Improving teaching: Leading effective learning in science

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These pages are based around a series of common questions on science lessons that a senior leader may explore with the subject leader or science department.

Pupils learn effectively in science when they are engaged, their curiosity is fired and they see the relevance of science to their own lives. As a senior leader and line manager of science there are questions you may want to discuss with the science department to support their delivery of effective science lessons.

These materials are specifically written with school senior leaders and line managers of science in mind, especially those who may be new to the senior leader role or who are non-scientists. You’ll find advice on what to expect in an effective lesson with particular emphasis on aspects specific to science. You can explore these pages in sequence or jump straight to a topic that is of particular interest to you. You’ll also find materials and information through links within the pages. These may be to other pages on this website which help to answer your question or to related external resources.
What is the vision for and attitude to science in your school?

What is your vision for science?
Is this your vision?

- For your pupils?
- For your staff?
- For your school?
- In science?
Your vision for the science curriculum may reflect your experience and background in science, which may not always have been positive. You may find it helpful to discuss with your colleagues in the senior leadership team what explicit and implicit messages the following statements give to pupils:

<table>
<thead>
<tr>
<th>Role</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parent to child</strong></td>
<td>I was good at science and maths, so I expect you will be too.</td>
</tr>
<tr>
<td><strong>Governor to headteacher</strong></td>
<td>Science beyond about Year 7 is a mystery to me, so I can see why the pupils don’t find it easy.</td>
</tr>
<tr>
<td><strong>SLT member responsible for science</strong></td>
<td>Many of our pupils, particularly girls, are turned off by science as it’s overloaded with the need to acquire knowledge and remember facts.</td>
</tr>
<tr>
<td><strong>Headteacher, on curriculum provision for school</strong></td>
<td>We’re a specialist school in performing arts, but we expect our pupils to cover the statutory requirements for science.</td>
</tr>
<tr>
<td><strong>Head of science</strong></td>
<td>We only take pupils with A* and A GCSE grades into science A Levels, because others get lower grades and it reduces our school rating.</td>
</tr>
<tr>
<td><strong>Pupil to head of sixth form</strong></td>
<td>Science at Key Stage 3 was fun, but GCSE was just lots of facts. My friends tell me it's better at A Level so I might try it, but I might go for A Level in PE because it's human biology, which I love.</td>
</tr>
<tr>
<td><strong>Head of geography</strong></td>
<td>Science is hard, so pupils often take geography A Level because they'll get better grades than in sciences and it helps their UCAS forms.</td>
</tr>
</tbody>
</table>
Why are science graduates needed?

In the next 20 years, a good supply of trained scientists is required for the future health of the UK economy. Encourage all pupils to be scientifically literate, and more pupils to take A Levels in science and mathematics. Research into progression to post-16 sciences tells us that pupils who achieve A* and A like science being hard and make up their minds to go on to A Level science early in their lives. B-grade pupils who have good experiences of science lessons and enrichment activities are often turned on to science during GCSE. This has implications for how senior leaders help.

How can you improve pupils’ experiences, attainment and progress in science?

Use these materials on leading effective learning in science to address:

- structuring effective science lessons to secure pupils’ learning
- personalisation and progress in science lessons
- strategies to support learning in science.

Related Links

- Progression to post-16 sciences

Structuring effective science lessons to secure pupils’ learning

Senior leaders can address seven key questions to structure science lessons to secure pupils’ learning.

A good science scheme of work provides clear progression routes across the range and content of science, including How science works, and is underpinned by good lesson design. Particular features of effective science lessons build on generic good practice in teaching to secure pupils’ learning. It is helpful to explore how the science department’s planning supports pupil engagement and enjoyment in a climate that promotes learning. This can form part of the science department review. As a senior
leader and line manager of science, you may want to discuss the following questions with the science department to support the delivery of effective science lessons:

- How do you recognise effective lesson design in science?
- How can a senior leader support science lesson design?
- How does the science scheme of work support teachers’ planning?
- What do learning objectives and outcomes look like in science?
- How can you help pupils to be engaged and enjoy science lessons?
- What does a good climate for learning look like in science?
- What do you look for when reviewing science lessons?

How do you recognise effective lesson design in science?

Pupils learn effectively in science when lessons are designed to fire their curiosity, engage them and help them see the relevance of science to their own lives.

What are the features of a well-designed science lesson?

Lessons and their content are included in the department scheme of work, which is more than the subject specification. Lessons are designed to secure progress in content, including How science works and developing independent learners.

A well-designed science lesson includes:

- clear lesson objectives that incorporate range and content, including How science works
- a climate for learning that reflects pupils’ learning styles, prior attainment and knowledge
- different pedagogic approaches (see Improving teaching: leading learning – Secondary. For school leaders)
- teaching and learning strategies that display a good repertoire of delivery strategies to excite and engage pupils and make science relevant to the world around them
- classroom organisation that allows for different pupil groupings and arrangement of furniture, display, use and choice of equipment, and other adults (see Additional classroom support)

How can a senior leader support science lesson design?

