solve challenging problems requiring appropriate control of several variables, and report their findings clearly using accurate scientific language.
■ They research science issues using different sources of information. They demonstrate some originality in their approach, coming up with new ideas on how to tackle a problem or display data. They show imagination in forming hypotheses and in the way they go about their science work.
■ Pupils enjoy science and apply themselves well. They are able to explain the subject's value and show an appreciation of the impact of science on society, themselves and its contribution to life in a technological age.
■ Over time, the proportion of male and female pupils that progress to post-16 science studies is similar to the proportions nationally.

Teaching (which is now (2021) termed as Implementation)
■ The value of science is explained through the use of a range of relevant contexts, which also exemplify its impact on society. These examples engage pupils' interest, maintain curiosity and hone their understanding of research and the application of scientific skills.
■ Pupils engage well in practical work, including fieldwork. Teachers have a confident level of specialist expertise which they use well in planning and teaching their subject, using accurate assessment of individual pupils' prior knowledge and understanding.
■ Further discussion is prompted by informed responses to pupils' questions. Pupils have frequent opportunities for research using books and the internet. They are taught how to summarise and present their research as part of developing their literacy and communication skills.
■ Teachers have a clear understanding of progression in science skills, knowledge and understanding and how the 'big ideas' of science can be understood through

[1] Taken from the Subject Specific Guidance (Ofsted 2013)

increasingly demanding details and concepts. As a result, they use an appropriate range of resources and teaching strategies to promote good learning across all aspects of the subject.

■ Teachers give pupils many opportunities to show and apply their own knowledge, skills and understanding of science, and give extended explanations.

Curriculum (which is now (2021) termed as Implementation)

■ The curriculum is broad, balanced and well informed by current research and development in science education. It meets the learning needs of all groups of pupils and ensures effective continuity and progression, including in scientific enquiry and pupils' understanding of how science works.

■ Planned experiences for learning promote progress within and between year groups, and maintain a good balance between all four areas of the science National Curriculum. In primary schools, the key ideas are regularly reinforced over time through practical work.

■ Good links are forged with other subjects and the wider community to provide a range of enrichment activities that promote pupils' learning and engagement with science.

■ Good advice and guidance on progression in science beyond compulsory education is embedded in the curriculum….,

■ Opportunities to promote spiritual, moral, social and cultural development are systematically planned and delivered to ensure every pupil benefits.

Leadership (which is now *(2021): both a separate criteria of L&M as well as within Intent & Implementation)*

■ Leaders are well informed by current developments in the subject and are aware of developments in science education, including in other schools and by national agencies and associations.

■ Pupil progress in science is tracked during the year with feedback from this used to drive intervention and extension activities.

■ Subject reviews, self-evaluation and improvement planning are successfully focused on raising attainment and improving the provision for science. They are carried out systematically and the outcomes communicated effectively to all science staff so that there is a common understanding of priorities.

■ There are shared common purposes among those involved in teaching science. Teachers have good opportunities to share practice among themselves and have access to subject training within and beyond the boundaries of the school, where appropriate. Science reflects wider whole- school priorities including consistent application of literacy and numeracy policies.

■ Science leaders ensure that health and safety information is up-to-date and understood by colleagues.

Part G: Science: Quality of Education (Good)

This template includes the current criteria for the Quality of Education judgment of 'Good' along with columns for the SL / SLT to insert where they perceive is a best-fit with the 'old' subject specific criteria along with their own internal evidence.

As such it serves two purposes, one as a CPD activity to consider the match between the 'old' subject specific criteria and then 'new' criteria and secondly to benchmark / evaluate the school's provision against this.

INTENT		
NEW HANDBOOK	**EVIDENCE**	**OLD SUBJECT CRITERIA**
Leaders adopt or construct a curriculum that is ambitious and designed to give all pupils, particularly disadvantaged pupils and including pupils with SEND, the knowledge and cultural capital they need to succeed in life. This is either the national curriculum or a curriculum of comparable breadth and ambition. [*If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]*		
The school's curriculum is coherently planned and sequenced towards cumulatively sufficient knowledge and skills for future learning and employment. *[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]*		
The curriculum is successfully adapted, designed or developed to be ambitious and meet the needs of pupils with SEND, developing their knowledge, skills and abilities		

to apply what they know and can do with increasing fluency and independence. *[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]*		

