Cambridge Assessment International Education

Teacher Guide

with advice for Cambridge Primary Science 0097

This Cambridge Teacher Guide is for use with the Cambridge Primary Science Curriculum Framework published in September 2020 for first teaching in September 2021.

Version 1.0

Contents

Introduction

Welcome to the Cambridge Primary Science Teacher Guide. This guide is designed to provide a suggested approach to the implementation of Cambridge Primary Science in your school.

It includes:

- an introduction to Cambridge Primary Science, including an overview of the design and content of the curriculum framework and schemes of work
- step-by-step guidance on the planning process
- guidance on effective teaching for Cambridge Primary Science
- guidance on creating a positive learning environment
- guidance on monitoring learners' progress and evaluating evidence to inform next steps for teaching and learning
- information about assessments provided by Cambridge International
- information about training and other support available from Cambridge International
- a glossary of the key terminology used in this guide.

If your school already delivers one or more Cambridge Primary Sciences, you may already be familiar with some of the information covered in this teacher guide. However, we still recommend that you familiarise yourself with this guide, especially *Section 1: Overview of Cambridge Primary Science*.

The structure of this teacher guide allows you to find, use and refer back to sections when they are relevant to you. Where sections contain information that is relevant to many subjects, you will often find Science-specific exemplification too. This will enable you to see easily how the information relates to Cambridge Primary Science.

Science-specific exemplification is indicated by a coloured vertical line to the left of the text.

This teacher guide should be read alongside the Cambridge Primary Science Curriculum Framework and the accompanying schemes of work at **https://primary.cambridgeinternational.org**
Here you will also find additional resources to support your school's implementation of Cambridge Primary Science (see Section 6.1).

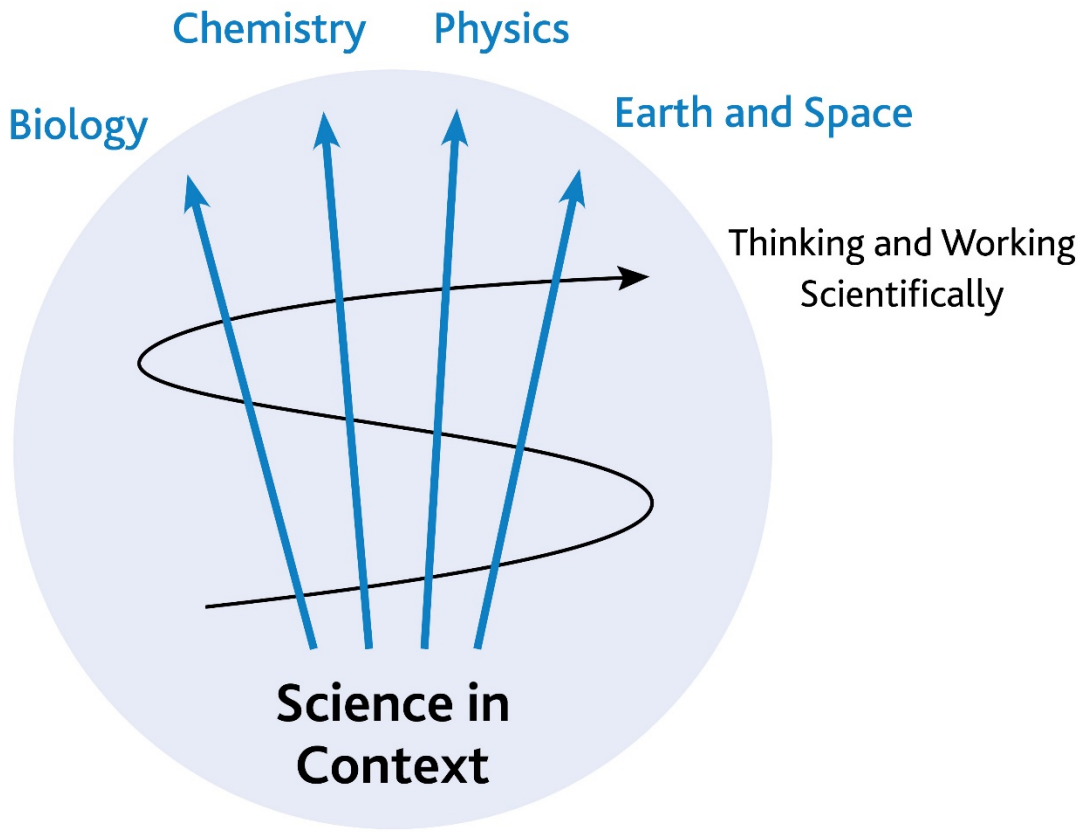
Section 1: Overview of Cambridge Primary Science

1.1 The curriculum framework

The Cambridge Primary Science Curriculum Framework provides a comprehensive set of learning objectives for six stages. The curriculum framework is typically for learners aged 5 to 11, but it may be appropriate to use it for slightly different ages to suit your context.

The learning objectives in the curriculum framework provide a structure for teaching and learning. They also provide a reference for checking learners' development of knowledge, understanding and skills. The learning objectives are divided into main areas of learning called 'strands'. In Cambridge Primary Science, there are six strands, divided into three categories:

- a skill strand – Thinking and Working Scientifically
- four content strands – Biology, Chemistry, Physics, and Earth and Space
- a context strand – Science in Context.



All the strands support learners in understanding and investigating natural phenomena and provide a foundation for developing future scientific skills, knowledge and attitudes. Although each strand is presented separately, it is intimately connected to the other strands.

Each strand, except for Science in Context, is further divided into 'sub-strands'. Sub-strands are based around the key concepts of each strand. Sub-strands help to identify progression and are useful when designing long-term plans, medium-term plans and other teaching resources.

Thinking and Working Scientifically

This strand relates to the development of scientific skills and covers three core scientific approaches:

- **Models and representations**: Scientists use models and representations to represent objects, systems and processes. They help scientists explain and think about scientific ideas that are not visible or are abstract. Scientists can then use their models and representations to make predictions or to explain observations. Cambridge Primary Science includes learning objectives about models and representations because they are central to learners' understanding of science. They also prepare learners for the science they will encounter later in their education.
- **Scientific enquiry**: Learners need to develop scientific enquiry skills around the purpose and planning of experiments and investigations, evidence collection, analysis, making evaluations and conclusions. These skills enable learners to investigate the world around them and relate their scientific knowledge to observable and testable phenomena.
- **Practical work**: Learners require good skills of observation, measurement and equipment handling. These skills enable learners to collect accurate and reliable data within investigation work. The development of practical work and the skills associated with it supports the collection of data.

The three core scientific approaches are reflected in the sub-strands:

Strand	Sub-strands
Thinking and Working Scientifically	Models and representations (from Stage 2 onwards) Scientific enquiry: purpose and planning Carrying out scientific enquiry Scientific enquiry: analysis, evaluation and conclusion

The four content strands

- **Biology** is the study of living things and how they interact with each other. Learners develop understanding about life processes, including how the structure and development of living things allow them to maintain these processes.
- **Chemistry** is the study of matter. Matter takes the form of materials that are made up of substances. Learners develop understanding of materials and substances, their properties and their physical and chemical changes.
- **Physics** is the study of the interaction of matter and energy. Learners develop understanding about how heat and electrical current are transferred through matter, how light and sound behave, how magnets interact and how forces affect objects.
- **Earth and Space** covers the study of the planet Earth, the wider Solar System and beyond. Learners develop understanding about the connections between land, oceans, atmosphere and life of our planet. They investigate how the key cycles that shape our planet Earth are closely linked with the Solar System. Learners also explore the Earth's formation, geology and climate.

The sub-strands for the four content strands are:

Strand	Sub-strands
Biology	Structure and function Life processes Ecosystems (from Stage 2 onwards)
Chemistry	Materials and their structure Properties of materials Changes to materials
Physics	Forces and energy Light and sound Electricity and magnetism
Earth and Space	Planet Earth Cycles on Earth (from Stage 5 onwards) Earth in space

Science in Context
This strand provides a framework of statements to help learners study and understand the learning objectives within the other five science strands in a context relevant to them. Learners recognise how the Cambridge Primary Science curriculum relates to the real world by linking concepts and processes learned in the classroom to scientists and their work, science phenomena, and ideas and events relevant to their age and experience. In Stages 1 to 3, science activities should focus on learners' experiences and surroundings. In Stages 4 to 6, the science activities should draw on broader local contexts or from elsewhere in the country and region.

There are no sub-strands for this strand.

1.2 Key features of the curriculum framework

Note: Some key terminology relating to Cambridge Primary Science is included in the glossary at the back of this teacher guide. There is also a glossary in the Cambridge Primary Science Curriculum Framework.

Thinking and Working Scientifically, particularly the development of scientific enquiry skills, underpins the Cambridge Primary Science Curriculum Framework. You should integrate the learning objectives for the Thinking and Working Scientifically strand into your lessons as often as possible.

You should also try to integrate Science in Context into your lessons as often as possible to support learners in seeing how science is relevant to their lives.

Cambridge Primary Science allows you to plan lessons that involve all three categories of strands at the same time. It therefore provides a framework for a holistic science education. (See Section 3.4.)

1.3 Progression in learning

The curriculum framework is a planning tool. The learning objectives within it are designed to promote progression in learning from Stage 1 to Stage 6 and onwards into Lower Secondary. It enables development of knowledge, understanding and skills through a spiral approach: by revisiting and engaging with topics and skills at deeper levels and in different contexts across the stages.

The tables below contain some example learning objectives. They show how the development of knowledge, understanding and skills progresses across the stages.

	Thinking and Working Scientifically learning objectives
Stage 1	**1TWSp.02** Make predictions about what they think will happen.
Stage 2	**2TWSp.02** Make predictions about what they think will happen.
Stage 3	**3TWSp.03** Make a prediction describing some possible outcomes of an enquiry.
Stage 4	**4TWSp.03** Make a prediction describing some possible outcomes of an enquiry.
Stage 5	**5TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.
Stage 6	**6TWSp.03** Make predictions, referring to relevant scientific knowledge and understanding within familiar and unfamiliar contexts.

Be aware that, as in the example above, learning objectives in Thinking and Working Scientifically are often developed over two years to support learners in consolidating and developing skills.

	Chemistry learning objectives
Stage 1	**1Cp.01** Understand that all materials have a variety of properties.
Stage 2	**2Cp.01** Describe a property as a characteristic of a material and understand that materials can have more than one property.
Stage 3	**3Cp.01** Describe differences in the properties of solids and liquids.
Stage 4	**4Cp.01** Use the particle model to explain the properties of solids and liquids.
Stage 5	(No relevant learning objective in the progression sequence)
Stage 6	**6Cp.02** Know that gases have properties, including mass.