You may find the following additional resources useful:
How can a senior leader support science lesson design?

An effective departmental scheme of work includes lessons that are designed to secure progress in scientific content, including *How science works*, and develop independent learners.

- Are you able to identify where the lesson and content fit in with pupils’ learning?
  - Does the department have a scheme of work (in addition to subject specifications) into which the lesson fits? (see Developing a scheme of work)
  - Does the department have long-term, medium-term and short-term plans?
  - Are lessons themed or subject led? (see Example of cross-curricular planning)
  - How is progress in learning from 11 to 19 planned for? (see Planning for effective learning and teaching)
  - How is prior knowledge considered?
Does the lesson identify the essential objectives, outcomes and success criteria to secure progress in:

- key ideas? (see Overview of the five strands of progression)
- skills and the processes of How science works?

How does the lesson structure:

- support engagement with and enjoyment of science? (see Enhancement and Enrichment)
- encourage personal development and independent learning?
- accommodate preferred learning styles?
- support effective feedback throughout the lesson to secure pupils’ progress?

How is each part of the lesson taught?

- Has consideration been given to appropriate teaching and learning strategies to support the context of the lesson and pupils’ progress?
- How effective is the practical work in supporting learning and stimulating creativity (see How important are practical activities in science)?
- How has classroom management been planned for to secure a climate for learning?
- How are other adults used in the classroom or laboratory (see How are other adults used in the classroom? and Additional classroom support)?
- How well is coherence between each part of the lesson managed (see Lesson models for science)?

How do you know that pupils have made progress in the lesson?

Does the lesson allow for:

- reflection on prior knowledge?
- reflection on pupils’ progress, for example through plenaries? (see Plenaries Tips)
How does the science scheme of work support teachers’ planning?

The scheme of work helps teachers prepare lesson plans that support the delivery of effective lessons. An effective scheme of work supports learning by clearly mapping out progression in scientific content, including *How science works*, and is adaptable and allows flexibility to meet pupils’ needs.

Key features of an effective science scheme of work

The following features are the signs of an effective scheme of work:

- It makes clear reference in the planning to progression, which is reflected in the individual lessons.
- There is appropriate emphasis on *How science works*.
- Planning includes learning objectives for range and content, including *How science works*.

Which routes does the scheme follow?

Learning units can follow a logical progression in which:

- the range and content leads the progression and integrates *How science works* (see *Teaching sequence 1 example: Led by ‘range and content’*)
• How science works leads the progression and integrates the range and content (see Teaching sequence 2 example: Led by 'How science works')
• the range and content run in parallel with How science Works (see Teaching sequence 3 example: Led by 'range and content' and 'How science works')
• Developing a scheme of work

Is the scheme flexible?

Does the scheme of work:

• take into account pupils' different starting points in range and content, including How science works?
• create lessons that are challenging, motivating and engaging for pupils at all levels?
• allow for future development and revision of the content and delivery?

The secondary science framework gives information on planning an 11–16 science scheme of work. See Planning for effective learning and teaching.

Related Links

• Planning for effective learning and teaching

What do learning objectives and outcomes look like in science?

These examples will help senior leaders identify how dual and combined learning objectives link to differentiated outcomes for pupils. As with all subjects, in science the learning objectives and outcomes provide focus, meaning and purpose for each lesson, so that pupils know what outcomes the teacher expects.

How might objectives and outcomes be linked?

Science learning objectives include the scientific content and the processes of How science works. These can be presented separately as dual objectives or combined as a single objective with linked outcomes for pupils.
What does a dual objective look like?

This is an example of a dual objective:

- to use the idea of energy transfer and particles to explain conduction, convection and radiation (range and content)
- to develop the use of models to describe scientific processes (*How science works*).

**Pupil outcome**

- Pupils will use models to explain simply how the energy is transferred from one place to another.

What does a combined objective look like?

This is an example of a combined objective:

- to use models to explain conduction, convection and radiation.

**Pupil outcome**

- Pupils will use models to explain simply how the energy is transferred from one place to another.

How can this outcome be differentiated?

In both cases, this outcome may have been personalised as follows.

- Pupils will use models to explain simply how the energy is transferred from one place to another.
- Pupils will explain the strengths and weaknesses of a model to suggest that energy transfer can be through particle vibrations and particle movement.
- Pupils give an explanation, making explicit connections between temperature and energy transfer in convection and conduction, and noting how the particle model does not apply.

**Related Links**

- Planning for effective learning and teaching
- Learning objectives and outcomes

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How can you help pupils be engaged and enjoy science lessons?

When pupils are engaged and enjoy their science lessons, they demonstrate curiosity and enthusiasm, and are more confident in their contribution to discussions and when answering questions. They generate questions of their own, are creative and show perseverance when solving problems, including those in a practical context. Subsequently they are able to demonstrate progress in their learning.

