

Primary Science: Is It Missing Out?

Recommendations for reviving
primary science

September 2014

Executive summary

Introduction

A recent Wellcome Trust study, *The Deployment of Science and Maths Leaders in Primary Schools* (October 2013)¹, found that very few schools have access to high levels of science expertise and that strategic leadership for the subject is weak. This raises concerns about the status of primary science and the accountability systems in place for it.

Reinvigorating primary science is a key priority for the Wellcome Trust. This summary therefore considers how some of the issues uncovered in our latest study and other work can be addressed, and makes recommendations for the future.

Summary of recommendations

The UK should champion primary science.

- Policy makers should ensure that education leaders at all levels are accountable for the provision and quality of primary science teaching.
- School leadership teams (including governors and headteachers) should value and aspire to excel in primary science.

Primary schools should have access to science expertise.

- Policy makers should require that all primary schools have, or have access to, science leaders with expertise in primary science, and ensure that the resources and infrastructure to enable this are provided.
- Science subject leaders must regularly access high-quality continuing professional development (CPD) to ensure that their expertise is sustained.
- Class teachers must take responsibility for their professional development in science.
- School leadership teams should prioritise access to high-quality science-specific CPD.

Primary science should be well-resourced.

- School leadership teams should use recommended benchmarks to guide their resourcing of science.
- Science subject leaders should have strategic responsibility for a dedicated science budget.

Report Summary

Deployment of Science and Maths Leaders in Primary Schools (October 2013)

The aim of this work was to explore how science and maths expertise is currently used in schools and to understand the strategic drivers behind the different models of deployment. Research consisted of:

- an online survey completed by 209 schools in England with primary age pupils
- follow-up interviews with 21 of the schools that completed the survey
- detailed case studies of science provision and leadership in three of the schools followed-up.



Very few [schools] measured their [science] departments' performance against the lofty goal of 'maintaining curiosity'."

Ofsted, 2013

Why should we care about primary science?

Pupils should be inspired by their first formal educational encounters with science at primary school. Primary science should develop pupils' understanding of the world, nurture their curiosity and teach essential skills, including enquiry, observation, prediction, analysis, reasoning and explanation. Science provides a 'motivating context' for pupils to develop and improve skills in many areas, including literacy² and mathematics.

Children start to develop perceptions about whether science is 'for them' towards the end of primary school³. It is therefore essential that all primary school pupils experience inspiring science that builds their understanding of the value and place of science in their lives. This will lay the bedrock for their future studies, enable them to make well-informed decisions in our increasingly hi-tech world and give them access to a wide range of rewarding careers.

As the future economy will require a larger proportion of the workforce to possess high levels of scientific and technological skill⁴, we need more students to continue to study science subjects beyond the statutory curriculum and move into related employment. If more pupils are enthused to study science, starting at the primary level, this will help secure our economic future.

Science is a core and compulsory subject for all primary school pupils. As schools plan to deliver the new national curriculum for science (which will become statutory in England from September 2014), leaders have the chance to ensure that this subject is placed at the heart of primary teaching.

Is science missing out?

Twenty-five years after the inclusion of science in the national curriculum, devised to ensure a minimum entitlement for all pupils, our research shows that there is a distinct gap between schools that value and invest in science and those that do not⁵. We are concerned by evidence of a general decline in primary science teaching, as described below.

Strategic leadership and accountability

Primary schools have the freedom to decide how to implement their curricula based upon statutory requirements and the needs of their pupils. Although academies and free schools need not follow the national curriculum, they must teach a broad and balanced curriculum including science. There is no specification, however, for how much time must be devoted to teaching science.

Until May 2009 pupils in their final year of primary education in England took statutory science tests. Schools prepared for the tests with extensive revision, and the science curriculum had become defined by these tests, raising concerns that pupils were missing out on breadth and richness in the teaching of science. When these formal tests ceased, schools had more freedom to develop science, particularly by extending practical enquiry. While some schools have made the most of these opportunities, in a survey conducted by the Wellcome Trust in 2011 many reported a decline in the status of science⁶, with it often being perceived as less important than the other core subjects, English and maths. Furthermore, research published by the Wellcome Trust and Ofsted in 2013 found that English and maths tend to take priority in primary schools' allocation of resources and curriculum delivery. Science may be taught for only an afternoon each week, or else be taught within in an overall topic^{7,8}. The opportunity to enrich science through practical, enquiry-led teaching has been missed.

