A Summary of Ofsted's Science Subject Report: Finding the Optimum

In February 2023, Ofsted published their latest report into science teaching, Finding the optimum: the science subject report - GOV.UK (www.gov.uk). The report evaluates the common strengths and weaknesses of science education and considers the challenges that science faces. The evidence was gathered as part of routine inspections. The report uses the Ofsted Science Research Review, Feb 2019, as a lens through which to evaluate science in both primary and secondary schools. Here we provide a summary of the primary science findings. We strongly recommend you read the full report to capture some of the examples given by Ofsted.

Key findings from the report

- Most schools are offering a curriculum which is **at least as ambitious as the National Curriculum**.
- **Science education in England is a strength and schools compare favourably in international comparisons** although recent comparisons show a relative decline in performance at age 10 and for Y9 pupils (TIMSS).
- Where science was strong, **pupils had learned detailed and connected knowledge of the curriculum and remembered what they had learned previously**. In a significant minority of schools, pupils were not developing secure knowledge of science. In these schools, the focus was on covering content, rather than ensuring it was learned.
- Science is a core subject of the national curriculum and **pupils benefit from regular opportunities to revisit and build on their knowledge so that is not forgotten**. It was a concern, that in a small number of schools, some pupils went entire half terms without learning any science.
- Some pupils came out of lockdown with significant gaps in their scientific knowledge and COVID-19 prevented primary and secondary colleagues from working together to support pupils' transition.
- **Leaders' plans to develop pupils' disciplinary knowledge were usually much less developed** than their plans to develop pupils' substantive knowledge. This limited how pupils got better at working scientifically over time. Not enough consideration was given to **identifying the disciplinary knowledge that is needed to work scientifically**. Too often, the focus was simply on identifying practical activities to complete.
- **Pupils in primary school were much more likely to take part in hands-on practical activities** than pupils in secondary school.
- Some pupils did not have **sufficient opportunities to practise and consolidate what they had learned before moving on to new content.** This meant they did not remember key content taught previously. Often this happened when teachers were expected to teach **too much content in a short time.**
- Overall, most leaders saw their school science curriculum as **a description of what pupils needed to know and do**. They planned the curriculum carefully so that pupils **studied content in a**

logical order. However, leaders generally did not see the curriculum as something that could make learning easier. For example, very few leaders had planned their science curriculum to **take account of what pupils learned in mathematics**, and rarely did science curriculums **help pupils avoid misconceptions**.

- In some secondary schools it was incorrectly assumed that pupils learned little science in primary school. This led to some content being unnecessarily repeated in year 7 and beyond.
- In some primary schools, **the knowledge of the natural world that children are expected to learn in Reception was not clear enough** with just general topic areas or activities planned. This limited how effectively children were prepared for learning science in year 1
- Teachers generally had secure subject knowledge. **Clear explanations from teachers, alongside carefully selected teaching activities, supported the learning of specific content and played a key role in helping pupils learn science.**
- Very few schools had a clear plan of how **teachers' knowledge of science and how to teach it, was developed over time through continuing professional development (CPD).**
- **Despite the pandemic, many subject leaders were improving and developing their school's science curriculum.**
- **Subject leaders played a crucial role in developing** school science curriculums and supporting teachers to teach them. However**, not all SLs had access to dedicated leadership time and subject leadership training.**
- In some schools, assessment as learning was taking place at the expense of assessment for learning. Some pupils were asked to recall knowledge that they had not successfully learned first time around. **Generally, assessment did not check whether pupils had remembered what they had learned in previous years.**
- In some schools, there was not enough focus on **checking whether pupils had learned the disciplinary knowledge that is needed to work scientifically.** These schools only focused on checking that pupils had learned substantive knowledge. This was more common in primary schools.