IMPLEMENTATION		
NEW HANDBOOK	**EVIDENCE**	**OLD SUBJECT CRITERIA**
Teachers have good knowledge of the subject(s) and courses they teach. Leaders provide effective support for those teaching outside their main areas of expertise.		
Teachers present subject matter clearly, promoting appropriate discussion about the subject matter being taught. They check pupils' understanding systematically, identify misconceptions accurately and provide clear, direct feedback. In so doing, they respond and adapt their teaching as necessary without unnecessarily elaborate or individualised approaches.		
Over the course of study, teaching is designed to help pupils to remember long term the content they have been taught and to integrate new knowledge into larger ideas.		
Teachers and leaders use assessment well, for example to help pupils embed and use knowledge fluently, or to check understanding and inform teaching. Leaders understand the limitations of assessment and do not use it in a way that creates unnecessary burdens on staff or pupils.		
Teachers create an environment that focuses on pupils. The textbooks and		

other teaching materials that teachers select – in a way that does not create unnecessary workload for staff – reflect the school's ambitious intentions for the course of study. These materials clearly support the intent of a coherently planned curriculum, sequenced towards cumulatively sufficient knowledge and skills for future learning and employment.		
The work given to pupils is demanding and matches the aims of the curriculum in being coherently planned and sequenced towards cumulatively sufficient knowledge.		
Reading is prioritised to allow pupils to access the full curriculum offer.		
A rigorous and sequential approach to the reading curriculum develops pupils' fluency, confidence and enjoyment in reading. At all stages, reading attainment is assessed and gaps are addressed quickly and effectively for all pupils. Reading books connect closely to the phonics knowledge pupils are taught when they are learning to read.		
The sharp focus on ensuring that younger children gain phonics knowledge and language comprehension necessary to read, and the skills to communicate, gives them the foundations for future learning.		
Teachers ensure that their own speaking, listening, writing and reading of English support pupils in developing their language and vocabulary well.		

IMPACT		
NEW HANDBOOK	**EVIDENCE**	**OLD SUBJECT CRITERIA**
Pupils develop detailed knowledge and skills across the curriculum and, as a result, achieve well. This is reflected in results from national tests and examinations that meet government expectations, or in the qualifications obtained.		
Pupils are ready for the next stage of education, employment or training. They have the knowledge and skills they need and, where relevant, they gain qualifications that allow them to go on to destinations that meet their interests and aspirations and the intention of their course of study. Pupils with SEND achieve the best possible outcomes.		
Pupils' work across the curriculum is of good quality.		
Pupils read widely and often, with fluency and comprehension appropriate to their age. They are able to apply mathematical knowledge, concepts and procedures appropriately for their age.		

Part H: Science: Quality of Education (Exemplar)

This is the authors initial interpretation of a best-fit between the previous ***(Part E)*** *subject criteria and the current (2021) QoE (2021) criteria* ***(Part F).***

INTENT		
NEW HANDBOOK	**EVIDENCE**	**OLD SUBJECT CRITERIA**
Leaders adopt or construct a curriculum that is ambitious and designed to give all pupils, particularly disadvantaged pupils and including pupils with SEND, the knowledge and cultural capital they need to succeed in life. This is either the national curriculum or a curriculum of comparable breadth and ambition. [*If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]*		Leaders are well informed by current developments in the subject and are aware of developments in science education, including in other schools and by national agencies and associations. The curriculum is broad, balanced and well informed by current research and development in science education. It meets the learning needs of all groups of pupils and ensures effective continuity and progression, including in scientific enquiry and pupils' understanding of how science works.
The school's curriculum is coherently planned and sequenced towards cumulatively sufficient knowledge and skills for future learning and employment. *[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]*		Planned experiences for learning promote progress within and between year groups, and maintain a good balance between all four areas of the science National Curriculum. In primary schools, the key ideas are regularly reinforced over time through practical work. In secondary schools, sufficient time and high-quality practical resources to teach science through practical investigation and illustration are provided, with the result that students are motivated to study the subject further at 16 and 18. Good advice and guidance on progression in science beyond compulsory education is embedded in the curriculum, and pathways do

		not limit progression, particularly if vocational subjects are taken at Key Stage 4.
The curriculum is successfully adapted, designed or developed to be ambitious and meet the needs of pupils with SEND, developing their knowledge, skills and abilities to apply what they know and can do with increasing fluency and independence. *[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]*		