Be aware that, as in the example above, some stages may not be part of the progression for a scientific concept. This arrangement of content means Cambridge Primary Science gives you time to cover the breadth of scientific content as well as developing learners' depth of understanding over the whole curriculum.

To enable effective progression in your teaching of Cambridge Primary Science, you need to be familiar with the progression of knowledge, understanding and skills across stages. This will help you to build on prior learning in every stage. The progression of learning objectives across Stages 1 to 6 is available at **https://primary.cambridgeinternational.org**

The ideas in the schemes of work provide guidance on the types of teaching and learning activities appropriate at each stage (see Section 1.4).

1.4 The schemes of work

This teacher guide provides support in using the Cambridge Primary Science Curriculum Framework to plan and deliver lessons using effective teaching and learning approaches. To support your planning there is also a scheme of work for each stage at **https://primary.cambridgeinternational.org**

The scheme of work for each stage of Cambridge Primary Science contains:

- suggested units showing how the learning objectives in the curriculum framework can be grouped and ordered
- at least one suggested teaching activity for each learning objective
- a list of subject-specific vocabulary that will be useful for your learners
- common misconceptions
- sample lesson plans.

You do not need to use the ideas in the schemes of work. Instead, use them as a starting point for your planning and adapt them to suit the requirements of your school and the needs of your learners. The schemes of work are designed to indicate the types of activities you might use, and the intended depth and breadth of each learning objective. These activities are not designed to fill all of the teaching time for a stage. You should use other activities with a similar level of difficulty, for example, those from endorsed resources.

Section 2: Planning

2.1 Getting started

This section looks at the process of planning how to develop your learners' knowledge, understanding and skills within and across the stages of the curriculum framework.

Planning is important to ensure:

- consistency across different groups of learners and different teachers
- availability of resources before starting to deliver lessons
- development of appropriate knowledge, understanding and skills according to your learners' needs
- a variety of teaching approaches to meet your learners' needs
- opportunities for monitoring, evaluation and feedback
- a positive and inclusive learning environment.

You need to plan:

- the knowledge, understanding and skills your learners need to develop in each term/semester
- the order, progression and continuity of knowledge, understanding and skills
- effective lessons led by learning objectives.

The following sections provide guidance on the planning process, including how you can build in flexibility to allow you to adapt coverage, delivery and timing to suit your teaching style and your learners' needs.

If you are delivering Cambridge Primary Science for the first time, you can use the schemes of work as a starting point for your own planning. These are available at **https://primary.cambridgeinternational.org**

2.2 Description of planning stages

There are three main planning stages:

- **Long-term planning** involves outline planning of how to cover the curriculum framework for a particular stage across the school year. It includes thinking about:

timing of learning, including considering holidays, school events and educational visits, and outside activities that need to happen at suitable times of the year
access to resources, including considering whether resources are available or need to be purchased
balanced coverage of each strand in the curriculum framework
any concepts and skills that your learners might need more time to develop.

  Long-term planning involves making decisions as a school and in the context of your school's overall curriculum plan.

- **Medium-term planning** involves more detailed planning of the teaching sequence of learning objectives in each term/semester. It is also useful to record any initial ideas for effective teaching activities.

  Do not expect your medium-term plan to be perfect first time. Start with an estimate of how long you think learners will need to develop the knowledge, understanding and skills for the term/semester. Then adjust your plan as the term/semester progresses in response to the needs of your learners. You are the best judge of the capabilities of your learners and how long it will take them to develop the required learning.

- **Short-term planning** involves writing lesson plans. Lesson plans are led by the learning objectives, or parts of learning objectives, you are focusing on in the lesson.

A lesson plan:
provides essential information for all adults involved in the teaching
improves continuity in the absence of regular teaching staff
considers the learning needs of all learners to create an inclusive learning environment
provides outlines of resources, timings, and teaching and learning activities.

A key purpose of short-term planning is to build on learners' responses to previous lessons, enabling them to progress in their learning.

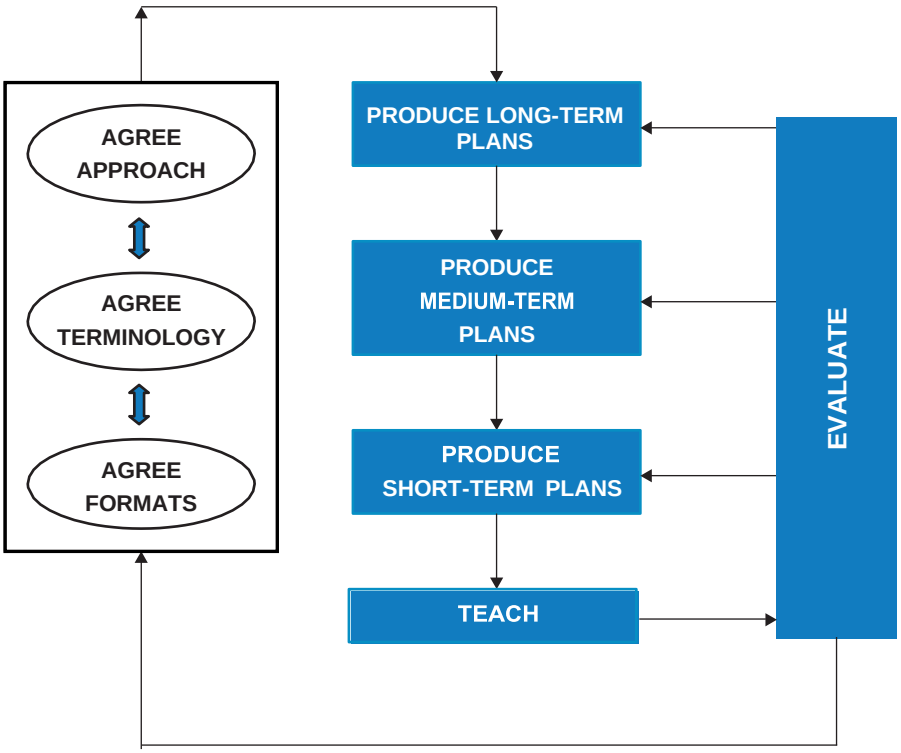
2.3 A consistent approach to planning

We suggest that you work with colleagues at your school to develop a consistent approach to planning. This will ensure the best possible support for learners' progression from Stage 1 to Stage 6. Discussions with your colleagues can also deepen your own understanding and inform your approaches to teaching. Discussions will build a network of teachers who understand the Cambridge Primary Science Curriculum Framework and are able to deliver it in an effective and motivating way.

Finding shared planning time is not always easy. You may already have face-to-face planning time with your colleagues or you may need to decide how to organise this. You may also decide to collaborate with colleagues across the year using technology such as email, a virtual learning environment or social media (with appropriate privacy settings).

Before starting to plan, you and your colleagues will need to download the Cambridge Primary Science Curriculum Framework from **https://primary.cambridgeinternational.org** and familiarise yourself with its structure and coverage.

The diagram below provides a suggested approach to collaborative planning:



It is likely that you will decide to have separate planning time for producing long-term, medium-term and short-term plans (the middle column of the diagram). However, it is also useful to have an initial meeting for all the teachers who will deliver Cambridge Primary Science to discuss and make the decisions shown in the first column of the diagram:

- **Agree approach:** Decide with colleagues and management the general approach to delivering Cambridge Primary Science. This includes how frequently the subject will be delivered, for how long and by which teachers.

- **Agree terminology:** Ensure everyone involved in teaching Cambridge Primary Science understands the key terminology relating to planning and the curriculum framework so that, for example, 'long-term plan' means the same to everyone.

- **Agree formats:** Although it is not essential for everyone to use the same documentation for recording planning, it is very helpful for communication and common understanding of curriculum requirements. We recommend that all teachers delivering Cambridge Primary Science use the same templates.
  Possible templates are available at **https://primary.cambridgeinternational.org**.

Evaluating planning

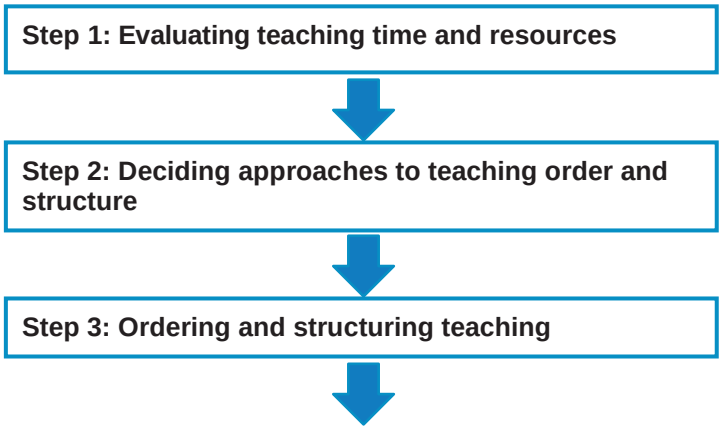
It is always a good idea to check how well something works before moving forwards. Therefore, the 'Evaluate' stage in the diagram above is a very important stage. The arrows in the diagram show how evaluation of teaching informs all the stages of planning. If there is a problem delivering a lesson (for example, if learners need more time than expected to develop a skill), it is often assumed that there is something wrong with the lesson plan. This can be true, but sometimes the problem is because the medium-term plan or long-term plan needs changing in some way. Your initial decisions (in the first column of the diagram) may also need to be revisited.

You should expect to adapt how you teach Cambridge Primary Science as you find out what works well with your learners.

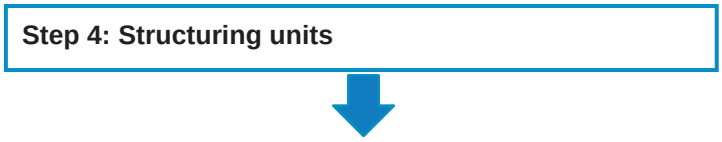
2.4 The planning process

The process for planning each stage of the Cambridge Primary Science Curriculum Framework can be divided into three phases. These phases are shown in the diagram below. The steps in each phase are explained in detail in Sections 2.5–2.7.

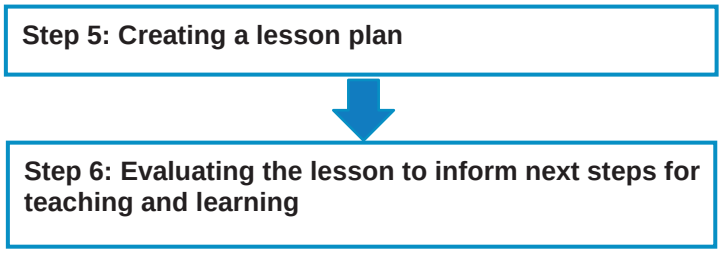
Phase 1: Long-term planning



Phase 2: Medium-term planning



Phase 3: Short-term planning



You can use the schemes of work for Cambridge Primary Science at **https://primary.cambridgeinternational.org** to support your planning.

