A response to the Ofsted Research Review for Science: Guidance for primary schools

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Content

About this **guidance**

Ofsted's Research Review for Science is welcomed by the sector and has stimulated much discussion, debate and collaboration. This guidance is designed for teachers, senior leaders and professionals with an interest in how the review relates to primary science practice in particular.

It has been brought together by Primary Science Quality Mark, The University of Manchester's SEERIH and the Association for Science Education. Professional dialogue and consultation with members of these organisations gave the opportunity to reflect on the research review through a primary science 'lens'. From this 5 issues emerged as significant, allowing for:

- **further clarification of the points raised in the review**
- **consideration of how the issues impact on primary science expertise and leadership**
- **prompts for next steps to be suggested**
- **myths and misinterpretation of the issues to be challenged.**

How to use the guidance

The guidance should stimulate reflection and dialogue amongst primary science subject leaders, teachers and professionals who support them. The guidance should be shared with all teachers of primary science, and ideally discussed with senior leaders and in a staff meeting. Primary science professionals should use the prompt questions to stimulate reflection on current practice from which to identify next steps towards high-quality science education.

About the **Ofsted Research Review for Science**

The Review was published online in April 2021 with the aim of exploring research literature in order to inform understanding about factors that could contribute to 'high quality' science education from Early Years (0-5 years) to Key Stage 5 (16-18 years). It is important to note that the Review is based on research literature and is not a summary of findings from Ofsted's school visits, which will be the subject of its next report.

The Review considered a wide range of research evidence, but studies were selected rather than identified by a 'systematic review', whereby all literature within a set date and search criteria is comprehensively analysed (for more detail about research selection principles and filters, see Ofsted, 2021).

The review is not a to-do list.

'Since there are a variety of ways that schools can construct and teach a high-quality science curriculum, it is important to recognise that there is no singular way of achieving high-quality science education'.
Ofsted, 2021: introduction

There are many mentions of primary science throughout the Review, but it does not represent phase-specific guidance, hence the need for this publication.

Primary Science

Science has been a core subject in the Primary National Curriculum (NC) in England since 1988. The aims in the current NC are clear.

- **To develop scientific knowledge and conceptual understanding**
- **To develop understanding of the nature, processes and methods of science**
- **To understand the uses and implications of science, today and for the future**

The Ofsted Research Review describes science as a important entitlement for all young people and describes the purpose of science in terms which reflect the primary NC aims. The Review focuses on how science knowledge is taught and learned. It does not cover all areas of science education e.g. science clubs, careers etc, and Ofsted has acknowledged that this does not mean that these are not important.

Research reported in the Primary Science Capital Teaching Approach has shown that young people's perceptions of science are often formed before the age of 11 and many primary children already think 'science is not for me'. This negatively impacts children's identity with science as something which is part of their lives, their ability to see a science- related future and to use science to take actions on matters both personal and global. The PSCTA resource explains the importance for equity and social justice of building all children's engagement with science through teaching approaches which broaden what and who counts in science.

Primary schools have a moral purpose to ensure that alongside scientific knowledge, all children develop positive attitudes and dispositions towards science.

5 emerging issues for primary science teachers

Five key issues emerge from the review that are of particular relevance to primary science teachers, science subject leaders and their senior leadership teams. Guidance is provided on each of the following:

1. Subject leadership and developing teacher expertise in science is a necessity
2. Expertise in science requires children to build substantive and disciplinary knowledge
3. Improvement of children's science learning needs to be curriculum-led and sequenced
4. Purposeful selection of a range of teaching approaches includes direct instruction and enquiry-based teaching
5. Teachers need sufficient subject knowledge to assess effectively

1.

Subject leadership and developing teacher expertise in science is a necessity

'In primary schools, there is at least one teacher who specialises in teaching science and science leaders have dedicated leadership time.

Teachers, teaching assistants and technicians have access to high-quality subject-specific continuous professional development (CPD) to develop subject knowledge and pedagogical content knowledge. This is aligned to the curriculum.