IMPLEMENTATION		
NEW HANDBOOK	**EVIDENCE**	**OLD SUBJECT CRITERIA**
Teachers have good knowledge of the subject(s) and courses they teach. Leaders provide effective support for those teaching outside their main areas of expertise.		Teachers have a clear understanding of progression in science skills, knowledge and understanding and how the 'big ideas' of science can be understood through increasingly demanding details and concepts. As a result, they use an appropriate range of resources and teaching strategies to promote good learning across all aspects of the subject. There are shared common purposes among those involved in teaching science. Teachers have good opportunities to share practice among themselves and have access to subject training within and beyond the boundaries of the school, where appropriate. Science reflects wider whole-school priorities including consistent application of literacy and numeracy policies.
Teachers present subject matter clearly, promoting appropriate discussion about the subject matter being taught. They check pupils' understanding systematically, identify misconceptions accurately and provide clear,		Teachers give pupils many opportunities to show and apply their own knowledge, skills and understanding of science, and give extended explanations. Pupils enjoy science and apply themselves well. They are able to

direct feedback. In so doing, they respond and adapt their teaching as necessary without unnecessarily elaborate or individualised approaches.		explain the subject's value and show an appreciation of the impact of science on society, themselves and its contribution to life in a technological age.
Over the course of study, teaching is designed to help pupils to remember long term the content they have been taught and to integrate new knowledge into larger ideas.		They research science issues using different sources of information. They demonstrate some originality in their approach, coming up with new ideas on how to tackle a problem or display data. They show imagination in forming hypotheses and in the way they go about their science work. They show confidence and competence in the full range of stage-appropriate practical work, including planning and carrying out science investigations in groups or individually.
Teachers and leaders use assessment well, for example to help pupils embed and use knowledge fluently, or to check understanding and inform teaching. Leaders understand the limitations of assessment and do not use it in a way that creates unnecessary burdens on staff or pupils.		Pupil progress in science is tracked during the year with feedback from this used to drive intervention and extension activities.
Teachers create an environment that focuses on pupils. The textbooks and other teaching materials that teachers select – in a way that does not create unnecessary workload for staff – reflect the school's ambitious intentions for the course of study. These materials clearly support the intent of a coherently planned curriculum, sequenced towards cumulatively sufficient knowledge and skills for future learning and employment.		Pupils use their scientific knowledge and understanding well in most situations to give accurate explanations or solve challenging problems requiring appropriate control of several variables, and report their findings clearly using accurate scientific language.
The work given to pupils is demanding and matches the aims of the curriculum in being coherently planned and		Pupils regularly work independently, often taking the initiative in individual work and when working with others.

sequenced towards cumulatively sufficient knowledge.		
Reading is prioritised to allow pupils to access the full curriculum offer.		
A rigorous and sequential approach to the reading curriculum develops pupils' fluency, confidence and enjoyment in reading. At all stages, reading attainment is assessed and gaps are addressed quickly and effectively for all pupils. Reading books connect closely to the phonics knowledge pupils are taught when they are learning to read.		
The sharp focus on ensuring that younger children gain phonics knowledge and language comprehension necessary to read, and the skills to communicate, gives them the foundations for future learning.		
Teachers ensure that their own speaking, listening, writing and reading of English support pupils in developing their language and vocabulary well.		

IMPACT		
NEW HANDBOOK	**EVIDENCE**	**OLD SUBJECT CRITERIA**
Pupils develop detailed knowledge and skills across the curriculum and, as a result, achieve well. This is reflected in results from national tests and examinations that meet government expectations, or in the qualifications obtained.		They show confidence and competence in the full range of stage-appropriate practical work, including planning and carrying out science investigations in groups or individually. Pupils use their scientific knowledge and understanding well in most situations to give accurate explanations or solve challenging problems requiring appropriate control of several variables, and

		report their findings clearly using accurate scientific language. Pupils enjoy science and apply themselves well. They are able to explain the subject's value and show an appreciation of the impact of science on society, themselves and its contribution to life in a technological age.
Pupils are ready for the next stage of education, employment or training. They have the knowledge and skills they need and, where relevant, they gain qualifications that allow them to go on to destinations that meet their interests and aspirations and the intention of their course of study. Pupils with SEND achieve the best possible outcomes.		Over time, the proportion of male and female pupils that progress to post-16 science studies is similar to the proportions nationally.
Pupils' work across the curriculum is of good quality.		Opportunities to promote spiritual, moral, social and cultural development are systematically planned and delivered to ensure every pupil benefits.
Pupils read widely and often, with fluency and comprehension appropriate to their age. They are able to apply mathematical knowledge, concepts and procedures appropriately for their age.		Good links are forged with other subjects and the wider community to provide a range of enrichment activities that promote pupils' learning and engagement with science.

Part I: Preparing for a subject specific deep-dive: Science

Resources (to have at hand)

- Science self-evaluation report
- Science development (action) plan
- Long / medium term planning, including your progression map (skills; knowledge)
- Examples of pupil's work across year groups (at least from say EY / KS1 / KS2), including sequential learning

Suggested questions

(When responding to any questions, try not to focus solely on 'describing' what you / colleagues have been engaged in, BUT: what has been the impact / outcome of any actions.)