Section 3.4 also provides guidance and examples to support your planning for Cambridge Primary Science.

2.5 Long-term planning

Step 1: Evaluating teaching time and resources

Establish the amount of lesson time available for Cambridge Primary Science and how this is split across the year.

Here are some questions to consider:

- How many lessons are there for Cambridge Primary Science in each term/semester?
- How many teaching hours are there in each term/semester?
- How many teaching hours are there across the year?

Remember to consider the impact on teaching time of any school events or educational visits.

For guidance, the Cambridge Primary Science curriculum is based on learners having the following number of hours for science shown in the table below. Your actual number of teaching hours may vary according to your context.

Stages	Suggested total number of hours per stage	Suggested hours of science per week
1–2	45	1.5
3–4	60	2
5–6	75	2.5

Create a list of key resources for Cambridge Primary Science, and consider which resources are available in your school and which resources you need to purchase.

Step 2: Deciding approaches to teaching order and structure

Decide the overall approach you want to take to the teaching order and structure of Cambridge Primary Science.

Here are some questions to consider:

- Will we need to share teaching and learning resources? If so, how will we do this?
- Do we have any preferences about which content is covered in each term/semester? Do we need to plan to have outside activities or educational visits at a suitable time of year?
- Will our learners find some areas of learning more difficult? Do we need to allow extra time for teaching these? When in the year would it be better to teach these more difficult areas?
- Are there any concepts or skills that our learners will need more time to develop?

Step 3: Ordering and structuring teaching

Consider how you will order teaching across the year and how you will structure it into units.

Here are some questions to consider:

- Which content and skills will we cover in each term/semester?
- How will we group content and skills within each term/semester?
- Which content and/or skills is it beneficial to teach together?
- Which learning objectives is it beneficial to revisit more than once across the year?
- How will we ensure that we have included each learning objective for the stage?
- Do our units form a logical whole with meaningful learning and progression?

As part of your long-term planning for Cambridge Primary Science, consider these questions too:

- Have you allocated enough time for practical investigations and experiments?
- Are there any Thinking and Working Scientifically learning objectives that you need to cover more frequently? This may depend on individual class needs.
- Over the year, are there specific terms/semesters where you can integrate Science in Context more easily?
- Have you thought about progression over the year, so that learning in one term/semester supports learning in another, especially when there is related content? For example, you could teach chemistry learning objectives in one term/semester before teaching the related learning objectives from physics.
- How will you ensure that there is progression of teaching and learning for learning objectives that are included in more than one stage?

The schemes of work for Cambridge Primary Science at **https://primary.cambridgeinternational.org** provide suggested units in a possible teaching order.

2.6 Medium-term planning

Step 4: Structuring units

Record your learning objectives for each unit with ideas and guidance on teaching approaches and activities.

Here are some questions to consider:

- What prior experience do we expect our learners to have?
- What new knowledge, understanding and skills do we need to teach? How long will learners need for this learning?
- Is there a natural order of teaching for the learning objectives within each unit?
- Which learning objectives should we revisit across units? Which parts of these repeated learning objectives will be the focus for each unit?
- What teaching approaches will we use?
- What activities can we use to teach the learning objectives?
- What is the key vocabulary for each unit?
- What are the key resources for each unit?

See Section 4.2 for more information about resources and Section 4.3 for more information about digital technologies and eSafety.

As part of your medium-term planning for Cambridge Primary Science, consider these questions too:

- Are you focusing more on one aspect of Thinking and Working Scientifically than on others? If so, is this appropriate for your learners?
- Have you integrated Science in Context in each unit? If so, why? If not, why not?
- What practical investigations and experiments are you going to include in each unit? Are there any resource limitations that you need to consider? If so, how will you overcome those limitations?
- Are there enough practical investigations and experiments in your units to meet your school vision for the teaching of science?
- Are you working with other teachers to consider how to reinforce key scientific vocabulary in other subjects (e.g. as part of activities in English lessons)? Some scientific words are unique. Other scientific words may be similar to words that learners already know, but have a different meaning. If learners have multiple opportunities outside science lessons to use and apply scientific vocabulary, they will be able to learn it more effectively and use it accurately.
- Do all your learners speak English as their first language? Or will you need to provide additional support to some of them (e.g. to promote confidence in using scientific vocabulary)?

The schemes of work for Cambridge Primary Science at **https://primary.cambridgeinternational.org** provide one possible medium-term plan. They arrange

the learning objectives in units in a logical and progressive teaching order. Each learning objective has at least one suggested teaching and learning activity. Activities are designed so that learners are actively engaged in their own learning. More information about teaching approaches can be found in Section 4 of this teacher guide.

2.7 Short-term planning

Step 5: Creating a lesson plan

Producing detailed lesson plans for single lessons is particularly useful when first working with the Cambridge Primary Science Curriculum Framework. Remember that lesson plans should be led by the learning objectives (or parts of learning objectives) that are the focus for the lesson.

Good lesson planning enables successful teaching and an enjoyable learning experience. However, lesson plans should be flexible enough to be adapted. New learning builds on learners' prior knowledge, understanding and skills. Before teaching new content or skills, it is important to check that learners have the required prior experience. If the required prior knowledge, understanding and skills are not secure, you will need to address this before introducing new content and skills. Sometimes learners might be ready to move on more quickly than you anticipated. Sometimes they might need more time and support on a particular concept or activity.

We recommend you consider the following when creating lesson plans:

- learning objectives (or parts of learning objectives) and concepts/skills you will focus on
- success criteria (see Section 5.2)
- planned activities
- how activities will consider the needs of all learners
- resources
- timing for each part of the lesson
- groupings (individuals, pairs, small groups, whole class) and group sizes
- expectations for learner outputs
- opportunities for identifying and addressing misconceptions
- opportunities for evaluating achievement of learning objectives to inform next steps for teaching and learning. (See Section 5 of this teacher guide for more information about monitoring and evaluating learners.)

As part of your short-term planning for Cambridge Primary Science, consider these questions too:

- How will you identify learners' difficulties during practical investigation and experiment work?
- How will you identify which science misconceptions you need to address in the lesson itself, and which ones it would be better to address in a later stage?
- Is your lesson trying to cover too many Thinking and Working Scientifically learning objectives? When you are designing practical investigations or experiments, decide on one or two skills to focus on, even though multiple skills may be required. This approach ensures that teaching and learning remain focused in a lesson.
- Where will you find opportunities for learners to use their first, second or third language to discuss scientific vocabulary?

The schemes of work for Cambridge Primary Science at **https://primary.cambridgeinternational.org** contain sample lesson plans to guide your own lesson planning.

Step 6: Evaluating the lesson to inform next steps for teaching and learning

You must be prepared to amend your lesson plans for subsequent lessons to reflect the learning that has already taken place. A good set of lesson plans may have notes written all over them to show what went well, what should be considered for the next lesson and what might be changed before using the same lesson with another class.

Here are some questions to consider after a lesson, to inform your future lesson plans:

- How did my lesson plan help me to respond to my learners' needs? What changes did I make from my plan and why?
- What did each learner achieve today? What progress did they make?
- Are we ready to move on, or do I need to revisit aspects of the learning objectives with all or some learners?
- Is there anything I need to remember when teaching this lesson to another class?

Planning helps you to ensure that all necessary learning is achieved across a term/semester or year. Although 'unplanned' activities should not lead your teaching, you should not stick so firmly to your intended lesson plans that you cannot follow a new idea. Excellent lessons can result when something happens to stop a planned lesson, for example, a local or national event or when an individual brings something interesting into school. Learning takes place when learners are motivated and enthusiastic. So, you should feel able to use such stimuli to develop learners' knowledge, understanding and skills in line with the curriculum framework.

Sometimes you may find that learners achieve learning objectives more quickly than you expected. This will allow flexibility to plan additional activities that encourage broader or deeper learning.

Section 3: Teaching and learning approaches

This section considers some of the different teaching and learning approaches that Cambridge International recommends for developing learners' knowledge, understanding and skills in Cambridge Primary Science.

3.1 Active learning

Active learning involves learners being engaged in their learning rather than passively listening and copying information. Learners take part in a variety of activities that involve thinking hard. The focus should always be on the learning objective, rather than the task itself.

Active learning can take place inside the classroom or outside the classroom, and by working individually, in pairs, in small groups or as a whole class. It can be done with or without the use of special resources and digital technologies. It may involve moving, but it does not need to. The important thing is that learners are engaged in their own learning and have some responsibility for their progress.

Active learning encourages learners to think about their thinking (metacognition) through opportunities to plan, monitor, evaluate and make changes to progress their learning.

Useful principles for active learning include:

- identifying and building on learners' prior experiences
- ensuring that activities have an appropriate level of challenge: neither too easy, nor so challenging that they can't succeed even with guidance
- using a variety of individual, pair, group and whole-class activities
- promoting effective communication (see Section 3.3)
- using success criteria to give learners some responsibility for their own progress (see Section 5.2).

Your role in active learning is to direct and scaffold learning, and to prompt links with prior learning. You can also encourage regular self- and peer-assessment (see Section 5.6).

For Cambridge Primary Science, you can promote active learning in the following ways:

- Learners observe a phenomenon and ask their own question to investigate. Learners then set up an investigation to answer their own question.
- Learners first apply previous scientific knowledge and understanding to help them explain a new phenomenon. Then they learn the science behind the new phenomenon and reflect on how supportive their prior understanding was.
- Learners watch you do a scientific demonstration. As you demonstrate, ask learners to predict what will happen. Learners then make observations on the experiment and reflect on whether their predictions were correct.

You can find more information about active learning in the Cambridge International resource *Getting started with Active Learning* at **https://www.cambridge-community.org.uk/professional-development/gswal/index.html**

3.2 Learner groupings

There are many different ways of grouping learners. As you plan your lessons, aim to use an effective balance of individual, pair, group and whole-class activities to develop both independence and collaboration:

Individual activities
Learners benefit from working independently at times. One way of helping learners to become more independent is to use the 'three before me' rule: learners are expected to use three different sources

of information (for example, talk partner, different peer, resources) before they ask you. Peer- or self-assessment can be beneficial following individual activities (see Section 5.6).

For Cambridge Primary Science, you could try these individual activities:

- Learners research a scientific topic using secondary sources of information (e.g. the internet, textbooks). Then they produce a report, presentation or poster on their findings.
- Learners carry out a practical investigation or experiment (e.g. testing the properties of materials and recording their observations).
- Learners create individual scientific models that demonstrate their own personal understanding of a scientific phenomenon (e.g. a model of how the Earth orbits the Sun).

Pair activities

Having someone to share ideas with is invaluable. A critical friend can offer advice and new ideas. Working in pairs helps learners to build meaning while both partners are focused and engaged in their own learning.