How do you know if your pupils are engaged and enjoying science?

Pupils are engaged in their learning and enjoy science when their teacher:

- makes clear the purpose and relevance of science lessons and links this to the real world and the pupils' life experiences (see Science Enhancement Programme (Publications))
- creates an effective climate for learning so that pupils feel confident with the concepts, skills and experiences being presented to them
- relates new knowledge and experiences to prior learning and embeds How science works skills and processes in lesson content (learning targets can help with this, see Assessment Focus 4: Using investigative approaches)
- makes clear the progress pupils are making
- provides activities that generate curiosity and interest, including using science, technology, engineering and mathematics (STEM) providers. (see STEMNET)

Engaged and excited pupils:

- are able to explain the value of science and show an appreciation of the impact of science on society
- know the contribution of science to life in a technological age
- are keen to share with teachers and others their experience of science both within and outside the classroom
- are keen to be part of the school science community and share this with their peers
- see science as a desirable pathway to future careers through post-16 science (see Progression to post-16 science – Factors, forces, processes and policies for senior leaders)
What does a good climate for learning look like in science?

Pupils feel supported and safe physically and emotionally when the environment supports and celebrates learning. Science teachers can create this environment in lessons through high-quality teaching with clear ground rules for health and safety in practical activities and laboratory routines.

Teachers achieve a positive climate for learning in the science laboratory by relating science pedagogy to the demands of practical work, including health and safety.

How are pupils supported to feel secure and safe physically and emotionally?

Teachers support learning through:

- explicit classroom and laboratory routines, such as for the way pupils enter and leave and the way lessons begin and end
- effective routines for ensuring that all pupils have equal access to science equipment and resources
- making sure health and safety is explicit and referred to often (see How does health and safety feature in science lessons?)
- ensuring pupils feel safe and are confident to contribute their ideas knowing that their contributions will be valued.

How does the environment support learning?

The following features of the science area support learning.

Related Links

- Enhancement and Enrichment
- Assessment Focus 4: Using investigative approaches
- Progression to post-16 science – Factors, forces, processes and policies for senior leaders
- Science Enhancement Programme (Publications)
- STEMNET
• Teachers, pupils, technicians and teaching assistants take pride in the science teaching areas.
• There are clear systems for storing and moving equipment so that only what is required is available at any one time.
• Classroom displays support learning, celebrate success and are linked to the scientific world beyond the classroom.
• Health and safety notices are clear and relevant.
• Teachers model positive relationships in an environment where pupils feel supported and valued.
• Pupils are motivated, understand how to make progress and are confident that their contributions will be valued.

What do you look for when reviewing science lessons?

What to look for when reviewing science lessons

• Quality of planned learning in science: Has planning met the needs of all pupils through a range of teaching and learning strategies?
• Enjoyment of learning and attitudes: How is interest in and engagement with science demonstrated by pupils?
• Assessment for Learning: Do teachers take account of pupils’ prior learning, assess their progress throughout a lesson and provide information about how to improve in range and content, including How science works?
• Progress: Are there opportunities for pupils to question and develop ideas to acquire knowledge, develop understanding and practise science skills to help them make good progress? Progress is a key factor for judging the quality of learning in the lesson.
• Quality of science provision: Is the imaginative use of ICT and support of other adults precisely targeted?

For more information about what Ofsted is looking for and the evaluation schedule that sets out the judgements that inspectors will make and report on, see the Ofsted Evaluation Schedule.

Related Links

• Ofsted Evaluation Schedule
Personalisation and progress in science lessons

Senior leaders can address six key questions to secure personalisation and progress for pupils in science lessons.

In effective science lessons, teachers build opportunities for pupils to link scientific ideas and evidence to the real world. Through appropriate questioning, modelling and explanations, pupils take responsibility for their own learning.

Lessons that are planned to secure progression meet the needs of all learners by using appropriate intervention to overcome individuals’ barriers to learning.

Teachers and other adults in the classroom can secure pupils’ progress through personalisation and appropriate curriculum pathways that meet individual pupils’ needs. Teachers and other adults may need continuing professional development (CPD) to improve their subject knowledge and pedagogical skills.

As a senior leader and line manager of science, you may want to discuss the following issues with the science department to support personalisation and progress in effective science lessons:

- What does personalisation look like in science?
- Does your science curriculum meet the needs of all of your pupils?
- Building pupils’ confidence in *How science works*, explanations, argument and decisions
- How well are your science teachers equipped to deliver effective science lessons?
- How is good progress demonstrated in science?
- How are other adults used in the classroom?

**Related Links**

- [Ofsted evaluation schedule](tlr.nationalstrategies.dcsf.gov.uk)
What does personalisation look like in science?