- Are you covering all the statutory content of the national curriculum for science in each year group? What about 'working scientifically' skills? Are cross-curricular links highlighted?
- How do the concepts you teach progress up through the years and during the course of a unit of lessons? Is there a logical sequence to the lessons?
- What strategies do you use to assess learning? Do your teachers know where the children are in terms of science knowledge and 'working scientifically' skills?
- Are pupils encouraged to develop a wide scientific vocabulary? Do you provide opportunities for them to talk like scientists and discuss scientific ideas with each other?
- Do you have an up-to-date action plan which identifies weaknesses and outlines steps to address them?
- How is your curriculum coverage planned to ensure progression throughout the school? (e.g. is it already on the school's website?)
- How do you ensure coverage of the Science curriculum across all year groups?
- What published schemes, if any, do you follow? Or, if not – how have you planned your own SoW?
- How do you ensure that all teachers build on prior knowledge if a topic is repeated? (e.g. Light in Science) o Explain the rationale behind your yearly overview – why certain topics are taught in a particular order (e.g. why you teach Plants in Spring)?
- How do you plan for the progression of knowledge and scientific skills – what was the prior knowledge from the year before (if topic also appeared in that year group) and what were the prior scientific skills? Is the current class teacher aware of this?

- What CPD have Staff had on the Science curriculum, why (e.g. how did you identify the need) and what has / is the impact of this?
- How confident are teachers, including TA's in teaching the whole of the Science curriculum, especially 'working scientifically'?
- What do children think of your subject?
- What links are there between Science and the rest of the curriculum? (e.g. can you give me some examples?)
- How do you know if pupils 'learn and remember the curriculum'?
- How do you monitor your subject? And what does this tell you about the quality of Teaching & learning?
- How do you use the wider community, e.g. trips, visitors in your subject?
- What's on your action plan this year? And why?
- What are the strengths/ areas for development in your subject?
- How do teachers differentiate in Science lessons?

Lesson Observations

- How does the lesson fit in with the overview for your subject?
- Is the correct vocabulary being used?
- How are misconceptions addressed? Are teachers thinking of them prior to teaching in order to prevent/tackle them?
- How do teachers use questioning to target specific pupils and in a sequential/chronological order? Do they routinely 'dig deeper' to try to find out a pupils reasoning (e.g. awareness of disciplinary knowledge)?
- Are the children learning new knowledge and skills?
- Does the teacher's questioning encourage learning and enquiry?
- Is the teacher's subject knowledge good?
- What would you expect to see in 'good' Science lessons?

Questions to pupils
e.g. Year 1 – Changing Materials

- What is the difference between hot and cold?
- What is melting?
- How do you know when something is melting?
- Using a thermometer - what is it / what can it be used for / what unit of measurement is used on a thermometer? Do you know what degrees and Celsius mean?

e.g. Year 3 – Rocks, Fossils and Soil

What do you know about fossils?
Is it only animals that can be fossils?
Does an animal have to be eaten to be a fossil?
If a plant can be a fossil, do plants have bones?
What is sedimentary, igneous and metamorphic?
Explain how the tasks taught link to your subject overview and what would come next.

A P Associates
educational consultants

Annex 1: Science – Outstanding (in ‘old’ money[2])

Ofsted produced this guidance to support their subject specific reviews (Eiii above)

Achievement

- Pupils show exceptional independence; they are able to think for themselves and raise their own questions about science knowledge, understanding and scientific enquiry.
- They are confident and competent in the full range of stage-related practical skills, taking the initiative in planning, carrying out, recording and evaluating their own scientific investigations.
- Pupils frequently use their scientific knowledge and understanding very effectively in written and verbal explanations, solving challenging problems and reporting scientific findings formally.
- They work constructively with other pupils, demonstrating common understanding in discrete well-focused roles, with all playing a part in successful investigations.
- Pupils show high levels of originality, imagination and innovation in their understanding and application of their knowledge and skills.
- Their practical work incorporates a variety of contexts, including fieldwork.
- Pupils research contemporary issues and understand the impact of science on society.
- They develop a sense of passion and commitment to science, showing strong application and enthusiasm to learn more through scientific endeavour.
- Over time, the proportion of male and female pupils that progress to post-16 science studies is similar to the proportions nationally.

Teaching

- Teachers expect each pupil to operate as a scientist, engaging fully in practical work using science skills, knowledge and understanding to inform their work.
- Pupils are aided in moving beyond the limits of the National Curriculum or examination specification in order to maintain curiosity.
- Answers to pupils’ questions are accurate and effective at stimulating further thought. Their confidence extends to all areas of science taught, and in secondary schools, not just in their specialist subject. This stimulates pupils’ inquisitiveness.
- Teachers have a very clear understanding of how science is learnt best, using the scientific phenomenon itself as the core focus of lessons. This includes scientific investigation and practical work, including fieldwork; research using a range of resources; evaluation; discussion; and opportunities for pupils to deliver high-quality presentations.
- Pupils’ active participation in their learning secures outstanding progress across all aspects of the subject because teachers use a very wide range of innovative and imaginative resources including local contexts, along with well-chosen teaching strategies.