For Cambridge Primary Science, you could try these pair activities:

- Learners work in pairs to analyse scientific data and agree on what the data is telling them.
- Learners carry out a practical investigation or experiment in pairs, with each learner having a specific role. For example, one learner adds salt to water while the other learner observes closely what happens as more salt is added.
- Learners play a game of 'Guess what?'. Give each learner a set of cards showing different materials. They each secretly choose one of the materials. In pairs, they take turns to ask questions about the properties of their partner's material. They eliminate cards from their own set until they are left with the card showing their partner's material.

Group activities

When working in small groups, learners can support and guide each other's learning, and learn how to collaborate and cooperate.

For Cambridge Primary Science, you could try these group activities:

- Learners work as a group to plan, carry out and record research on a topic they have selected (e.g. each learner in the group researches one organism within a food chain).
- Small groups of learners move round a circus/carousel of activities, trying out each one.
- Learners work together in small groups to carry out a lengthy practical investigation or experiment that lasts several lessons (e.g. observing the impact of different conditions on plant growth over time). Within the groups, each learner has a different role.

Whole-class activities

Consider the purpose of whole-class activities carefully to ensure that all learners are engaged.

For Cambridge Primary Science, you could try these whole-class activities:

- Learners take part in a whole-class investigation, all working on the same question and then bringing their data together to provide an answer. For example, learners could investigate the temperature at which different solids melt. First, they plan the investigation as a whole class (e.g. discussing what the variables are and what to control). Then, learners carry out the experiment in groups, so that the whole class generates repeat measurements in parallel. It is only when the groups come together as a whole class to share their data that the question can finally be answered.
- Learners play a class game of 'What's in the bag?' Hide something in a bag. Learners ask yes/no questions to gradually deduce the material that is hidden. For example, *Is the material hard? Is the material smooth? Is the material heavy?*
- Learners take part in a whole-class role play to model a scientific concept (e.g. modelling solids, liquids and gases and changes of state).

Organising learner groupings

Learners can be grouped in many ways. Allowing learners to choose their own groups often results in friendship groups, but learners need experience of working with a variety of peers. So, it can be useful to organise groups yourself.

One quick method of grouping learners more randomly is to have numbered groups and to allocate a group number to each learner, for example as they enter the room. If learners are choosing their own groups, give them instructions for how to choose sensible 'working' groups and a time limit to arrange themselves (say 30 seconds).

How you group learners for a particular activity might depend on your method of differentiation (see Section 4.1).

Assigning group roles

One way to support group activities is to assign a role to each group member. This allows each learner to focus on one particular area whilst still working towards a shared goal. It is important that group members still communicate with one another so everyone inputs into the group's progress towards their shared goal.

The group roles you choose will vary according to the activity. Key responsibilities that the roles might include are:

- making sure everyone has the resources they need
- making sure everyone has the information they need
- making sure everyone is involved in tasks, discussions and decisions
- keeping a record of ideas and decisions
- making sure the task is completed on time
- reporting findings, for example, by presenting to the whole class.

Once learners are proficient in different group roles, you might allow learners to decide amongst themselves who will take on each role.

Guidance on monitoring group activities is included in Section 5.4.

Setting rules for group activities

Learners need clear rules about how to conduct group activities. You should discuss and develop these with your class. They could include some of the following:

- Respect and value everyone's opinions.
- Do not interrupt when others are speaking.
- Encourage everyone to speak.
- Give and accept constructive criticism.
- Take your fair share of the tasks.
- Support each other and make sure everyone understands.
- Stick to deadlines.
- Listen to each other and to any teacher instructions.

To encourage more effective collaboration, it is important that learners talk with each other rather than asking you to provide answers or to make decisions for them. You might want to introduce a rule which limits the number of questions each group can ask you during any one lesson or learning activity.

You need a clear signal to indicate when you want the class to stop and listen. One way of doing this is by positioning yourself at the front of the room and holding up your hand. Another effective method is counting down from five to zero with the expectation that by the time you reach zero the class is silent and still, and all eyes are on you.

3.3 Developing effective communication

Language awareness

Language awareness means understanding the possible challenges and opportunities that language presents to learning.
Language is an essential communication tool in all lessons, and you should celebrate learners' diversity of languages. Even though the Cambridge Primary Science resources are written in English, it does not mean that all the communication in your lessons must be in English.

Learners need a minimum level of linguistic and conceptual knowledge in their first language to develop a second language successfully. Once this knowledge is firmly established in a first language, learners can draw on this learning when working in an additional language.

Learners will benefit from being able to use their first language to aid their understanding of Cambridge Primary Science. By communicating in different languages, they will be able to transfer skills, concepts and learning strategies across languages. To do this, it is important that all Cambridge Primary Science teachers are 'language aware'. This means understanding the possible difficulties that language presents to learning. Such difficulties might arise because a learner is learning your Science through an additional language, or it might be the first time a learner has come across certain vocabulary or structures in their first language.

A teacher who is language aware understands why learners face the difficulties they do and what they can do to support them. You can encourage them to make use of their first language to understand ideas and concepts. You can pre-teach key vocabulary and use visuals with words to encourage understanding. Pre-teaching key vocabulary can also help to promote a more inclusive learning environment. This does not mean giving learners a list of random words to go away and look up in a dictionary. This will only demotivate them. Instead, you can introduce vocabulary to learners by using photos or familiar contexts of interest to learners. You can ask learners to create mind maps, or brainstorm known words and phrases to help them access a text, audio or video clip.

The schemes of work for Cambridge Primary Science at **https://primary.cambridgeinternational.org** contain lists of key vocabulary that it would be useful for your learners to know. You can use these lists to guide your vocabulary pre-teaching. You should also aim to model using key vocabulary in your lessons.

Promoting talk

Using talk partners helps to create a positive learning environment. Many learners feel more confident discussing with a partner before giving an answer to the whole class, and learners get opportunities to work with different people.

Using talk partners:

- involves all learners
- enables learners to practise speaking skills in a safe environment
- helps learners to generate ideas and opinions in a safe environment
- develops coherent thinking
- enables learners to learn from each other
- enables participation by learners who are less confident in whole-class situations
- develops collaborative and cooperative skills
- provides thinking time
- encourages extended responses.

You can organise talk partners in a structured or a random way. It can be beneficial to change partners at regular intervals.
For example, for Cambridge Primary Science, you could ask learners to discuss a given prediction and the scientific knowledge that informs that prediction.

One effective technique is 'think, pair and share'. Learners are given the opportunity to think about a question, then discuss it with a talk partner and then share their ideas with a small group or the whole class.

For example, for Cambridge Primary Science, you could play 'Odd one out'. Give pairs of learners a set of pictures relating to a learning objective. Each picture should show something that could be the odd one out for different reasons. For example, for a biological classification activity, you could have a set of pictures showing a lion, a whale, a fish, an insect and a lizard.

- First, learners think individually about which picture is the odd one out and why.
- Next, they discuss their ideas with their talk partner and agree which picture shows the odd one out and why.
- Finally, learners share their decision and their reason for it with the whole class.

Managing discussions

Group or whole-class discussions enable learners to develop their own thinking and learn from one another. Discussion also gives learners the opportunity to practise their language and communication skills. Effective topics for discussion build on prior knowledge and enable learners to generate a range of different ideas and opinions.

Every class has a mix of louder and quieter learners. This poses two challenges: how to encourage quieter learners to participate in discussions and how to stop more confident learners taking over discussions. Here are two strategies for encouraging participation from all learners:

- **Speaking tokens:** Give each learner four tokens (these could be buttons, pebbles or small pieces of paper). Each time a learner contributes to a discussion, they put down one token. Their aim is to put down all their tokens by the end of the discussion. This encourages quieter learners to offer their ideas. Louder learners have to prioritise their comments, which gives others more chance to participate.

- **Discussion prompts:** To encourage learners to talk about different ideas, you can use a range of discussion prompts.

  For example, in Cambridge Primary Science you could start a discussion about what happens to a solid when it is added to a liquid and 'disappears'. Use the following questions to further the discussion:
  Where has the solid gone?
  What evidence do you have for your statement?
  Are there any other possible explanations?
  What scientific knowledge can help us think about what has happened?

Promoting learner questions

When a learner asks a question, you should encourage other learners to answer the question rather than answering it yourself. For questions that require more thought, it is important to give learners time to think before they answer.

If some learners are not confident enough to put their hand up and ask a question, you could try using the following approaches:

- **Question wall:** Choose an area where questions and answers can be posted. This could be a poster to write on or sticky notes to stick on the wall. Learners add their questions and also add answers to others' questions. At appropriate times in your teaching sequence, review the questions with the whole class.

- **Question box:** Have a box in which learners can post their questions. Review questions in the box regularly and use them to direct your planning.

- **Question starters:** One way to help learners to ask open questions is to regularly model open question starters. These encourage learners to give more detailed answers and to justify their reasoning. Examples include:

Why …?

How do we know that ...?
What if ...?
How does this compare to ...?
How would you ...?
How did ...?
Explain why ...?
What might it mean if ...?
What might happen if ...?
How could you tell if ... is true?

Promoting writing

Learners' writing skills need to be developed across the curriculum, not just in language lessons. Discuss writing skills with the language teachers in your school; find out which skills have already been taught and how you can best consolidate and develop these skills through your writing activities in Cambridge Primary Science.