An effective science curriculum fires pupils’ curiosity about phenomena in the world around them, offering opportunities to form explanations and encouraging them to develop their critical and creative thinking.

Teachers build opportunities for pupils to link ideas and evidence, and develop argumentation, decision-making and problem-solving skills.

How is personalised learning in science lessons developed?

The day-to-day interactions between science teachers and other adults and pupils in the classroom provide the foundations for the effective development of personalised learning in science.

Pupils learn in science through high-quality teaching that seeks to engage, support and challenge the learning of all pupils, giving them opportunities to consider what they know, explore their understanding and make sense of scientific ideas.

What are the key features of personalised learning in science?

The key features are:

- highly focused lesson design with sharp learning objectives and learning outcomes (see What do learning objectives and outcomes look like in science?) incorporating both range and content, including How science works, which meets the needs of all learners
- high demands for pupil involvement and engagement with their science learning
- high levels of interaction for all pupils in teacher-led lessons and in practical and group work (see Interactive practicals)
- appropriate use of teacher questioning, modelling and explaining
- an emphasis on learning through dialogue, with regular opportunities for pupils to talk both individually and in groups about their science learning (see Maximising pupil progress (formerly known as Progressing to level 6 and beyond in science with added 'How science works'))
• an expectation that pupils accept responsibility for their learning and work independently
• regular use of encouragement and praise to engage and motivate pupils (see Assessment for Learning in science – Unit 2a: Developing oral feedback in science and Unit 2b: Developing written feedback in science).

How do science teachers overcome learning barriers in science?

To overcome potential barriers to learning in science, teachers tailor lessons to pupils' needs (Wave 1 intervention), provide intervention support programmes (Wave 2) and provide specialised individualised provision (Wave 3) to accelerate and maximise pupils' progress and minimise performance gaps (see Examples of types of intervention in science).

Teachers can use science learning discussions in small groups (The learning discussion: A strategy to support better progress for underperforming groups in science) and one-to-one conversations to identify causes of underperformance and address them through appropriate teaching and learning strategies.

Some of the common barriers to learning across the 11–16 science curriculum are given below.

Organisms, behaviour and health

• Life processes: Barriers to learning for 'Life processes'
• Variation and interdependence: Barriers to learning for 'Variation and interdependence'
• Behaviour: Barriers to learning for 'Behaviour'

Chemical and material behaviour

• Particle models: Barriers to learning for 'Particle models'
• Chemical reactions: Barriers to learning for 'Chemical reactions'
• Patterns in chemical reactions: Barriers to learning for 'Patterns in chemical reactions'

Energy, electricity and forces

• Energy transfer and electricity: Barriers to learning for 'Energy transfer'
• Forces: Barriers to learning for 'Forces'

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The environment, Earth and the universe

- Changing environment and sustainability: Barriers to learning for 'Changing environment and sustainability'
- Changing Earth: Barriers to learning for 'Changing Earth'
- Earth, Space and beyond: Barriers to learning for 'Earth, Space and beyond'

Does your science curriculum meet the needs of all your pupils?

In a personalised science curriculum, teachers plan the most appropriate routes for all pupils. Pupils are supported by the teaching and learning styles embedded in the different pathways. If you consider the teaching and learning of each of the science specifications, you can plan how best to use the specifications to support the needs of individual pupils.

Issues to consider when selecting science provision for your school

It is helpful if you consider the following points within the science curriculum in your school:

- the benefits of science in the curriculum and the statutory and non-statutory requirements
- the range of pathways possible in science, along with the positive and negative features of particular pathways
- curriculum provision in science placed in the context of your school
- the full range of specifications available – including those not offered previously by your school (see the AQA, Edexcel and OCR websites)
- how your school’s choice of science curriculum can influence pupils’ options to progress to post-16 science and take up careers in science (see Improving progression to post-16).

Considerations for the science department when designing curriculum pathways

See the Curriculum provision in secondary science booklet.
The main factors to consider when designing 11–19 curriculum pathways in science are as follows.

- How does the Key Stage 3 curriculum build on and extend the range of experiences that pupils had before age 11?
- How does the curriculum provision for age 11–16 provide for progression in the development of scientific knowledge processes and skills?
- What range of curriculum experiences do you provide through the Key Stage 3 curriculum so that pupils have sufficient knowledge, skills and understanding in *How science works* across a range of scientific contexts before transferring to the Key Stage 4 curriculum?
- What arrangements do you make for starting the Key Stage 4 curriculum at different times to provide for the range of pupils' progress and needs?
- How do you and parents decide whether pupils study one, two or three science GCSEs, or a different course, for example BTEC?
- Different courses in science emphasise different pedagogies which suit pupils' individual learning styles.
- If pupils are studying two or three GCSEs, are the courses offered as series or parallel models?
- How do the courses offered allow pupils to progress to science learning post-16 and higher education?
- When pupils are successful in science and science-related subjects, are doors opened to future careers? *Future Morph* shows pupils some of the amazing and unexpected places to which science, technology, engineering and mathematics can take them.