Curriculum

[2] Dec 2013, Ofsted

- The imaginative and stimulating science curriculum is skilfully designed to match the full range of pupils' needs and to ensure highly effective continuity and progression in their learning. The curriculum equips pupils in all year groups with an excellent balance of subject knowledge and understanding, and the skills of scientific enquiry, across the three main areas of biology, chemistry and physics.
- An excellent range of learning opportunities involves pupils frequently in scientific enquiry, practical work, fieldwork, research, use of ICT, individual and group work, discussions, modelling and evaluation.
- The contexts in which science is taught are relevant to pupils' lives, capture their interest and reflect current science from the worlds of industry, research and other science-based endeavours such as health care.
- The non-statutory entitlement for all pupils with Key Stage 3 science attainment at Level 6 and above that would benefit from the study of triple science GCSEs is met.
- There are productive links with other subjects in the school, including with mathematics, design technology and English.
- Excellent links with other agencies and the wider community provide a wide range of enrichment activities to promote pupils' learning and engagement, such as science-based clubs and visits to sites where science is at the heart of the activities. Regular visits by science professionals who share their relevant experiences should relate to pupils' experiences of science in lessons.
- Rigorous planning for pupils' spiritual, moral, social and cultural development ensures that all pupils experience the full wonder of the universe and develop a responsible attitude to environmental protection.

Leadership

- Leadership is informed by a high level of science expertise and vision and is improving the performance and practice of members of the department (secondary) or school as a whole (primary).
- Pupil progress in science is tracked frequently, with feedback from this used to drive intervention and extension activities.
- Science teaching embraces whole-school policies on literacy and numeracy and the subject systematically contributes strongly to improving these aspects.
- There is a strong track record of innovation and this is recognised and shared in the department to promote raising standards. Subject review, self-evaluation and improvement planning are well-informed by current good practice in science education. This should involve participation in debate and developments with other science providers in a wider area.
- Subject leadership inspires confidence and whole-hearted commitment from pupils and colleagues. There are effective strategies to delegate subject responsibilities where appropriate, share good practice and secure high-quality professional development in the subject.
- Continuing professional development is well targeted and thoroughly evaluated for its impact on maintaining pupils' curiosity. It includes up-to- date training for technical support staff, and a current understanding of health and safety matters relating to science teaching.
- Resources, including teaching time, practical facilities and staff professional development, match the ambition and expectations of staff for high achievement and the future success of pupils in science.

Annex 2: Meeting the needs of pupils with SEND

Notes taken from
Teacher Handbook SEND – Embedding inclusive practice (January 2024)
(https://nasen.org.uk/resources/teacher-handbook-send)

Planning inclusive lessons

- In the first instance the purpose, process and products of the lesson (the learning journey/intent) need to be clearly articulated to learners and time taken to ensure all learners understand the journey ahead.
- Connection making can reduce a learner's fear of the unknown and can make them more ready to engage in the learning.
- Always present connections in a clear manner, verbally and visually; some learners will likely require a scaffold, for example a visual representation or key vocabulary, in their books that they can refer to at the start of each lesson.
- As all foundation subjects are often only an hour or so a week (out of 25 hours of lessons), some learners are likely to need a reminder of what they are learning about at the start of a lesson, and where it sits within the learning sequence as well as where it sits in relation to other relevant subject specific contexts and knowledge that it is building upon, prior to a whole-class retrieval starter activity.

When planning inclusive lessons, teachers need to consider how they can enable pupils to engage with the new learning:

- Are you connecting previous learning - are there prior skills or knowledge that learners can build on in this unit of study?
- Are there key words whose meanings they need to be able to understand in order to be able to engage with the core concepts being taught?
- Are there pre-requisite skills or knowledge that are required to be successful, e.g. in **History:** do pupils need a clear understanding of the difference between primary & secondary sources?

Task:

- *Have you identified the key subject specific words for each of the topics that pupils will learn during each year and how/when are these made available to pupils?*
- *What subject specific skills will pupils need to know and understand prior to the start of each new topic? And how will you ensure that pupils will be able to practice these?*

- Explicit instruction needs to be carefully planned for learners with SEND.
- New material needs to be delivered in small steps, with teachers considering how much information is presented at any one time.