To help develop learners' research and written communication skills, you will need to support them in making notes, organising ideas and structuring writing in sentences and paragraphs which link clearly. Here are some strategies to help with this:

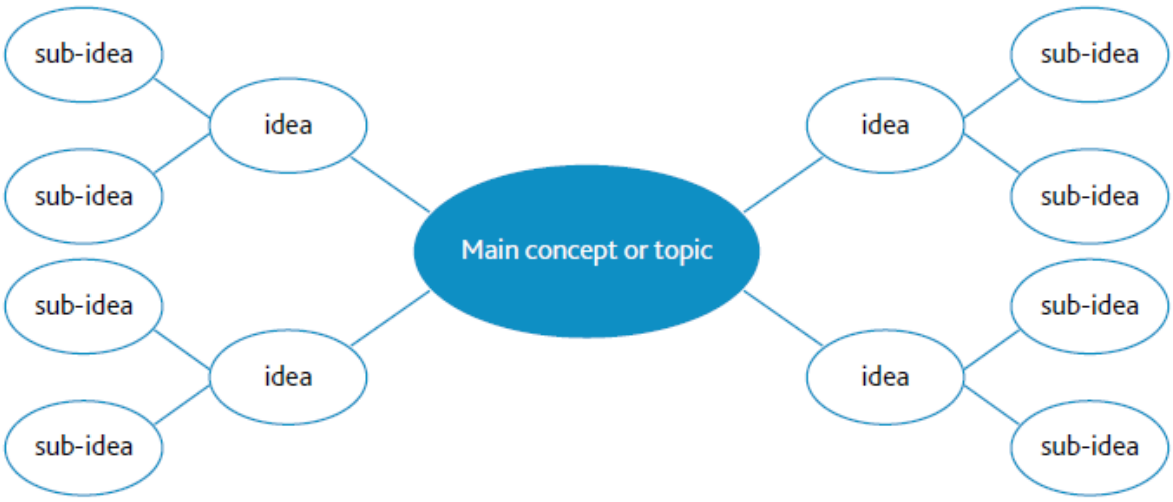
- **Making notes:** Graphic organisers help learners to represent their ideas visually and begin to organise their ideas by considering concepts such as sequencing, and cause and effect. They help guide learners' thinking, and involve learners in their own learning. Examples of graphic organisers include:

KWL charts, in which learners categorise what they **K**now, what they **W**ant to learn and, later, what they have **L**earned

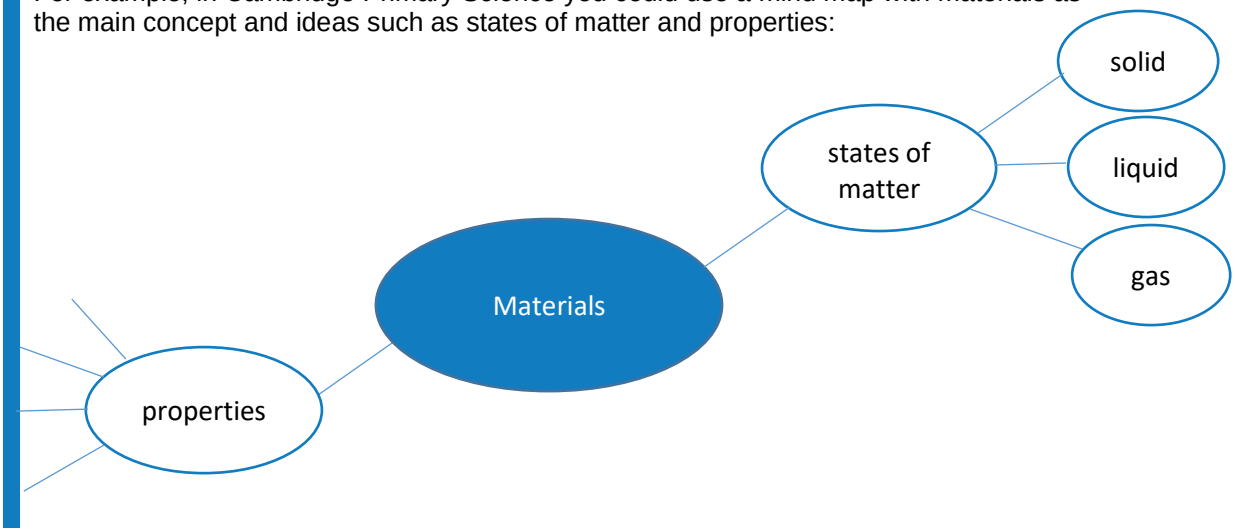
What do you know already?	What do you want to learn?	What have you learned?

For example, in Cambridge Primary Science you could use a KWL chart to:
- review what learners know about the Earth, space and the Solar System
- find out what they want to know about the Solar System
- record their learning about the names of planets and the position of the Sun.

mind maps, in which learners show the components and connections for a main concept or topic.



For example, in Cambridge Primary Science you could use a mind map with materials as the main concept and ideas such as states of matter and properties:



- **Organising ideas:** Sentence starters or writing frames help learners to plan how to organise their ideas before writing.

  For example, in Cambridge Primary Science you could provide sentence starters for predictions and conclusions:

  I predict …… because ……..

  ……..

  I conclude that ……..

  My data indicates that ……..

- **Structuring writing:** By modelling writing to the class you can demonstrate how learners can structure their ideas with clarity and to suit the purpose. It enables learners to see a high-quality piece of work and discuss its key features. Learners can then apply similar features in their own writing.

3.4 Approaches to teaching and learning in Cambridge Primary Science

Sections 3.1–3.3 above provide guidance on active learning, using different group sizes for activities and effective communication. These are all important for Cambridge Primary Science. This section gives you guidance on other teaching and learning approaches that are important for Cambridge Primary Science.

We have designed Cambridge Primary Science to be a holistic curriculum. The most effective science teaching develops learners' scientific knowledge and skills in a cohesive way and helps learners to understand how and why science is relevant to their lives.

You should consider the content strands first when you make your long-term, medium-term and short-term plans. This ensures that all scientific knowledge will be covered over a stage and that your units are cohesive based on their content.

When you have selected the content, you can then consider, if appropriate, which Thinking and Working Scientifically skills you wish to develop alongside the content. The skills you choose to develop the most will depend on the needs of your learners but you need to ensure that all learners develop every skill over the course of a stage.

After you have selected your content and the skills you wish to develop, you can then choose, if appropriate, to contextualise the learning through the Science in Context learning objectives. You should consider how the context will help learners connect science to their lives and support them in understanding the real-world importance of the subject.

For example, consider the following:

- First determine your plan for the content:
  - When will you teach each learning objective?
  - How much time will you give to each learning objective?

- When you have decided the content, consider opportunities for developing Thinking and Working Scientifically skills:
  - Which Thinking and Working Scientifically learning objectives can you link to content learning objectives?
  - Which skills are the most important to develop?

  For example, when teaching the following Chemistry learning objective:

  4Cc.01 Describe solidification/freezing and melting, using the particle model to describe the change of state

  you can plan to cover, over two lessons, the two Thinking and Working Scientifically learning objectives:

  4TWSc.08 Collect and record observations and/or measurements in tables and diagrams
  4TWSm.03 Draw a diagram to represent a real world situation and/or scientific idea.

- When you have decided the content and Thinking and Working Scientifically objectives, you can now consider if any units or individual lessons will benefit from being contextualised.

  For example, for learning objective **4Cc.01** above, you could use the following Science in Context learning objective:

  4SIC.02 Describe how science is used in their local area

  to support learners in identifying where scientific understanding of solidification/freezing and melting is used in their local area (e.g. in industry, shops, the home). This will give learning about **4Cc.01** real meaning to learners.

Some lessons will not involve any Thinking and Working Scientifically skill. This is not a problem. It means that in those lessons learners can focus on developing their understanding of scientific knowledge within Chemistry, Biology, Physics and Earth and Space. You can decide when it is appropriate to develop Thinking and Working Scientifically skills, and which skills should be developed.

Similarly, some lessons will not include a context, perhaps because there is no suitable context or because a context would distract learners from developing their scientific knowledge or skills. You can decide when to use Science in Context learning objectives to help contextualise science learning.

Cross-curricular links

It is important that learners can think critically and creatively as scientists. Therefore, we recommend that Cambridge Primary Science is taught as a separate science. This will help to build a solid foundation of the distinct knowledge, understanding and skills for science which enables learners to develop deep understanding.

Learners should have opportunities to apply their knowledge, understanding and skills in as many contexts as possible. This includes applying learning from one science in:

- another science
- experiences outside the formal curriculum (in co-curricular activities such as sports events, drama productions, concerts, charity activities)
- cross-curricular projects.

Making links between Cambridge Primary Science and Cambridge Primary Global Perspectives will be particularly helpful in developing key skills in research, analysis, evaluation, reflection, collaboration and communication.

Helping learners to make these connections empowers them with the ability and confidence to think more holistically.

Here are some examples of activities that apply knowledge, understanding and skills from Cambridge Primary Science in the context of other subjects:

- **PE:** Learners can use their scientific understanding of the importance of movement in maintaining human health (**4Bp.04**) and their understanding of the circulatory system (**6Bs.01**) to support their learning in PE.
- **Music:** Learning from Stage 5 Physics, Light and Sound (**5Ps.01**, **5Ps.02** and **5Ps.03**) about how sounds are made and pitch changes, and about volume, can reinforce learning in music.

Cross-curricular projects give learners opportunities to use knowledge, understanding and skills from more than one subject. For example, as part of a project to make a school vegetable patch, learners use their science skills in order to discover the best conditions for healthy plants (temperature, light, water). To do this, they plan and conduct scientific investigations to compare the growth rate of different plants under different conditions. Then they use their mathematical skills to find the most useful statistical representation to show and interpret the data. Finally, learners present their findings. They could make a poster which summarises what they have discovered about vegetables. Alternatively, they could write a non-fiction text (e.g. a 'Beginners' guide to growing vegetables') with a list of instructions.

To help you to identify other cross-curricular links and to make best use of the knowledge, understanding and skills taught in other subjects, it can be helpful for teachers across your school to plan collaboratively. Remember to ensure that cross-curricular activities always focus on learning objectives for one or more subjects in order to progress learning effectively.

Section 4: The learning environment

4.1 An inclusive learning environment

An inclusive learning environment gives all learners the opportunity to fulfil their potential.

Learners bring different competencies to their lessons. For example, some might excel in mathematics and science, but find subjects where they need to write at length a challenge. Your learners will inevitably have differing language levels, and for some learners English might be a second, third or even fourth language. This diverse range of competencies and backgrounds should be celebrated.

As a teacher, it is part of your role to discover the competencies and backgrounds of your learners and to get the best from every learner. Achieving this will involve creating a positive learning environment in which all learners feel confident to make suggestions, take risks, ask for help and admit when they find something difficult.

By using a variety of teaching strategies, you can address the needs of learners with a variety of backgrounds, competencies and interests. These strategies will contribute to an overall inclusive learning environment. Each learner will feel valued and supported, and be able to develop and succeed in your lessons and beyond.

Benefits of an inclusive learning environment include:

- being able to connect with and engage all your learners
- being prepared to tailor prompts, support or challenge to individual needs
- being prepared to help learners with any issues that arise
- more motivating lessons for learners
- more confident learners who share their opinions and ideas, and ask questions
- more application and development of language skills
- happy and successful learners
- enthusiastic lifelong learners.

Teaching strategies for inclusive learning

To help motivate all learners, aim to present information in different ways for different activities, using a range of textual, oral, visual and hands-on resources. Wherever possible, use real-life contexts that are meaningful to your learners, and vary contexts to appeal to different learners.

Your focus should be on learning development rather than on presentation of learning. So, try to provide flexibility and choice in how learners demonstrate their knowledge, understanding and skills. You could let learners choose how to present their ideas to the class, for example, giving a verbal presentation, using a verbal explanation of an image, or using an on-screen presentation.

You can further develop an inclusive environment by:

- ensuring that all learners are familiar and comfortable with routines and expectations
- involving all learners in activities and discussions, for example, by randomly choosing learners to answer questions
- ensuring that all learners take an active role in their own learning process, for example, by using success criteria (see Section 5.2)
- giving learners opportunities to make their own decisions
- showing appreciation of everyone's ideas and contributions
- sharing or displaying strategies for effective collaboration
- encouraging learners to develop their own ideas, take risks and work creatively, for example, by modelling, sharing your thinking and learning from your mistakes
- ensuring learners have time to explore and consider ideas fully, for example, by giving adequate thinking time after asking a question
- encouraging learners to give reasons for their ideas, for example, by asking follow-up questions

- using varied questioning techniques and encouraging learners to ask their own questions (see Sections 3.3 and 5.3).