**Related Links**

- AQA
- Edexcel
- Future Morph
- OCR

**Building pupils' confidence in *How science works*, explanations, argument and decisions**

The science curriculum emphasises pupils learning not only about the world around us (the content) but also how we know what we know (the process of science, or *How science works*).
Aspects of How science works

How science works is not just about skills or practical work (see How important are practical activities in science?), but about the processes and skills that underpin our knowledge about scientific ideas and how these ideas are developed.

Teachers can use the Framework for secondary science, which summarises the strands that make up How science works.

- Explanations, argument and decisions
  - Scientific thinking: developing explanations using ideas and models
  - Scientific thinking: challenge and collaboration in the development of explanations
  - Scientific thinking: developing argument
  - Applications, implications and cultural understanding
  - Communication for identified audience and purpose.

- Practical and enquiry skills
  - Using investigative approaches: planning an approach
  - Using investigative approaches: selecting and managing variables
  - Using investigative approaches: assessing risk and working safely
  - Using investigative approaches: obtaining and presenting primary evidence
  - Working critically with primary evidence
  - Working critically with secondary evidence.

The traditional content of science is still relevant because it provides the essential context through which How science works is developed (see Overview of the five strands of progression).

What will this look like in science lessons?

How science works gives a change of emphasis in lesson objectives and outcomes (see What do learning objectives and outcomes look like in science?) as well as in the sorts of activities that pupils do.
Pupils developing in *How science works* are able to:

- identify the key pieces of evidence that support accepted scientific ideas – for example, that the world is spherical or that matter is made up of small particles
- debate scientific issues for which the evidence presented is currently inconclusive – for example, climate change
- consider ethical and moral dimensions in their discussions, recognising that decisions in everyday life are often as much about ‘should we?’ as they are about ‘can we?’ – for example, weighing up the benefits and risk associated with advances in human genetics.

**More-engaging science lessons**

By increasing the emphasis on *How science works* within a range of contexts, teachers can:

- make science lessons more engaging for pupils
- encourage the development of group work and discussion skills
- help pupils learn to communicate their findings in a range of media
- help pupils make sense of the science content
- develop pupils into scientifically literate adults who can make informed choices about science.

See also [How does the science scheme of work support teachers’ planning?](#).

**How well are your science teachers equipped to deliver effective science lessons?**

Are your science teachers equipped to deliver effective science lessons?

When you, as a senior leader, carry out observations of science lessons, good science teachers will show expertise in three main areas.

- Pedagogy – the practical business of teaching and learning, driven by professional knowledge and understanding. It is what you need to know and be able to do to teach well.
- Subject knowledge – specific to the science curriculum you offer.
**How science works** – the range of processes that underpin scientific content and collectively represent scientific enquiry.

**Why is the teaching of some aspects of How science works underdeveloped?**

- Changes to the curriculum: Some aspects of *How science works* – for example, argumentation – are relatively new and unfamiliar, so some teachers have not yet developed skills in teaching them.
- New areas demand new approaches to teaching and learning: Some newer and unfamiliar aspects of range and content such as animal behaviour demand different approaches to teaching and learning that are relatively uncommon in science lessons.
- Previous emphasis only on content: Previously teachers have supported pupils’ acquisition of content knowledge (‘what we know’, often referred to as ‘the facts’) with little emphasis on the processes of science or *How science works*. The approaches to teaching and learning that support pupils learning ‘the facts’ have tended to be didactic with limited opportunity for interaction or discussion.

**How can this expertise be developed?**

- Pedagogical skills: These can be developed through your school’s teaching and learning policy and sharing of expertise and coaching across departments.
- Subject knowledge: Provide teachers with opportunities to keep up to date with current developments in their subject areas and develop expertise across unfamiliar areas, for example earth science, and biologists learning about physics.
- *How science works*: Teachers may find this area particularly challenging if it wasn’t covered in previous training and experience, hence their need for continuing professional development (CPD) opportunities.

**Where can CPD in science come from?**

CPD can be provided:

- in school by teachers sharing good practice and using resources, for example CPD resources.
- by local authorities, CPD providers, higher education institutions and awarding bodies
- by scientific learned societies:
  - [Royal Society of Chemistry](https://www.rsc.org)
  - [Society of Biology](https://www.societyofbiology.org)
  - [Institute of Physics](https://iop.org)
  - [The Association for Science Education](https://www.ase.org.uk)
  - [Science Learning Centres](https://sciencelearning.org.uk)

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Creating opportunities for science CPD in a busy school timetable

New ways can be found to enable effective CPD to take place. These include:

- flexible use of training days as twilight sessions
- development time following periods of examination, such as at the end of June and during July
- in-house learning and teaching groups utilising weekly after-school meeting time
- reorganising the timetable to enable pupils to leave earlier once a week so that teachers can meet
- utilising the expertise available in school during non-teaching periods
- coaching
- using new technology, for example filming lessons using software for a specific focus such as questioning.