- All new material should be presented both verbally and visually (dual-coded) wherever possible.
- High-interest, engaging materials such as images or short documentary clips can provide a strong start to a lesson, e.g. in **Geography** a short clip of an erupting volcano can help learners begin to understand the impact of an eruption the surrounding area.

Task:

- *Have you identified for each topic 'high-interest, engaging materials' that will be accessible to all pupils?*

- Less confident learners will benefit from having access to content of a time period prior to reading as this can motivate and support them when working through what may for them be challenging texts.

Task:

- *How do you make available to all pupils resources to support them prior to the introduction of each new topic?*

Modelling and scaffolding are key components of an inclusive lesson.

- Learners benefit from seeing the teacher model the application of for e.g. in **Art & Design** of skills in connection with subject content and watching a teacher perform 'live' research and live writing.
- A teacher / assistant 'thinking aloud' whilst modelling writing tasks can support learners when they progress to independent practice.
- Modelling should be a planned part of every lesson, with further modelling and/or scaffolding as needed when identified through formative assessment in a lesson.
- Given that for almost all foundation subjects, lessons are usually spread apart over a week/fortnight, it is crucial that new learning is recapped at the start of the following lesson. Teachers should also ensure, wherever possible, to address any misconceptions within that lesson. Misconceptions that are observed through marking between lessons can be addressed through short videos uploaded on a virtual classroom between lessons and/or at the start of the next lesson.
- For some learners with additional learning needs, misconceptions can become embedded in their understanding, impacting further progression. It is therefore vital that misconceptions are addressed directly at the earliest possible stage. It will often be beneficial to address these misconceptions in small groups or with individuals to check understanding.

Task:

- *Have you identified what 'may be' the common misconceptions that teachers and assistants need to be aware of prior to the start of each new topic? (e.g. in **Geography** it's not uncommon for pupils to be clear about the differences between: ocean; sea & channel. In **Science**, it is frequently: permeable; porous; pervious & absorbant.)*

Teaching strategies that can support learners in answering whole-class questions in lessons are:

- Additional processing time, e.g. provide questions to learners in advance of the discussion • Visual prompts
- Co-constructing answers with peers, e.g. Think - Pair - Share

- Pre-teaching content ahead of the lesson
- Mixed-ability groupings
- Communication aids
- Sentence frames and/or sentence starters with explicit reference to language function (specific to **Scientific** skills, e.g. hypothesising, summarising, evidencing).

Strategies to Scaffold Learning

How to support learners who struggle to access lessons because of literacy difficulties?

- Encourage oracy; talking about writing first and unpicking tricky words results in better understanding and written fluency. Think, Pair, Share tasks are essential, and enabling learners with SEND to succeed here by seating them near a student who is more confident with speaking would be an asset.
- Provide sentence starters and key word banks, ideally as a generic 'literacy mat' which can be used alongside knowledge organisers to embed common styles of geographical writing.
- As evaluation is a key skill it should be built into all topics. This is often challenging for pupils, especially those with SEND. Showing learners how to evaluate using models, guided examples on a visualiser, and guided reading are very helpful. Using an evaluation prompt, such as the one below, can be very useful to enable the students to apply their own ideas to the evaluation.
- Remember that **Historical; Geographical & Scientific** literacy is often high level. Consider your own use of tier 2 and 3 language in explanations; make links to everyday language and ensure your use of tier 2 and 3 language is accessible. Regularly check understanding of learners with SEND through questioning.
- Provide visual aids to enable learners to identify, for e.g. in **Art & Design:** artists and their work, as well as to identify equipment and media**; Design & Technology –** the tools and techniques they will be expected to use / perform**; Geography –** rivers around the world; different building styles and materials / rural and urban environments; **History –** images of where in the world specific events took place and of the people involved**.**
- Use frequent modelling to show learners how to structure sentences but keep it achievable; it is better to model an imperfect answer and ask the learner to suggest improvements than to model an unachievably high-quality response. This is especially important when preparing for assessments and giving feedback, so learners clearly understand how they can achieve an excellent answer and improve their own.
- Using extended guided reading in lessons is an essential way of enabling all learners, and especially those with SEND, to access the content effectively. Articles should be adapted where necessary, and often it is more effective to write pieces bespoke for the topic you are doing. The process of delivering these in class is also important to get right, and there is an example of a Highly Intentional Process below, Figure 1, page 4. (Figure 2 on page 5 is a task for the subject leader to complete)