Feedback from learners can help you to develop an inclusive learning environment. A possible approach is to give out small pieces of paper at the end of a lesson. Learners record:

- how much they think they learned during the lesson using numbers 1 to 5, with 5 being the most learning
- how confident they felt during the lesson, using 

Learners could also record one or two suggestions for how you could help them to learn more.
In the next lesson, you can explain and discuss the changes you are making so everyone feels included, and able to learn and achieve in the lesson.

In Cambridge Primary Science, practical investigations and experiments should be accessible to all learners through a variety of resources whenever possible. Use clear instructional sheets, including instructions with visual cues rather than text only. When it is not possible to offer learners a range of resources, because of the nature of the investigation or experiment, ensure you have additional adult support so that all learners can participate.

As some parts of Cambridge Primary Science require learners to observe the natural world, you should be aware of any learners with visual disabilities, including learners with colour blindness.

Differentiation

Differentiation can help to make your lessons more inclusive. Differentiation means thinking about your learners' needs and trying to match teaching methods, learning activities, resources and the learning environment to individual learners or groups of learners. It aims to enable learners to reach their own goals through carefully planned activities, creating a positive learning experience and promoting successful learning.

Differentiation allows you to provide appropriate challenge for each learner. This can be by providing support for learners who are struggling with a concept or skill, and providing extra challenge for learners who achieve competence in a concept or skill more quickly.

For an inclusive learning environment it is important that support or challenge activities are based on the same learning objective as the rest of the class.

Some possible methods of differentiation are:

- **Using different learner groupings:** You can vary learner groupings depending on the learning activity or learning objective. For example, sometimes you might organise learners into groups containing learners with different competencies. By organising groups in this way, learners who need more support can gain ideas and skills from others, while other learners can develop their own understanding by explaining their ideas to others. In this way, all learners will be able to progress.

- **Varying the activity or outcome:** This is when learners work on the same learning objective in different ways. For example, different learners might use resources that offer different amounts of support, or different learners might demonstrate their learning in different ways.

- **Varying the amount of adult support:** This is when learners receive additional support from either you or a teaching assistant. For example, you might work with a small group of learners who need more support; other learners might work in unsupported groups with a summary sheet of questions to focus their learning.

4.2 Learning resources

To teach Cambridge Primary Science, you will need a variety of resources. However, you should be able to find all the resources required in your local environment or buy them from local shops. For example, you will need: a range of materials, including rocks and soils, for learners to investigate and study; plastic bottles or jars to use as containers.

Some of the scheme of work activities suggest the use of particular resources. They also include suggested alternatives that you can use if you have not got these resources. Activities that require a resource that may be more difficult to find are marked 'Requires additional resources', with a suggested alternative activity immediately below.

4.3 Digital technologies

Digital technologies are a valuable resource that can help learners to develop their knowledge, understanding and skills. They are particularly beneficial when used as one of a range of effective teaching and learning methods. To make best use of digital technologies in lessons, develop your awareness of a range of digital technologies and consider carefully how and why they can support learning. Your aim in using digital technology should be impact and progress, rather than to 'engage' and 'enthuse'.

Digital technologies can empower learners to be more autonomous in their learning. It is important that you and your learners are confident in evaluating when digital technologies may add value to the learning. Learners need to be critical in their selection of the most appropriate technology to support their requirements.

The technology you have available will influence how you choose to use it. For example:

- if you only have one computer available, you could set it up in an area suitable for independent activities such as research
- if you have audio/visual recording equipment available, you could use it to record learners as a basis for self- or peer-assessment activities
- if you have access to an interactive whiteboard or projector, you could use whole-class activities where learners present their work to others for evaluation and discussion
- if you have access to video conferencing tools, you could use them for collaborative activities with others beyond your school
- if you have access to a computer suite, you could use this for a particular investigation or research activity.

Mobile devices such as tablets can also be useful tools to support learning. They enable learners to make choices about when to use technology for a particular activity, such as making notes, researching and checking ideas, or preparing an interactive quiz.

There are many opportunities for using digital technologies in Cambridge Primary Science. For example, learners could:

- use online virtual labs, simulators or models to develop their scientific understanding
- use data loggers to support the collection of data (e.g. temperature)
- enter data into spreadsheets and manipulate the data, including by generating graphs
- use book-making apps (free ones are available) to make an interactive science report about an investigation including videos, voice recordings and photos.

Remember though that you should not overuse technology. It should only be used when there is clear added value for your learners.

You can find more information about digital technologies in the Cambridge International resource *Digital technologies in the classroom* at **http://www.cambridgeinternational.org/images/271191-digital-technologies-in-the-classroom.pdf**

Cambridge Primary Digital Literacy develops learners' understanding of how to use digital tools effectively and safely. You should be aware of the teaching and learning in Cambridge Primary Digital Literacy, and aim to provide opportunities for applying digital literacy skills through Cambridge Primary Science whenever appropriate.

eSafety

There are many positives to using digital technologies, but you also need to make learners aware of the potential dangers and how to keep safe when using computers, especially online. You should provide opportunities for learners to consider their own behaviour when using digital technologies and the impact their actions can have on others.

We recommend that all schools have an acceptable use policy which describes in detail what learners and school employees should and should not do once they are given access to the school's computer network. Care should be taken to ensure that the acceptable use policy is followed in all lessons, including Cambridge Primary Science lessons. If concerns arise, teachers should follow the policy, including making contact with local child protection and law enforcement agencies if appropriate. Ultimately it is your responsibility to make sure that learners are safe in your classroom and that they follow any national, regional or school regulations.

If internet sites will be used, you must check these before the lesson and make sure that all learners know how to use online resources safely and responsibly. Internet filtering and monitoring tools should always be in place and anti-virus software should be up to date.

Your guidance to learners will depend on their age, maturity, background and the content that is being delivered. Many online tools are designed for use by learners aged over 13, but younger learners can access this technology safely through supervised use or by using school-approved accounts. Learners should have clear instructions about what they should do if they feel unsafe when using digital technologies; this should include how they report their concerns.

4.4 A safe environment

Learners should feel safe and be safe in their learning environment. eSafety is one element of a safe learning environment (see Section 4.3), but it is also important to consider other risks in your Cambridge Primary Science lessons.

An essential part of this curriculum is that learners develop skills in scientific enquiry. This includes collecting primary data by experiment. Scientific experiments are engaging and provide opportunities for first-hand exploration of phenomena. However, they must, at all times, be conducted with the utmost respect for safety, specifically:

- It is the responsibility of the teacher in charge to adhere and conform to any national, regional and school regulation in place with respect to safety of scientific experimentation.
- It is the responsibility of the teacher in charge to make a risk assessment of the hazards involved with any particular class or individual when undertaking a scientific experiment that conforms to these regulations.

Cambridge International takes no responsibility for the management of safety for individual published experiments or for the management of safety for the undertaking of practical experiments in any given location. Cambridge International only endorses support material in relation to curriculum content and is not responsible for the safety of activities contained within it. The responsibility for the safety of all activities and experiments remains with the school.

Throughout biology, learners study a variety of living things, including animals. As part of the University of Cambridge, Cambridge International shares the approach that good animal welfare and good science work together.

Learners should have opportunities to observe animals in their natural environment. This should be done responsibly and not in a way that could cause distress or harm to the animals or damage to the environment.

If living animals are brought into schools then the teacher must ensure that any national, regional and school regulations are followed regarding animal welfare. In all circumstances, the teacher responsible must ensure all animals have:

- a suitable environment, including being housed with, or apart from, other animals (as required for the species)
- a suitable diet
- the opportunity to exhibit normal behaviour patterns
- protection from pain, injury, suffering and disease.

There is no requirement for learners to participate in, or observe, animal dissections for Cambridge Primary. Although dissection can provide a valuable learning opportunity, some learners decide not to continue studying biology because they dislike animal dissection. Several alternatives are available to dissection (such as models and diagrams) which you should consider during your planning.

If you decide to include animal dissection then animal material should be obtained from premises licensed to sell them for human or pet consumption, or from a reputable biological supplier. This approach helps to ensure animal welfare standards and also decreases the risk from pathogens being present in the material. Neither you nor your learners should kill animals for dissection.

When used, fresh material should be kept at 5 °C or below until just before use. Frozen material should be defrosted slowly (at 5 °C) without direct heat. All fresh or defrosted material should be used within 2 days. Preserved animal materials should only be handled when wearing gloves and in a well-ventilated room.

The responsibility for ensuring the welfare of all animals studied in science remains with the school.

4.5 Learning beyond school

Learning does not only occur in the school environment. To help broaden learners' understanding, it is important to consider learners' outside interests and experiences, and provide opportunities for them to make connections between experiences inside and outside of school. One way to enable this is to introduce new areas of learning by asking learners to share what they already know, perhaps using a class KWL chart (see Section 3.3).

There are opportunities for you to broaden learners' understanding of Cambridge Primary Science beyond school. Try these activities, for example:

- Take learners on a field trip so that they can observe different environments, animals, plants or physical phenomena.
- Encourage learners to participate in local, regional, national or international activities and competitions that link to what they are learning in school.

There are also opportunities to bring outside experiences into school. For example, invite a visitor who is knowledgeable about science or who uses science as part of their job (e.g. a botanist, nurse, doctor, miner, engineer, electrician) to come in and talk to learners about how they use science in their work.