Science teachers engage with subject associations, and take responsibility, with support from the school, for developing their own subject knowledge throughout their career.'

Ofsted, 2021: systems

What does this mean for primary science?

Primary science expertise:

All teachers teach the science national curriculum regularly, and there is clear system in place for developing subject and pedagogical content knowledge specifically for primary science.

Primary science leadership

Science is core and needs dedicated science subject leadership which has appropriate allocation of professional development, time, resource, strategic recognition and support. Science subject leaders should have a clear understanding of opportunities for supporting the leadership of science in primary schools and have links with local and national forums, networks, initiatives and subject associations.

Prompts for next steps

1. Is science a key part of the school improvement strategy and is this linked to performance management review and school improvement plans?
2. What training and support has been identified to support the science subject leader to develop the specialism, and is this ongoing?
3. How does the science subject leader use their time to monitor and improve science teaching, learning and assessment?
4. Is there a clear plan for development and succession of science subject leadership?
5. How are staff supported to develop their primary science expertise? And how is this monitored?

Should there be one teacher who teaches science across the school?

Myth Buster

No, there should always be a science subject leader, but all teachers can be teachers of science.

2.

Expertise in science requires children to build substantive and disciplinary knowledge*

'The curriculum is planned to build increasingly sophisticated knowledge of the products (substantive knowledge) and practices (disciplinary knowledge) of science.

Disciplinary knowledge (identified in the 'working scientifically' sections of the national curriculum) comprises knowledge of concepts as well as procedures.

When pupils develop their disciplinary knowledge, they learn about the diverse ways that science generates and grows knowledge through scientific enquiry. This is not reduced to a single scientific method or taken to mean just data collection.'

Ofsted, 2021: Curriculum

What does this mean for primary science?

Primary science expertise:

Primary science teachers need to plan for children to build their:

- substantive knowledge (science content)
  - conceptual knowledge of different ideas in science,
- disciplinary knowledge (Working Scientifically)
  - understanding about the nature of science and how scientists work to build knowledge
  - skills to gather and analyse evidence across a range of enquiry types.

Primary science leadership

A science subject leader needs an overview of progression across the school for both substantive and disciplinary knowledge, aligned to the National Curriculum objectives. All teachers should use the NC to plan for the development of knowledge and skills across year groups.

Prompts for next steps

1. Which substantive topics are taught when and why has this order been decided upon?
2. What disciplinary knowledge is taught each term? How do the children build this knowledge within lessons? How does this develop across year groups?
3. What CPD and resources are provided to ensure that all teachers have a good understanding of the key substantive and disciplinary knowledge in the NC for their year group?

Should I teach substantive and disciplinary knowledge separately?

Myth Buster

No, the National Curriculum states that Working Scientifically should always be clearly related to science content. It may be appropriate to teach how to use a piece of equipment before children use it an enquiry context, or for children to learn the names and features local invertebrates before going on a bug hunt.

*See Terminology on page 14.

3.

Improvement of children's science learning needs to be curriculum-led and sequenced

'A high-quality science curriculum not only identifies the important concepts and procedures for pupils to learn, it also plans for how pupils will build knowledge of these over time.

Careful curriculum design, where new knowledge is broken down into meaningful components and introduced sequentially, can support all pupils to learn scientific concepts.

High-quality science curriculums are coherent'.

Ofsted, 2021: Organising knowledge

What does this mean for primary science?

Primary science expertise:

The National Curriculum is a sequenced set of age appropriate scientific concepts and procedures. Primary science teachers need to use this effectively, looking backwards and forwards beyond their own year group topics to identify how substantive and disciplinary knowledge progress and also for connections between science topics. When planning a topic they should focus on 'what' is taught as well as 'how' it is taught, ensuring that lessons and activities are sequenced to ensure that key ideas are learnt and applied. Teachers should use formative assessment strategies to check children's understanding to inform next steps.

Primary science leadership

A science subject leader needs to ensure that science is not planned and taught as series of 'silo' topics, but that there is continuity between year groups which ensures that children build a conceptual framework for science into which new knowledge is fitted and built on.