Figure 1: Highly Intentional Process - Guided reading in Geography Lessons

HIP stage	Activity	Rationale/ notes	Sample Language
0: Homework to learn vocabulary (1 week before the reading)	In the week before the reading is used, set a homework assignment where the vulnerable students (or all of the students) are given a copy of the key vocabulary to learn. This should also be shared with the EAL/SEN/Literacy coordinators and TAs where relevant	This reduces the cognitive load for the students when the reading happens in class, and enables them to have a deeper understanding of the text as it is read	This homework is important so that we can make the most of the reading time next week. It will also enable you to tackle the task we do following the reading and succeed with this.
1: Pre-teach vocabulary (1-3 mins max - be careful not to spend too long)	Using the glossary, which is found at the start of the article, Select up to 5 pieces of tier 2 or 3 vocabulary from the article. Teach it directly, giving a simple definition and one or two sentences using the word. Ensure that you make the pronunciation of the word clear. Some teachers may want the class to repeat the words back to them - this will depend on your class dynamic.	Teach briskly - limit the number of questions. Word choice and definitions must be preprepared - it is very difficult to make up on the spot and retain clarity.	This word is …. Say it back to me (my turn your turn) It means ……… It might be used like this (example 1) Or like this (example 2)
2: Preview the article (1-3 mins max - be careful not to spend too long)	Explain to the students what the article will be about, and what content it will cover. Teachers should also explain WHY the article is being read - this is important metacognitively - and could be related to why the knowledge is important, but also what they will be using the knowledge for afterwards (eg extended writing/ comprehension questions)	Helps students feel secure before reading, and be more likely to understand Head off any likely misconceptions re particularly difficult words, ideas or concepts	We are going to learn from an article about…. Some of the things it will help us to understand are… Look out for the section about…. Basically, this means that …..
3: Teacher reads (approx 15 mins but will vary)	Teacher reads from the article with enthusiasm and clarity. Teacher uses this stage to inspire the class: invite questions, explain things, check understanding. As you read each paragraph, scroll through the visual prompts on the board. Do explain these but not for more than 15 seconds to try not to break the flow of the reading too much. Depending on the class, their confidence and your feeling, you may also want to try 'jump in' reading. This is when the teacher pauses on a word of note (often those in the glossary) and the whole class repeats it out loud. If going on to do extended writing, the students should highlight sections which are relevant to the question they will be answering. If doing comprehension questions, this is not needed as questions will be numbered to match paragraphs and students should have to look and re-read sections to find answer.	Allows teachers to teach and inspire Provides another opportunity to check and address misconceptions The jump in reading can aid in concentration and tracking, and also enhance the ability of students in their pronunciation of the more challenging and relevant key terms	Now's your chance to check that you understand, and ask any questions you may have.

Figure 2: Highly Intentional Process - Guided reading in xxxxxx Lessons
(This is a task for you to complete)

HIP stage	Activity	Rationale/ notes	Sample Language
0: Homework to learn vocabulary (1 week before the reading)	In the week before the reading is used, set a homework assignment where the vulnerable students (or all of the students) are given a copy of the key vocabulary to learn. This should also be shared with the EAL/SEN/Literacy coordinators and TAs where relevant	This reduces the cognitive load for the students when the reading happens in class, and enables them to have a deeper understanding of the text as it is read	This homework is important so that we can make the most of the reading time next week. It will also enable you to tackle the task we do following the reading and succeed with this.
1: Pre-teach vocabulary (1-3 mins max - be careful not to spend too long)			
2: Preview the article (1-3 mins max - be careful not to spend too long)			
3: Teacher reads (approx 15 mins but will vary)			

How can I support learners who struggle to retain vocabulary?

- Print knowledge organisers including word banks and visual supports for learners with SEND who need them as a reference in every lesson.
- Use retrieval practice at the start of lessons to revisit key words, identify and repeatedly focus on the most important tier 3 vocabulary. Use oracy strategies; learners are more likely to retain words between lessons if they are able use them verbally in sentences. This will include questioning to probe learners to retrieve the correct word.
- Ask learners to highlight where they have used key vocabulary in their sentences in order to recognise and reinforce this skill.

Task:

- Have you identified key vocabulary / terms for each topic and do all pupils have access to these before and during lessons?

How can I support learners who struggle to access lessons because of numeracy difficulties?

- Work with colleagues to embed geographical numeracy in the curriculum, so that learners come to expect it as part of geography lessons, e.g. mean, median, mode, range and interquartile range
- Work with colleagues in the maths department to ascertain how and when mathematical skills and concepts are taught. If there are resources learners use to scaffold their learning in maths, ensure they have access to them in geography as well.
- Allow the use of calculators. As they are always permitted in geography exams, they should also be available in lessons.

Task:

- Have you worked alongside the subject leader for Mathematics to identify where learning in the subject you lead can support pupils numeracy?

How can I support learners who need additional time to develop conceptual understanding?