Parental involvement

Research shows that there is a clear link between parental engagement in learning and performance in school for learners of all ages. Your school should consider how best to involve parents in their children's learning in your context. This might include:

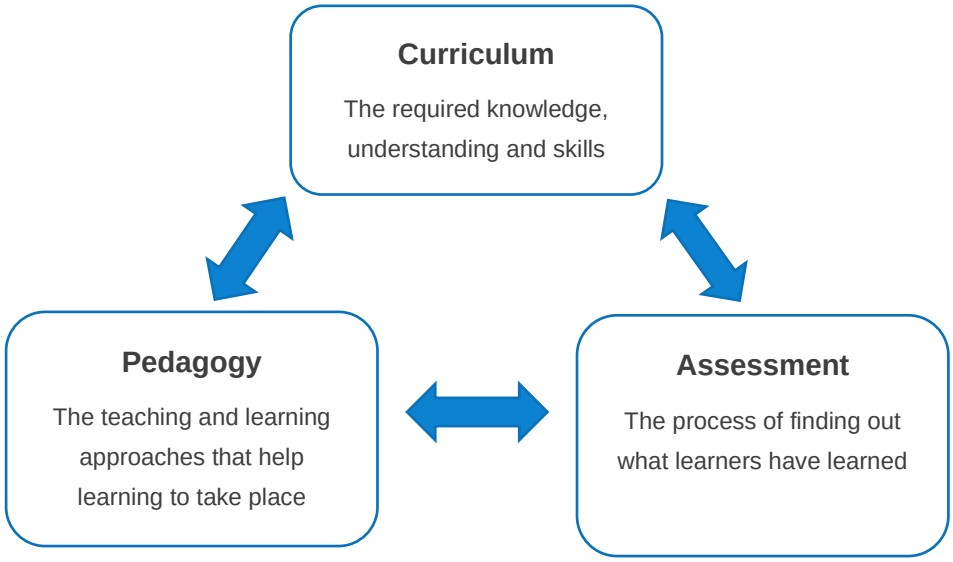
- communication of the content and skills that learners will cover in a term/semester
- explanation of key teaching and learning approaches that will be used
- general ideas for how all parents can support their children's learning
- specific ideas for how individual parents can support their child's learning
- activities carried out at home that involve exploring everyday contexts with parents
- presentations of learners' work in communal areas of the school and/or at special school events

- opportunities for parents to visit school, for example, to talk to learners about an area of expertise, to help with an activity, or to observe what happens during the school day.

Section 5: Monitoring and evaluation

5.1 Overview

For effective teaching and learning, there needs to be coherence between the curriculum, pedagogy and assessment:

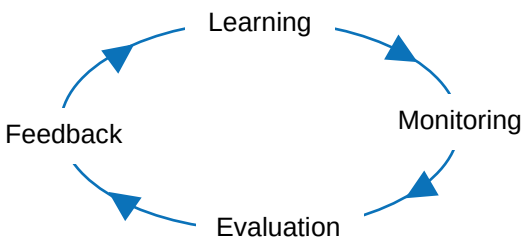


The learning objectives in the Cambridge Primary Science Curriculum Framework define the curriculum (see Section 1.1) and the activities you use in your classroom reflect your pedagogy. This section provides guidance on assessment.

Everyday assessment in lessons is important to enable you to support learners' progress towards achievement of the learning objectives. The sections below discuss:

- learning based on success criteria (Section 5.2)
- some techniques for monitoring progress in order to evaluate next steps for learning (Sections 5.3 and 5.4)
- giving feedback to learners to guide their progress (Sections 5.5 and 5.6).

Together these processes provide a cycle that support effective progress in learning.



Monitoring learning regularly, using a variety of informal methods, enables you to understand your learners' needs and plan next steps which will help them to make progress. For example, you might change your plan for the next lesson(s).

In addition to everyday assessments, it can also be valuable to assess learning over a longer period. Section 5.7 provides information about assessments provided by Cambridge International which cover a stage of learning.

5.2 Developing success criteria

Learning objectives describe what learners should know, understand and be able to do. Success criteria help you and your learners know when a learning objective has been achieved at an appropriate level. By having clear success criteria, learners know what is expected and are engaged in their learning. They have clear goals and can push themselves to achieve the learning objectives.

It is often helpful to display the success criteria throughout the lesson to help maintain focus and help learners to work independently. For example, if success criteria are in the form of 'steps', learners can check their 'success' by following the pathway created by the 'steps'. However, this is not the only approach and sometimes it may be more engaging to 'reveal' the success criteria at other points in the lesson.

You can create and express success criteria in different ways. Before learners start an activity, you might give learners a simple statement of what you expect from them (for example, I will be looking for …). Or you might involve learners in the creation of success criteria for an activity, to give them a clearer understanding of the expected learning.

Giving success criteria a central role in lessons and allowing learners to produce them:

- helps learners to gain a deeper understanding of what to do
- gives learners ownership of the criteria so that they can create a successful 'product'
- gives learners a basis for self- and peer-assessment (see Section 5.6)
- enables learners to become active learners (see Section 3.1).

One way to create success criteria with learners is to provide them with a learning objective for the lesson/activity and a question such as: *How will you know you have achieved this?* Another way is to use samples of work, perhaps from the previous year:

- Select two pieces of work: one that meets all the requirements and one that does not meet all the requirements.
- Ask learners to discuss with a partner what they like about both pieces of work and what could be improved.
- Collect feedback comments. Learners decide on the most important things to think about when they are doing the activity.
- Use feedback comments to produce success criteria.

You may be concerned that there is not enough time in lessons to create success criteria with learners. However, you will quickly discover that the process saves time usually spent on repeating instructions because all learners understand what they have to do and are keen to start the activity. However, even when learners are used to the routine of creating success criteria, you may decide not to use it for all activities.

Like learning objectives, success criteria may be limited to one lesson or may be spread over a series of lessons. There may also be several success criteria for one learning objective.

For example, learning objective **5Cc.01** covers several success criteria:

> **5Cc.01** Describe the processes of evaporation and condensation, using the particle model and relating the processes to changes in temperature.

Success criteria:

- I can describe how water changes state.
- I can explain how change of state is linked to temperature change.
- I can use the particle model appropriately to help describe a scientific phenomenon.

As you observe learners working towards success criteria, you will have many opportunities to monitor the development of their knowledge, understanding and skills. As part of an active learning environment, learners should also regularly reflect on their own learning and progress against the success criteria. Together your observations and learners' reflections will give you lots of information about each learner's strengths and weaknesses. You can use this to inform your future planning.

5.3 Using questions effectively

Questions can be a powerful tool for identifying how learners' knowledge, understanding and skills are developing. You can ask questions before an area of learning to find out what your learners already know and to monitor progress during a lesson or series of lessons. This will help you to decide what to do next (for example, deciding when to move on to a new topic, concept or skill).

Here are some tips and examples to help you make your questioning more effective. Most of the questions you ask will be verbal, but you can also use these tips for written questions:

- **Know your purpose**
  Make you sure you know why you are asking a particular question and what kind of information you are looking for. It is helpful to plan some questions in advance and include these in your lesson plan.

  The table below shows some common purposes, and examples of possible questions for Cambridge Primary Science:

Purpose	Example questions
To get an overview of learners' prior experience before introducing a new concept or topic	*Today we are going to start a new topic on plants. What do you already know about plants?*
To check learners' understanding of particular concepts and decide what to do next	To evaluate learners' understanding about the names and functions of plant parts: *What can you tell me about the roots of this plant?*
To clarify, extend or evaluate learners' own ideas	*What will happen when I add salt to water? Why do you think that?*
To clarify, extend or evaluate other learners' ideas	*Aiko thinks that the Moon moves around the Earth.* *Who agrees with Aiko? Who doesn't agree with her?* *What can we add to Aiko's answer?*
To consider approaches To show a variety of strategies and to make reasoning explicit	*Do plants need light to grow?* *How can we find the answer? What investigations can we plan and do?*
To make connections to prior learning to justify ideas	When looking at gases: *What do you already know about solids and liquids that could help you know about gases?*
To involve the whole class To consolidate ideas	After a group has shared their approach to a scientific investigation with the class: *What do you think about that approach?* *How is that approach different to yours?*
To inform further inquiry To show a variety of strategies for next steps	*We've found that seeds need warmth to germinate. What could we try next?* *How could we improve the investigation if we tried again?*

- **Use open questions more often than closed questions**

Closed questions can be useful to evaluate specific concepts, but open questions invite learners to say more. This often enables you to gather more information about their understanding. Open questions also enable you to stimulate learners' interest and motivate their thinking.
For example, after an investigation that concludes that seeds need warmth to germinate, ask: *Why does the seed need warmth to germinate?* This will generate more valuable insight into learners' understanding than if you ask: *At what temperature does the seed germinate?*

- **Ask one thing at a time**
  Limit your questions to one sentence.
  For example, this question asks both *what and* why: *What features does a camel have and why?* Instead, ask: *What features does a camel have? Why does it have each feature?*

- **Determine the focus, but do not assume a particular answer**
  For example, this question tells learners that melting is linked to increasing temperature *Do you think increasing the temperature will melt the ice?* Learners should complete the investigation themselves to establish the link. So, instead, ask: *What do you think you need to do to melt the ice? Why are you doing that?*

  As you become more experienced in teaching a particular topic, you will discover some common misconceptions or mistakes. Asking questions to discover whether learners have these misconceptions, or make these mistakes, can be a very useful focus.
  For example, if you ask: *Why do shadows change length during the day?* you will be able to see whether learners understand that the Earth spins and moves round the Sun, or whether they wrongly think that the Sun moves round the Earth each day.

- **Do not give options unless they are the only options**
  For example, if you ask: *Is a bird a predator or prey?* you make learners choose between the two options, instead of considering that a bird could be both predator and prey.

- **Allow thinking time**
  Provide learners with time to pause, think and reflect. Avoid expecting learners to answer questions straightaway and instead allow thinking time before taking responses. Similarly allow time after a response before moving on or asking follow-up questions, to give learners the opportunity to both consider the response and add their own ideas or questions.

- **Listen actively**
  Ensure that you listen to the answers learners actually give rather than waiting for your expected answer. Often unexpected answers will give you the most useful information about what learners know, understand and can do.
  Make sure learners do not think that the aim is to tell you the answer you want to hear. If this happens, they will try to 'guess what is in your head' rather than show you their current understanding.

- **Help learners to express their ideas fully**
  Sometimes a smile or a nod can encourage a learner to give a fuller answer. In addition, follow-up questions can help to develop a sequence of thoughts, clarify a learner's answer or engage the rest of the class.
  For example, ask learners to describe the adaptations an animal has for a specific environment. Then say: *How do these adaptations help the animal? Convince your partner that a particular adaptation is beneficial for the animal.*

- **Encourage learners to ask you questions**
  To encourage learners to ask you questions, try not to give all the information at once and create a learning environment that encourages learners' questions (see Section 3.3).

5.4 Monitoring individual, pair and group activities

You need to monitor learners' progress throughout lessons, both while learners are working individually and while they are working in pairs or groups. How much you intervene will depend on the age of the learners, but it is important that you do not intervene so much that learners become too reliant on you. Instead, you should allow learners to make mistakes, identify and correct errors, and support each other. This will encourage learners to become more confident and independent.

For group work, part of your role is to ensure that every member of the group is involved: that quieter learners are not excluded, that more confident learners share the responsibilities and that every member shares the responsibility for moving towards the goal. Standing back and observing learners is a good start. You can use your observations to inform follow-up questions or targets for individuals. For example, if an individual is not engaging well in an activity, you can set a small target and a time limit given before returning to observe the individual again:

- 'When I come back in five minutes, I want you to explain how you have ..'.
- 'When I come back in five minutes, I will pick one of you randomly to present your ideas. So make sure that you are all confident in your method and explanation.'

However you decide to monitor pair or group activities, it is important that you give all learners time to discuss their ideas, and that you move around the classroom and listen to the language that learners are using.