Related Links

- Institute of Physics
- Royal Society of Chemistry
- Science Learning Centres
- Society of Biology
- The Association for Science Education

How is good progress demonstrated in science?

You can observe how pupils are learning in science by their explanations of scientific concepts and how pupils demonstrate their competence in skills and processes. Pupils can demonstrate their progress against lesson objectives, outcomes (see What do learning objectives and outcomes look like in science?) and success criteria for learning activities.

How do pupils in science lessons demonstrate progress?

Pupils demonstrate progress in science content, including the processes of How science works, by being able to:
How do science teachers plan for pupils to be able to demonstrate their progress?

Teachers plan:

- activities that require pupils to reorganise and articulate their ideas about scientific questions and issues
- daily and periodic assessment opportunities to determine pupils' development of their understanding of scientific ideas and concepts, including planning key questions to provide evidence of progression (see Assessment for Learning in science Unit 1: Lesson scaffolding: structuring learning to develop Quality First teaching in science)
- for regular interactive learning (including group work) to provide opportunities for dialogue and developing thinking skills through using different pedagogies (see What does effective group work look like in science lessons? and Strengthening Teaching and Learning in science through using different pedagogies).

How are other adults used in the classroom?

You can use 'other adults' to engage pupils, promote their scientific understanding and raise their aspirations. 'Other adults' can enrich the curriculum by using their own experiences to bring the world of work into the classroom.

Who are the 'other adults'?

In science lessons, you can include adults from:

- the science department, for example teaching assistants, higher-level teaching assistants (HLTAs) and science technicians
the school, for example teaching assistants and sixth-form students
• the community, for example parents and governors
• science organisations, for example from universities, and local employers in Science, Technology, Engineering and Mathematics (STEM).

What are other adults doing?

Other adults can:

• support the planning and delivery of lessons
• help pupils understand difficult concepts
• use their knowledge of the pupils to pinpoint any misunderstandings or misconceptions and address these effectively
• support individual pupils who have missed lessons
• actively promote a positive climate for learning, removing barriers and encouraging pupils' active involvement in lessons
• give targeted support to groups of pupils or individual pupils who need one-to-one help (see Working together: Teaching assistants and Assessment for Learning)
• provide enrichment and enhancement to inspire pupils; for example STEM Ambassadors can act as role models and make links between the classroom and the world of work (see How is science, technology, engineering and mathematics (STEM) embedded in science lessons?).

For further information visit:

• STEMNET Ambassadors
• Enhancement and Enrichment
• or see the Science study guide: Enhancement and Enrichment.

Related Links

• STEMNET Ambassadors
Strategies to support learning in science

Senior leaders can address seven distinct activities in science lessons to support effective learning.

In effective science lessons, teachers build on generic strategies to support learning by using scientific language and contexts that link to the world around us.

Through carefully planned practical activities, pupils become confident in their scientific ability and are able to assess risk. Teachers can use writing to support learning, and new technologies and enrichment activities from the Science, Technology, Engineering and Mathematics (STEM) programme to enrich science lessons.

As a senior leader and line manager of science, you may want to discuss the following questions with the science department about strategies to support learning in effective science lessons:

- What is the impact of practical activities in science lessons?
- How can writing support pupils’ learning in science?
- What does effective group work look like in science lessons?
- How can science learning continue outside the classroom?
- How are new technologies used to support learning in science?
- How is Science, Technology, Engineering and Mathematics (STEM) embedded in science lessons?
- How does health and safety feature in science lessons?

How important are practical activities in science?

Effective practical work helps pupils enjoy their learning and make connections between scientific ideas and what they see in the world around them. In effective practical science lessons, pupils can tell you what they are doing and why they are doing it.
How can practical activities support pupils' learning?

Effective science teachers are able to explain the purpose of the practical activity in a lesson, relating it clearly to the learning they want pupils to achieve.

Practical activities can support pupils' learning by:

- illustrating key phenomena to help develop knowledge and understanding of science
- developing specific practical skills
- developing pupils' use of How Science Works (see Building pupils' confidence in How science works, explanations, argument and decisions) to collect valid, relevant and reliable evidence and relate this to scientific theories and ideas.

What will you see in an effective practical activity?

You will see pupils:

- making their own decisions and generating questions that challenge their thinking, rather than simply following instructions
- working collaboratively in pairs and groups towards a common task
- thinking creatively and critically about their practical work
- being interested and their imagination captured by the context and activity
- undertaking relevant activities inside and outside the classroom.

You can find examples of effective practical activities in the following resources.