Prompts for next steps

1. Are teachers planning lessons from activities or do they plan lessons from key ideas in a topic?
2. Do teachers know the substantive and disciplinary knowledge the children have experienced and learned in previous year groups? How do they build upon this? Do teachers know what comes next?
3. How is progression in substantive and disciplinary knowledge planned for within the context of the topic?
4. Where can teachers access guidance on the age-appropriate vocabulary, investigations and explanations?

I have to re-plan a science curriculum from scratch.

Myth Buster

No, the NC is the long term plan for most schools; teachers need to focus on planning that builds children's knowledge in a meaningful and cognitively appropriate way.

4.

Purposeful selection of a range of teaching approaches includes direct instruction and enquiry-based teaching

'Activities are carefully chosen so that they match specific curriculum intent. Teachers use systematic teaching approaches, where learning is scaffolded using carefully sequenced explanations, models, analogies and other representations to help pupils to acquire, organise and remember scientific knowledge. Teaching takes account of the limited working-memory capacity of their pupils when planning lessons. Pupils are not expected to arrive at scientific explanations by themselves without sufficient prior knowledge. Systematic approaches, alongside carefully selected texts, are used to teach the most important vocabulary in science.'

Ofsted, 2021: Pedagogy

What does this mean for primary science?

Primary science expertise:

Primary science teachers should recognise that direct instruction and enquiry-based teaching approaches are both forms of high quality teaching and learning in science. The skill of a teacher is to utilise a wide range of teaching approaches and to be responsive to the learners' needs in the lesson. As well as direct instruction and an enquiry-based approach, these will include other approaches such as drama, outdoor learning, cross- curricular etc, which draw on teachers' expertise in how children learn. Primary children need hands-on, practical experiences in science to inspire their curiosity and to build their understanding of the practices of science.

Primary science leadership

A science subject leader needs to ensure that all teachers recognise the difference between exploration, enquiry skills (plan, do, review), and enquiry types (observation over time, fair tests, pattern seeking, etc.). The curriculum should be discussed with staff to identify those science concepts that benefit most from direct instruction. In selecting a teaching approach teachers are best guided by their understanding both of children's prior learning and what opportunities they seek to provide to further develop children's disciplinary and substantive knowledge relevant to the topic.

Prompts for next steps

1. How are the science teaching approaches in your school developed, shared and evaluated?
2. Does selection of teaching approaches take account of prior learning?
3. How is a range of teaching approaches interwoven in your current topic plan and why?
4. Is there a shared understanding of the purpose and progression of science enquiry across the school?

Should my lessons move more towards direct instruction and demonstrations?

Myth Buster

No, selection of an appropriate teaching approach should depend on who and what you are teaching and why you are teaching it. Read more

5.

Teachers need sufficient subject knowledge to assess effectively

'Teachers and pupils are clear on the purpose of assessment. There is clarity about what is being assessed. Assessment is not overly burdensome on teachers' time in relation to marking, recording or feedback. Feedback is focused on the science content and not on generic features. Teachers have sufficient subject knowledge to be able to do this.'

Ofsted, 2021: Organising knowledge

What does this mean for primary science?

Primary science expertise:

Primary science teachers need sufficient subject knowledge to know what progression looks like. This does not mean knowing the answer to every child's question, but it does mean being aware of common misconceptions and developing confidence in the content at the appropriate level of the National Curriculum. Assessment can be used formatively, for example, to elicit children's ideas, identify gaps and adapt the pitch of lesson content. Some of this information can be used to inform summative summaries and end of year/key stage judgements.

Primary science leadership

A science subject leader can assist formative assessment practice by sharing a range of assessment strategies and support for subject knowledge. Ongoing discussions around pupil outcomes and moderation can support both impact of assessment and staff knowledge of progression.