- What will hold learners back if they don't understand it? Identify what the 'threshold concepts' in each topic are, e.g. democracy; evaluation; analysis & composition and refer to these concepts in some way during every lesson.
- Give examples of the same concept in different contexts. Try to personalise this or use examples from the news/ media/local area, at least something that is 'relevant' to the pupils. This is a vital part of effective teaching, with teachers regularly referring to recent events to engage the learners, and encourage them to go and seek out information themselves independently.
- Plan specific hinge questions you will ask learners, to ensure you can evaluate the extent to which each learner is understanding. Probe learners to go beyond three-word responses to questions.
- Anticipate misconceptions and when they arise in lessons, challenge them quickly; include them in your explanations.
- Ensure that all resources are uploaded for all lessons and homework and revision onto a suitable electronic platform, e.g. Google Classroom, and clearly labelled so that learners, support staff and families can access these remotely and at any time. This will enable learners to recap work and concepts where they need to and want to.

Task:

- Have you identified in advance of a topic the key questions which you will want to ask of pupils – questions that address not only: who; what; where; when; why and how as well as: similarities / differences; cause & effect; rank in order of importance; synthesise your responses, etc

How can I support learners who struggle with attention?

- Plan seating arrangements carefully. Consider the use of proximity for learners who need prompting. Also, ensure learners are sat away from distractions - these could be environmental, e.g. windows next to a playground, or relational, e.g. peers.
- Share the big picture of the lesson but also show examples of the outcome so that learners can visualise what the overall aim is.
- Chunk lessons into distinct episodes of explanation, modelling, practice, feedback, etc. so that learners have a structure to expect. Represent these parts of the lesson on a visual timetable, which you refer to throughout the lesson.
- Plan in active breaks and opportunities for learners to move during lessons.
- Use behaviour-specific praise to reinforce effort and focus.

Task:

- Re: a visual of the outcome expected of pupils – do you have / are you starting to build up examples from 'past' pupils as to what a 'good' example would be to share with pupils?

How can I support learners who struggle with change and transition?

- Predictable classroom routines are vital, with well-planned and structured lessons with clear expectations.
- Build trust through positive interactions and praise.

How can I support learners who struggle with fine motor skills?

- Consider using frames or adhesives (**e.g. in Art & Design and Design & Technology),** masking tape) that hold down learners' work to surfaces in cases where learners may struggle to hold a resource in place. Provide learners with larger scale materials to work on and gradually decrease the scale as they acquire greater control.
- Encourage learners to experiment with different media, for e.g. in **Art & Design** - when drawing offer chunkier graphite sticks as well as soft 'B' range pencils. Similarly, offer a range of painting application media – some learners may prefer a sponge to a brush or may even use their fingers at times.
- Plan each lesson well in advance, to consider points where learners may struggle and allow for adult guidance accordingly. Use of scissors can be a source of frustration for some learners and wider-handled or easy grip scissors can be a useful aid.
- Engaging in art and design activity is great for helping build fine motor skills for all children. Learners will enjoy and benefit from using malleable media such as clay or air dough.

How can I support learners who need additional time to develop conceptual understanding?

- Provide opportunities for small group learning either before (pre-teach) or during the lesson. This will support learners and allow time to ask questions or explore resources alongside adult intervention. These opportunities are part of the repetition process needed to maximise capacity to build up conceptual understanding.

- Take time to model and demonstrate each element of a process, allowing learners to develop their understanding through a step by-step approach. This will benefit all learners as it allows for an active participatory approach.
- Showing outcomes from the previous lesson's work can be a useful memory aid.
- Have visual aids in the form of worked examples that the learners can have to hand when completing independent tasks.

Task:

- Do you have / are you building up a bank of examples of 'finished' work to share with pupils, so that they can visualise the learning process / journey?

How can I support learners who struggle with attention?

- Starting off each lesson with a 'hook' - a question or image which inspires curiosity - can help engage learners. This is most effective when two to three questions are displayed, at varying levels of complexity, with learners invited to choose and engage with one of the questions. It could be helpful if the hook has a link to their own context so that learners have a concrete reference point.
- A 'chunked' approach alongside cognitive shifts can aid attention and focus. For example, after having read independently for a set amount of time, learners can then discuss in small groups before writing an answer to a set question in their books. Having a dual-coded lesson plan with known images for the different parts of the lesson and time allocated can support learners in engaging in each component of the lesson.
- Develop tasks that keep pupils engaged in their learning, e.g. if showing a video clip, provide learners with phrases to listen for or key questions to answer.

Task:

Do pupils have access to a resource (e.g. pen / pencil / paper) when observing a video / images which has key words / questions (e.g. who: what; where; when; why and how) to focus their notes?