Recommendations in the Ofsted Science Report

Curriculum	**A Curriculum Pathway - Curriculum content is sequenced in a logical order**
	"Where curriculum thinking was strong, leaders identified clearly what they wanted pupils to know and do, and then selected the best activity to teach it" "They saw the curriculum as a 'path' that can make learning science easier. In the best cases, leaders saw this path as provisional, so that the curriculum could be refined and developed in ways that would improve it, year on year." • the school science curriculum should be **a clear description of what pupils need to know and do** at each particular stage. This includes breaking down high-level National Curriculum outcomes into their component parts for individual units of work. • Substantive and disciplinary knowledge should not be taught in isolation. **Embed disciplinary knowledge within the most appropriate substantive content.** *e.g., a curriculum might plan for pupils to know the structure of flowering plants (substantive knowl.) and learn how biologists classify plants (disciplinary knowl.). By doing so, pupils deepen their understanding of plants and of classification.* • Consider the school science curriculum as a path which is carefully planned where pupils **study content in a logical order** and that this content **builds on prior learning** (where new content links to pre-existing schema). • **identify the specific misconceptions and difficulties** that pupils are likely to have so that teachers could then address these in lessons through **carefully selected** activities and teacher explanations. • Curriculum plans should take account of **sequencing across a year** to take advantage of the timing of specific phenomena *e.g. Y3 pupils learning about seed dispersal when this occurs in the local environment.* • Ensure that the science curriculum is planned to take account of what pupils learn in other subjects, particularly mathematics.
	A high-quality curriculum includes disciplinary knowledge
	"Leaders' plans to develop pupils' knowledge of working scientifically were typically much less developed than their plans to develop pupils' knowledge of substantive scientific concepts" "Sometimes, pupils struggled to recall what they had learned from practical work. They could only remember the activity. For example, pupils could remember that they grew plants, but could not remember what they learned." "Where curriculums were strong, leaders clearly identified the disciplinary knowledge that pupils needed in order to develop their understanding of these practices." • Ensure that pupils have enough opportunities to take part in **high-quality** practical work with **a clear purpose** so that pupils remember what they have learned from practical work rather than just the activity. • Ensure the curriculum **identifies and sequences the disciplinary knowledge that pupils need to work scientifically**. It should include developing their knowledge of all areas of working scientifically, including different types of scientific enquiry, such as pattern seeking, and concepts such as evidence and accuracy.

	The curriculum in Reception supports learning science in Y1
	"In most primary schools, leaders had considered how the curriculum in Reception supported pupils to learn science in Year 1." "This required leaders to have a clear understanding of the key vocabulary and concepts that they wanted children to learn, and the scientific phenomena that they wanted children to encounter and learn about." • Ensure the content taught in Reception is detailed as explicitly as it is for KS1 and KS2. This knowledge (for Reception) should connect with what pupils go on to learn in Y1 science. It should include **key vocabulary, concepts, and phenomena that they want children to acquire and experience.**
	Enough time is built into the curriculum for pupils to practise and consolidate what they have learned
	"Science is a core subject of the national curriculum, and pupils benefit from regular opportunities to revisit, connect and build on their knowledge so that it is not forgotten." "[In some schools], subject leaders did not allocate enough curriculum time to teach a concept; for example, in one school, pupils had very little time to develop their knowledge of the rock cycle before moving on to carrying out a scientific enquiry" • Ensure that **sufficient curriculum time is provided** for science lessons with regular opportunities to **revisit, connect and build** on their knowledge. • Build enough time into the curriculum for pupils to **learn and remember key knowledge, including time to practise and consolidate** • Ensure the school **curriculum identifies the key learning so that pupils are not expected to learn too much content in a short time** as this can increase cognitive overload and can inhibit learning.