Prompts for next steps

1. How are children's pre-existing ideas elicited? How are lessons tweaked as a result?
2. What support do staff need with science subject knowledge and identification of misconceptions?
3. How are children supported to think about their learning?
4. What opportunities do staff have for discussing pupils' learning and progress in science?
5. In terms of summative assessment, what information would be useful for the next classroom teacher? How can this be passed on in an efficient way?

Should everything pupils do be recorded in the same way?

Myth Buster

No, recording should be purposeful e.g. to support pupils with the lesson focus. This will look different for different age groups and topics.

Signposts to additional support

Teachers benefit from a wide range of professional support offered by organisations, charities and individuals within the primary science education sector.

Below is an non-exhaustive list of starting points to stimulate ongoing dialogue and development.

Science subject leadership accreditation

Primary Science Quality Mark (PSQM)
www.psqm.org.uk

Science association membership

Association for Science Education (ASE) with local and national networks, events, journals, guidance and resources
www.ase.org.uk

Regional support and resources

Primary Science Teaching Trust (PSTT)
pstt.org.uk

Science & Engineering Education Research and Innovation Hub (SEERIH), the home of the Great Science Share for Schools
www.seerih.manchester.ac.uk

STEM Learning
www.stem.org.uk

The Ogden Trust
www.ogdentrust.com

Assessment

Teacher Assessment in Primary Science (TAPS)
pstt.org.uk/resources/curriculum-materials/assessment

Pan London Assessment Network (PLAN)
www.planassessment.com

Terminology

Substantive knowledge	Disciplinary knowledge
Largely found in the 'science content' sections of the National Curriculum. This refers to what pupils learn about the products of science (knowledge produced by science). This includes knowledge of: • Biology concepts e.g. *living things*, *habitats*, *plants*, *body parts*, *digestion*. • Chemistry concepts e.g. *properties of materials*, *states of matter*. • Physics concepts e.g. *light*, *sound*, *electricity*, *forces*, *the Earth in space*. Pupil knowledge of these concepts is built up over time, as they are revisited in different topics.	Largely found in the 'Working Scientifically' sections of the National Curriculum. This refers to what pupils learn about ways of doing science and how scientists develop scientific knowledge. This includes knowledge of: • how scientists develop scientific knowledge by gathering and analysing data as evidence to develop explanations. • different types of scientific enquiry that scientists might use to answer their questions e.g. *observing for classification, collecting data to look for a pattern in a population, controlling variables in a fair test*. • how to carry out an enquiry to skilfully to answer scientific questions (plan, do, review) e.g. *planning what data will be collected, measuring with a ruler, timer or thermometer, drawing a table or graph, evaluating degree of trust in results, drawing conclusions*.
Disciplinary knowledge should typically be clearly related to the teaching of substantive knowledge. For example, pupils might learn about making systematic observations (disciplinary knowledge) when learning about growth of plants (substantive knowledge).	

References and recommended further reading

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About us

Jane Turner

Jane Turner is Director of the Primary Science Quality Mark based at the University of Hertfordshire where she is an Associate Professor. Jane is lead author of the 2011 ASE guide to Science Enquiry; *It's Not Fair Or Is it?*, has contributed to several primary and early years education publications and research projects and is series editor for *Snap Science* published by Harper Collins. She worked with the Department for Education as Curriculum Advisor for Primary Science and also as a consultant to the BBC, Wellcome Trust, Learned Societies, Education Endowment Foundation and industry on primary science assessment and curriculum. She is the current chair of the Association for Science Education and chair of the Learned Societies Primary Curriculum Advisory Group.

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Dr Lynne Bianchi is a specialist in curriculum and professional development, innovation and research in primary science and engineering education. She is a Senior Lecturer and Director of the Science & Engineering Education Research and Innovation Hub at The University of Manchester. Lynne is founder of national campaigns including the Great Science Share for Schools and Engineering Educates, and principal investigator on several research projects . She works with Learned Societies including the Royal Academy of Engineering, Royal Society and Institute of Physics and is currently an expert advisor for the Primary Curriculum Advisory Group and Education Endowment Foundation.

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