5.5 Giving feedback

In order to help learners make progress, they need to receive feedback on their knowledge, understanding, skills and effort, and how they can develop them further. All feedback should be specific, constructive and meaningful to learners – it needs to help learners to identify next steps. The most effective feedback occurs when feedback is given as learners work or soon after.

Most importantly, learners need the opportunity to act on feedback and carry out steps for improvement. Without opportunities to reflect, improve and demonstrate evidence of their competence, feedback cannot impact learning effectively.

When you are giving feedback, make sure it links clearly to success criteria and/or learning objectives you have already communicated to the class. Also ensure that your feedback gives the learner enough information to answer the following questions:

- How am I doing? (What progress have I made towards the success criteria / learning objective?)
- What should I do next? (What do I need to do to make further progress?)

Here are some types of feedback:

- **Verbal feedback**
  The most effective feedback occurs when the work is discussed face-to-face. Verbal feedback can be given to an individual, to a group or to the whole class. The language used in lessons has an enormous impact on learners. You should aim to create a learning environment where speaking freely about learning, misconceptions and mistakes is seen as beneficial to learning.

- **Non-verbal feedback**
  We should be aware that we are constantly giving our learners non-verbal feedback through our facial expressions and gestures, for example a smile or a nod of the head. Being aware of our non-verbal communication can help us to develop a positive, supportive learning environment.

- **Written feedback**
  Sometimes it is not practical to give verbal feedback to all learners, and work may need to be marked outside of a lesson. You need to ensure that your written feedback is appropriate for your learners, so they can read and understand your comments. You also need to ensure that you provide learners with time to read and respond to your feedback. Learners need to be clear

about how you expect them to respond to written feedback, for example they could respond by adding to or amending their work in a different colour.

5.6 Self- and peer-assessment

Feedback should not only come from you. It is also important to encourage feedback between learners (peer-assessment). Peer-assessment enables learners to learn from and support each other. It adds a valuable dimension to all learning. The opportunity to talk, discuss, explain and challenge each other, enables learners to progress further than they can unaided. It is important that learners' feedback is supportive and constructive. Your own feedback to learners will help to model effective feedback techniques.

Peer-assessment also develops learners' self-assessment skills. We should encourage learners to use self-assessment continually, so that reflection and improvement become a natural part of the learning process. Self-assessment promotes independent learning and helps learners to take increasing responsibility for their own progress. You could provide learners with a reflection journal where they can record their self-assessment for discussion with you or with peers at key points in the year.

5.7 Monitoring achievement

The previous sections describe ways to monitor progress lesson by lesson. It is also useful to give learners opportunities to demonstrate what they have achieved after a period of study.

As part of Cambridge Primary, end-of-stage, teacher-marked tests (progression tests) are provided for each of the Stages 3 to 6. These are available from the Cambridge Primary support site. Summative end of Primary tests (Cambridge Primary Checkpoint) are also available. These tests are externally marked and centre reports with Certificates of Achievement are issued.

Cambridge Primary Progression Tests
These tests are for use within the classroom to help measure the progress of learners and identify strengths and weaknesses. You can use the tests to assess the learning objectives from the curriculum framework. Analysis of the results of the tests provides diagnostic feedback to the learner on their strengths and areas that require improvement. The analysis of the strengths and weaknesses for the class can be used to reflect on the teaching and prompt changes to the planning for subsequent years.

Lessons following the test need careful planning to incorporate differentiation so that learners can target the particular areas of improvement identified in the reports. The reports may show similar problems for groups of learners which will help with organisation – groupings created for this may change from lesson to lesson. For learners who require more challenge, you could prepare a set of lessons that extend their skills and understanding while ensuring that any areas of weakness are addressed.

You can analyse your learners' test results using the reporting tool available on the Cambridge Primary support site http://primary.cambridgeinternational.org. The site allows you to:

- access the progression tests and store learners' marks
- organise your learners into groups, making it easier to administer the tests and run reports for each group
- use the reports to track learners' progress by comparing individual results against the rest of the class, the school or the average of all learners who have taken the same tests.
- compare results on a year on year basis
- analyse the reports to reflect on your teaching and then focus your efforts where they are needed most
- download your reports to share with other staff and parents.

Cambridge Primary Checkpoint
Cambridge Primary Checkpoint are additional (end of Primary) tests available to Cambridge Primary schools. These are intended for learners at the end of their final year of primary education, when they are around 11 years old. The tests provide an assessment of the learning objectives from Stage 6 of the curriculum framework. These tests are currently available twice a year in April and October.

Schools make entries for their learners using Cambridge International Direct. Cambridge International will then send the examination papers to the school. After learners have taken the Checkpoint tests, the tests are returned to Cambridge International for marking.

Cambridge International provides detailed feedback of the results of the Checkpoint tests, including:

- a centre report
- reports on teaching groups
- individual reports to learners.

Learners also receive an individual statement of achievement.

Details about Cambridge Primary Checkpoint (including past papers) are available from http://primary.cambridgeinternational.org

Section 6: Support from Cambridge International

6.1 Resources available from Cambridge International

Cambridge Primary centres receive access to a range of resources when they register. The Cambridge Primary support site at **https://primary.cambridgeinternational.org** is a password-protected website that is the source of the majority of Cambridge-produced resources for the programme. Ask the Cambridge coordinator or exams officer in your school if you do not already have a log-in for this support site.

Included on this support site are:

- the curriculum framework (see Section 1.1)
- grids showing the progression of learning objectives across stages
- schemes of work (see Section 1.4)
- templates for planning (see Section 2.3)
- worksheets for short teacher-training activities that link to this teacher guide
- assessments provided by Cambridge
- a list of endorsed resources which have been through a detailed quality assurance process to make sure they are suitable for schools teaching Cambridge Primary Science worldwide
- links to online communities of Cambridge Primary teachers.

6.2 Training

Self-study training

An online, self-study introductory course is available free to Cambridge Primary centres. It provides an introduction to Cambridge Primary, its educational philosophy and the services, and resources available to Cambridge Primary centres.

Tutor-led training opportunities

Cambridge International runs online training and face-to-face workshops on a range of subjects and teaching and learning approaches throughout the year.

You can see the training courses that are currently available by going to our website **https://www.cambridgeinternational.org** and searching for the 'Events and training calendar'. To find training courses relating to Cambridge Primary, select Cambridge Primary as the 'Qualification type'.

Glossary

This glossary is provided to support your understanding of the content of this teacher guide. The definitions are intended to be sufficient to guide an informed reader.

For more information on important ideas and themes in education, and how to use them in your school, please see the *Getting started with …* interactive resources provided at **https://www.cambridgeinternational.org/support-and-training-for-schools/teaching-cambridge-at-your-school/getting-started-with/**

Active learning – a classroom approach in which learners are encouraged to 'think hard', rather than passively receive information (see Section 3.1).

Closed question – a question that can be answered with 'yes' or 'no', or that has a limited set of short possible answers.

Curriculum framework – the document giving the structure of the curriculum specifying how learning is organised (see Section 1.1).

Differentiation – adaptation of teaching and learning to suit the needs of different learners, and to support progression from their current level of knowledge, understanding and skills (see Section 4.1).

Evaluate – use evidence to inform next steps.

Experiment – a specific procedure carried out to support, disprove or validate a scientific prediction. Experiments are often part of a wider investigation but not always.

Inclusive learning environment – a learning environment that considers learners as individuals and provides opportunities for all learners to fulfil their potential (see Section 4.1).

Investigation – a method of acquiring scientific knowledge based on a starting question. A scientific investigation often involves experiments but not always, e.g. using secondary sources of information to carry out a literature review.

Language awareness – understanding of the possible challenges and opportunities that language presents to learning (see Section 3.3).

Learning environment – places where learning takes place, including the classroom, the home and the outdoors.

Learning objectives – statements from the curriculum framework of the expectations of knowledge, understanding and skills that learners will develop; they provide a structure for teaching and learning, and a reference against which to check learners' attainment and skills development (see Section 1.1).

Lesson plan (or short-term plan) – an outline of the teaching and learning activities for a particular lesson (or series of lessons) led by the learning objective(s) for the lesson (see Section 2.2).

Long-term plan – an overview of the coverage of the curriculum framework across the year indicating the available teaching time and its division into terms/semesters, and the knowledge, understanding and skills to be covered in each term/semester (see Section 2.2).

Material – a type of substance or common mixture of substances. For example, wood is a material, although it is made of a mixture of substances. Metal is often a material type, although there are many metals.

Medium-term plan – an overview of the learning for each term/semester showing a logical, progressive teaching order of the learning objectives, grouped into units; it includes ideas for teaching and learning activities to deliver the learning objectives (see Section 2.2).

Metacognition – awareness of one's own mental processes; the process of getting learners to plan, monitor, evaluate and make changes to their own learning behaviour.

Model – demonstrate scientific understanding of a concept through the use of a scientific model. For example, making a paper skeleton models a human skeleton and how the different bones are arranged. Drawing multiple diagrams of particles in a solid demonstrates understanding of how particles in a solid behave.

Monitor – observe learners' performance and progress during an activity or over a longer period of time without getting actively involved.

Open question – a question that elicits a longer answer than a closed question, reflecting the respondents' understanding or thoughts.

Peer-assessment – when learners assess and give feedback on each other's work.

Reflect – think about what went well and not so well; think about your learning.

Representation – a way of showing scientific understanding of complex phenomena by means of diagrams, equations (word or symbol) or other models.

Scheme of work – support materials produced by Cambridge International for each stage of Cambridge Primary Science. Each scheme of work contains a suggested long-term plan, a medium-term plan with suggested teaching and learning activities and sample short-term plans (see Section 1.4).

Self-assessment – when individuals reflect on their own performance and progress.

Short-term plan (or lesson plan) – an outline of the teaching and learning activities for a particular lesson (or series of lessons) led by the learning objective(s) for the lesson (see Section 2.2).

Spiral approach – an approach in which areas of learning are revisited systematically so learners can engage in more depth and in different contexts.

Strand – a collection of learning objectives in the curriculum framework that form an area of learning (see Section 1.1).

Substance – matter which is composed of a single thing. For example, oxygen is a substance, but air is a mixture. Iron is a substance, but steel is made of iron mixed with other substances; steel is therefore a material and not a single substance.

Sub-strand – sub-sections in the curriculum framework which divide the strands into more specific areas for teaching and learning (see Section 1.1).

Success criteria – descriptions of how learners can demonstrate achievement of a learning objective (or part of a learning objective); they help learners to know if they have been successful in achieving the learning objective at an appropriate level (see Section 5.2).

Talk partner – a classmate with whom a learner discusses the answer to a question before responding (see Section 3.3).

Unit (of work) – in a medium-term plan, a group of learning objectives and activities based around a topic or theme and covering a series of lessons.

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