Pedagogy and Assessment	**Identifying misconceptions and supporting children to learn science**
	"Generally, assessment in science did not check whether pupils had remembered what they had learned in previous years." • **Identify the specific misconceptions and difficulties** that pupils are likely to have so that teachers can then address these in lessons through **carefully selected** activities and teacher explanations. • **Prior learning should be visited frequently to prevent content from being forgotten** • Teachers should have **a range of teaching and learning approaches for science from which they select the most appropriate one(s) for the learning objectives they are covering** (and any misconceptions identified). *e.g., when teaching air resistance, a teacher might allow pupils to explore how parachutes work. Then, they might do a demonstration where they drop simultaneously a sheet of paper and a sheet of paper crumpled into a ball to illustrate air resistance and provide a clear explanation. They might then show the pupils a video that repeats the explanation of air resistance. They could then take the pupils outside and get them to run across the playground pulling an open umbrella behind them, so pupils can feel the effect of air resistance. Finally, the pupils can be asked to carry out a scientific enquiry activity to explore the effect of air resistance on parachutes with canopies of different sizes.* • Lessons should provide time and opportunities for pupils to **think and discuss** their learning. • Lessons should enable pupils to **repeatedly practise any key vocabulary**. Overly technical vocabulary can interfere with learning if important foundational knowledge has not been secured. • Ensure **learning has been understood as intend before moving on** to new/more content. (This includes deliberately checking whether pupils have specific misconceptions using a variety of formative assessment strategies).
	Teacher explanations help pupils build connections
	• Ensure **teacher explanations avoid cognitive overload and carefully build on what pupils already know**. They play a key role in helping pupils **build connections** between what they are learning and their prior knowledge. They can also help to connect knowledge from other areas of the curriculum *e.g., when learning about the water cycle in geography after learning about states of matter and changes in science,Y4.* • Models and analogies can be helpful tools along with other teaching and learning approaches but should be used with caution as they can lead to misconceptions. Generally, models are more effective when pupils have initially secured some key knowledge that they need to understand them.

	SEND pupils
	• Pupils with SEND should be **expected to learn the same curriculum as their peers but should be well supported** with doing so. **Appropriate lesson pace and scaffolding, as well as additional support**, are effective ways to meet pupils' additional needs. • It **should not be assumed** that pupils with SEND learn better with practical activities as this can often **increase cognitive load** and distract from the key content to be learned.
	Assessment
	• Assessment for learning should involve **checking if pupils have learned the intended content** of the curriculum lesson by lesson. These checks can be low-stakes and informal. • **Being clear** on what we want children **to know and do** as a result of their learning and **the vocab we want them to be able to use to articulate their understanding** will support effective teaching *and* effective assessment. • Making connections with prior learning will help pupils to **embed learning into long-term memory**. Prior learning should be revisited frequently to prevent content from being forgotten. • Formative assessment in quiz styles can be effective for checking retention of component knowledge but it can be less effective for **checking how knowledge is applied. Being able to apply knowledge is important for embedding learning.** • **Feedback during assessment activities** should be provided to avoid reinforcing pupil misconceptions and misunderstandings. • Schools should **assess that both substantive and disciplinary knowledge**. Schools should focus on whether pupils have learned the disciplinary knowledge that is needed to work scientifically as well as checking that pupils have learned substantive knowledge. This includes, were relevant, that pupils can use their knowledge to select, plan and carry out different types of scientific enquiry.

Systems at subject and school level	**CPD**
	"Few schools had developed a systematic plan of how to develop teachers' knowledge of science and how to teach it." "Subject leaders typically valued being part of a wider group, for example the multi-academy trust's or local authority's science leaders' group. They thought that wider groups were valuable forums for sharing expertise." • Schools should create a systematic and continuous approach to **developing the science expertise of staff and subject leaders through quality CPD**. Teachers should have access to a high-quality ongoing programme of professional development and receive CPD for pedagogical approaches in science and CPD for substantive concepts as well as for disciplinary knowledge.
	Raising the profile of science as a core subject
	"In some schools, leaders refined and adapted their curriculum after teaching it. In this way, the curriculum developed and improved from one year to the next." "Where leadership was strong, subject leaders focused on improving the quality of education, and not just on administration. For example, they visited lessons to discuss with pupils what they had learned, and checked that books matched the intended curriculum. They used this information to decide the focus of science training sessions." "There were a small minority of schools where pupils went entire half terms without learning science. This is a concern because science is a core subject of the national curriculum, and pupils benefit from regular opportunities to revisit and build on their knowledge so that it is not forgotten." • School leaders should **support subject leaders to prioritise curriculum time** for teaching key scientific knowledge (substantive and disciplinary) with the **aim to reduce pressure** to simply cover content and move on. The focus should be on making sure **pupils learn and remember what has been taught, so that they develop increasingly sophisticated and connected scientific knowledge**. • **Support** for leadership (by SLT) and providing **sufficient time to lead and monitor** the subject **increases the impact** subject leaders can have.