- Interactive teaching in science develops teachers' understanding of interactive teaching and presents ideas for how to develop the teaching of specific scientific content.
- Getting Practical supports teachers, technicians and teaching assistants to improve the effectiveness of practical work.
- Practical Physics enables teachers of physics to share their skills and experience of making experiments work in the classroom.
- Practical Chemistry provides teachers of chemistry with advice on a wide range of experiments in chemistry.
- Practical Biology provides teachers of biology at all levels with experiments that demonstrate a wide range of biological concepts and processes.
- Guide G30, Successful Science Practicals, by CLEAPSS is a short guide containing a host of practical advice and tips which experienced science teachers will know but new teachers have to learn.
How can writing support pupils’ learning in science?

When you look at effective writing in science during lesson observations or work scrutiny, teachers have considered the reasons for pupils to write. Pupils develop a range of skills and can write in various appropriate genres. They are provided with opportunities to write with greater creativity.

Why write in science?

In effective science lessons, pupils write so that they can learn to:

- use scientific language accurately and concisely
- record findings precisely
- present information to different audiences using an appropriate range of formats
- use a range of genres used by the scientific community for different audiences
- use writing to clarify their ideas and link scientific ideas with appropriate evidence.

How do teachers develop writing in science lessons?

To develop writing in science lessons, teachers can do the following.

- Make the writing expectations clear to pupils at the start of the lesson, so that they can make progress in the knowledge and application of science. For example, in a lesson about healthy diets in children, the teacher makes clear to pupils the expectation that they will write a leaflet for primary pupils with content illustrating scientific knowledge and the application of the science of a healthy diet.
• Link the writing to the learning objectives (see What do learning objectives and outcomes look like in science?) so pupils use writing that helps them learn. In science, some pupils spend up to a third of their time writing, with some teachers using copying from books or whiteboards to control a class; this increases pupils' poor image of science.
• Initially scaffold the writing and then gradually remove the support once pupils have learned to write using language accurately and concisely, and in the appropriate structures. For example, provide writing frames, DARTS activities (directed activities related to text) and group work initially to help pupils be secure in tackling writing tasks, and then gradually remove the support so they can write extended passages without additional support.
• Provide pupils with different real contexts, audiences and purposes for their writing. For example, provide pupils with a real problem to investigate or research, such as the level of pollution in a local river or canal, and ask them to present their findings in the form of a report to a local council water engineer or water authority.
• Ensure pupils' writing uses a range of text types and forms so they learn to use scientific language accurately. For example, writing types in science can include letters, log book entries, magazine or newspaper articles, advertisements, poetry, screen plays, formal essays, and write-ups of scientific investigations.
• Provide pupils with opportunities to use writing to organise their thinking and record what they have learned in science lessons, as well as what they have done. The development of more independent and extended writing supports progress in pupils' knowledge and application of science.
• Use additional scaffolding and support to guide the writing of pupils with English as an additional language (EAL) and special educational needs (SEN) – see Narrowing the gaps in science.

You may find these materials useful:

• examples of types of writing in science
• examples of strategies for teachers to use to support pupils' writing in science in Maximising pupil progress (formerly known as Progressing to level 6 and beyond in science with added 'How science works')
• Maximising pupil progress (formerly known as Progressing to level 6 and beyond in science with added 'How science works')
• Literacy in science.

What does effective group work look like in science lessons?

Pupils are confident to share their ideas about science. They enter into dialogue with each other and the teacher, articulating and hence developing their understanding of key scientific ideas.
Group work in science enables pupils to:

- rehearse their scientific ideas and explanations in a safe environment with their peers
- challenge each other to provide evidence to support their scientific explanations
- explore different viewpoints on aspects of science with moral or ethical dimensions – for example, by taking on the role of an environmental protection officer or a Greenpeace activist
- learn skills of argumentation, including how to use scientific evidence to create a persuasive argument (see Ideas, Evidence and Argument in Science)
- develop an understanding of how the scientific community works to establish a consensus on new scientific ideas – a key aspect of How science works (see Building pupils' confidence in How science works, explanations, argument and decisions)
- collaborate on shared tasks, for example in the completion of practical activities.

For group work to be effective in science, it helps to:

- acknowledge the provisional nature of scientific knowledge and the importance of reasoned debate in the development of new scientific ideas
- select areas for debate or discussion in contexts that interest pupils
- create a climate for learning (see What does a good climate for learning look like in science?) where all contributions are valued and it is OK to be wrong
- incorporate success criteria for effective group work as part of the lesson objectives and outcomes (see What do learning objectives and outcomes look like in science?)
- rehearse effective behaviours for group work to develop pupils’ skills in this area.

Further advice and ideas for effective group work in science can be found in Strengthening teaching and learning in science through using different pedagogies, Unit 1, ‘Using group talk and argument’.

Related Links

- Ideas, Evidence and Argument in Science
How can learning in science continue outside the classroom?

Pupils neither learn science only in the classroom or laboratory nor confine their learning just to science lessons – science is everywhere. Effective science teaching builds strong links to science in the wider context.