Ofsted warned that weak leadership underlies the decline in science, reporting that leaders of about half the schools visited in their 2013 review "no longer saw science as a priority"⁹. As a consequence of this, targets are not set for achievement in science, inadequate teaching time is allocated and there is little monitoring of the quality



Schools said that their biggest need is CPD that is current, cutting-edge, accessible and affordable, but most importantly subject-specific”

Wellcome Trust, 2013

of science teaching. The process of holding schools accountable for the quality of science provision has been overlooked. The Wellcome Trust’s research found that science is rarely highly prioritised in school improvement planning or linked to other curriculum development areas. Decisions about how to use existing expertise, develop resources and enrich the curriculum are seldom based on evidence or self-evaluation and are more likely to be reactive than strategic¹⁰.

Teachers responding to our survey also raised concerns about a lack of access to science expertise in their schools¹¹. But it is not enough to make science-specific CPD accessible. Instead it must be used strategically to drive improvement, based on an understanding of why good science teaching is important.

Urgent action is required. The symptoms of decline described by teachers are the consequence of an undervaluing of primary science and a lack of strategic action to address deficiencies in provision, including the need for more expertise. Despite primary science being a core subject, accountability for primary science is lacking at all levels – from governance to education leaders in schools, authorities, academy providers and others.

Developing teachers

Young people report that good science teachers enthuse and inspire them¹². In most primary schools, children are taught the majority of lessons by their class teacher, who is expected to have the subject knowledge and pedagogic skills to teach a wide range of subjects in one cohesive curriculum¹³.

Since science became a compulsory subject in primary schools in 1989, there has been concern about the impact of teachers’ weak subject knowledge and low levels of confidence on pupils’ development in science, with claims that only very highly trained specialists should be teaching this subject to ensure that children do not develop misconceptions about specific phenomena. Weak subject knowledge in teachers contributes to low confidence and poor pedagogic skills¹⁴. Furthermore,

a teacher lacking confidence is unlikely to inspire pupils or change their perceptions that science is only for ‘brainy people’¹⁵. The latest Ofsted report notes that teachers must recognise the limitations of their scientific knowledge and know how to address these; they must also understand how children progress conceptually in science and plan lessons accordingly¹⁶.

Many organisations have made recommendations for improving primary science (see Appendix 1), and these regularly feature calls to address teachers’ subject knowledge, confidence and skills. However, it is clear that decision making about improving the teaching of primary science through professional development is *ad hoc*, rather than strategic.

Pupils engage most with practical science lessons that develop their learning through enquiry¹⁷, the teaching of which demands excellent pedagogical science skills, including knowing how to connect science to the wider world.

*“The goal of science education is not knowledge of a body of facts and theories but a progression towards key ideas which enable understanding of events and phenomena of relevance to students’ lives.”*¹⁸

To achieve this goal, teachers need access to high-quality science-specific CPD. Paradoxically, our deployment study shows that while headteachers acknowledge that subject-specific CPD would improve core knowledge and pedagogy, they prioritise generic CPD for its perceived wider impact and better value for money¹⁹. Research shows that pupils are more likely to benefit from specialist CPD because it changes teachers’ practices by making links explicit between professional learning and pupil learning. Generic CPD has little direct impact on pupils²⁰.

If the teaching workforce is not equipped to teach science well, pupils will miss out. Negative perceptions about science being hard will persist and students will be less likely to recognise the broader values of science or to continue to study it beyond any statutory requirements.



Many primary schools lack sufficient appropriate resources to teach practical science effectively”

SCORE, 2013

Resourcing science

Science should be taught through working scientifically. Hands-on practical learning is fundamental to science teaching and requires resourcing to be effective. But research undertaken in 2013 indicated that many schools do not have adequate resources or appropriate facilities to teach science²¹.

While primary science leaders are the budget holders for their subject, they may not have strategic responsibility for determining what is needed. Instead, they may simply use the amount allocated to purchase consumable materials and new equipment. Schools report that they seek alternative sources of funding wherever possible²².

Issues surrounding the resourcing of primary science are linked to matters of accountability and strategic leadership. Resourcing science is not seen as a priority since schools are not held to account for science achievement.