Science lessons make effective use of the wider context when:

• the focus of lessons links to contexts in the real world, inviting pupils to see the world around them through the eyes of a scientist
• pupils are encouraged to bring scientific questions to the lessons from their experiences outside the classroom, and time is created within the curriculum to conduct meaningful enquiries into these questions
• activities in science lessons move outside the laboratory or classroom (see Outside the classroom) into the local environment – for example, onto the school field to study habitats (see the Interdependence: Investigating local ecological relationships study guide) or into the local graveyard to examine the weathering of different rock types
• pupils encounter adults other than teachers who use science in their jobs – for example, ex-pupils working in science-related careers or local STEM Ambassadors

Learning about science is enhanced outside science lessons when:

• homework encourages research and creates opportunities for pupils to discuss science and scientific issues with parents, carers and other family members
• pupils have opportunities to see science in action in the real world, for example through fieldwork and other trips (see the Field Studies Council website)
• pupils attend science, technology, engineering and mathematics (STEM) clubs to enrich and enhance their experience of science beyond the formal curriculum and meet adults who use science in their jobs.

Related Links

• Outside the classroom
How are new technologies used to support learning in science?

Teachers deploy new technologies to make science lessons effective by:

- placing pupils’ learning in science firmly in the context of the twenty-first century – securing relevance and engagement
- enabling pupils to capture evidence as well as to present their findings through contemporary media
- enhancing teaching and learning through more effective practice in Assessment for Learning.

What new technologies might you see?

- Data logging captures evidence of events that happen very quickly or very slowly, and can be used when conventional methods would be impractical or time consuming.
- Live video provides experiences that can easily be reproduced in the classroom, for example to show detail in a demonstration of an experiment to the whole class or to show pupils what to look for down the microscope.
- A visualiser lets you share examples of good written responses with the whole class to promote discussion.
- An interactive whiteboard lets you, for example, show online resources including video or still images to set an immediate contemporary context for an aspect of science.
- Presentation software can be used to capture the output from group work and develop presentation and argumentation skills.
- Vodcasting or podcasting captures understanding of a scientific issue or concept to share with the teacher and/or other pupils for discussion. There is significant potential to expand the range of assessment evidence available to teachers.
- Electronic voting pads support effective plenaries and assessment of progress.

New technologies are being used effectively to support learning when:

- they do not dominate the lesson but become ‘transparent technology’
- they are used confidently, without undue emphasis, by teachers and pupils alike

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they improve outcomes for groups of pupils – for example those for whom conventional literacy is a barrier to demonstrating what they have learned
• the main focus for learning remains on the science.

Further advice and ideas for the effective use of new technologies in science can be found in:

• Using technologies to enhance learning (UTEL) professional development e-learning modules

How is science, technology, engineering and mathematics (STEM) embedded in science lessons?

In their everyday lives, pupils encounter science closely linked with other areas – in particular with technology, engineering and mathematics. Exploiting the links with these areas can give relevance to pupils’ learning and help them discover possible future career pathways and further ways to study science.

How can teachers plan together for a STEM curriculum?

Subject leaders from STEM subjects can jointly plan the learning in common areas of the curriculum to secure:

• progression in key ideas and skills across and between STEM subjects
• coherent use of terminology
• opportunities to bring together learning from across STEM subjects through themed activities and collapsed timetable days
• exposure to advocates for STEM careers, for example STEM Ambassadors

How can teachers access support with STEM to enrich and enhance the curriculum?

Support is available from:
How can teachers raise awareness of careers in STEM-related areas?

- **Future Morph** – shows pupils some of the amazing and unexpected places that studying science, technology, engineering and mathematics can take them.
- **STEM Ambassadors** – people from STEM backgrounds who volunteer as inspiring role models for young people.
- **ACCLAIM** – cameos featuring the work of leading scientists in the UK today.

Related Links

- Enhancement and Enrichment
- Future Morph
- ACCLAIM
- STEM Directories
- STEM Ambassadors
- STEMNET
- STEMNET contact

How does health and safety feature in science lessons?

Pupils learn how to manage risk in their lives and how to make decisions about science-related issues in the world around them, weighing up the potential benefits and the risks.

How can pupils learn about risk in science lessons?

Pupils have opportunities in their science lessons to learn about managing risk by:

- making risk assessments when planning practical activities – for example, taking sensible precautions when working with acids
• discussing the risks and benefits of applications of science in the real world — for example, in the context of whether to build a new generation of nuclear power stations.

How do science teachers manage risk in their lessons?

• Science teachers manage risk when planning learning for pupils. All practical activities require risk assessments that are included in the scheme of work and in the teachers’ planning for specific lessons.
• Teachers and technicians use the wide range of health and safety advice and good practice available from the school safety organisation CLEAPSS. Schools can sign up for this support through the local authority or directly with CLEAPSS.

Related Links

• CLEAPSS