From September 2014 all primary schools in England will have a statutory duty to teach science through ‘working scientifically’²³. If resources are inadequate, there is a danger that pupils will learn about science by watching demonstrations rather than by carrying out science investigations themselves – which is less engaging and fails to convey that science is something that you *do*²⁴.

How can we revive primary science?

Schools that inspire pupils, teachers and local communities to engage with science show strong leadership, good resourcing and a commitment to high-quality science teaching, with these all based on improvement planning. Primary science cannot be revived without access to science expertise, but there are many ways in which that expertise can be used effectively to impact upon pupils²⁵.

The UK should champion primary science

Policy makers should ensure that education leaders at all levels are accountable for the provision and quality of primary science teaching. Leaders must recognise the value added by effective science teaching and appreciate the importance of science in their students’ lives as well as for our future workforce.

School leadership teams (including governors and headteachers) should value and aspire to excel in primary science. The priority given to science in a primary school is dependent upon the attitude of the school’s leadership team²⁶. Science is thriving in primary schools where leaders understand how it can enhance learning. Effective governance can drive improvement in the leadership of science education but governors need to be supported to achieve this and recognise what makes a good primary science education.

Primary schools should have access to science expertise

Policy makers should require that all primary schools have, or have access to, science leaders with expertise in primary science, and ensure that the resources and infrastructure to enable this are provided. This requires commitment to high-quality initial teacher training (ITT) in science, and commitment to the provision of intensive subject-specific CPD to equip existing science subject leaders to support colleagues and lead improvement in science²⁷.

In 2011 the government stated: “For the allocation of ITT places from 2012/13, [the Training and Development Agency for Schools] will prioritise primary courses that offer a specialism, particularly in the sciences”²⁸. It is essential that this commitment is fulfilled and that newly qualified teachers



“If science and mathematics are to flourish in schools and colleges, support for these subjects must cascade down from leadership teams”

Royal Society, 2014

with a science specialism access high-quality CPD to enable them to become highly effective science leaders.

The current workforce urgently needs support through rigorous CPD to build expertise. The Wellcome Trust has invested in developing an intensive primary science CPD course, delivered by the National Science Learning Centre, and is now evaluating its impact through a randomised controlled trial (Appendix 2). Other routes to increasing capacity may include the ‘gold’ Primary Science Quality Mark²⁹, Chartered Science Teachers³⁰ or the Primary Science Teacher College³¹. How each school deploys its expertise depends upon its individual context³².

Science subject leaders must regularly access high-quality CPD to ensure that their expertise is sustained. Schools should invest in science CPD – there is a significant correlation between a school’s provision of science-specific CPD and the overall effectiveness of its science teaching. The Wellcome Trust, the government and industry partners have invested extensively in the National Science Learning Centre and Project ENTHUSE to make high-quality CPD easily accessible and affordable for *all* maintained schools, with bursaries that help cover the costs of course fees, travel, and supply cover and accommodation³³.

Class teachers must take responsibility for their professional development in science. The teaching standards³⁴ make clear the requirement that all teachers keep their skills and knowledge up to date. Currently primary teachers are not required to have any science qualification above GCSE, but in our recent study those surveyed said that subject-specific CPD to increase their subject knowledge would help them to improve their teaching³⁵.

School leadership teams should prioritise access to high-quality science-specific CPD. A key finding by Ofsted is that science teaching is much more likely to be outstanding when teachers and subject leaders receive science-specific training, and therefore it recommends that school leadership teams provide it³⁶.

Primary science should be well-resourced

School leadership teams should use recommended benchmarks to guide their resourcing of science. It is essential that decisions about resourcing follow strategic evaluations of provision and school improvement priorities.

Science subject leaders should have strategic responsibility for a dedicated science budget. Benchmarks of essential and desirable science equipment³⁷ provide science leaders with a clear framework for resourcing science appropriately, preparing them for teaching an exciting and invigorating curriculum.

Final comment

All pupils deserve to enjoy their science education and have access to rich practical experiences. They need to understand why science is important, so it is vital that schools are equipped with an inspiring workforce and are well-resourced. Enthusiasm will spread from leaders to teachers, to pupils and into the community.

“Where science has a good profile within the school as a result of dedicated leadership, and where staff are expected to teach exciting, investigative science with access to high-quality expertise, children are likely to enjoy learning the subject.”³⁸

Appendix I

Recommendations to improve primary science made between 2003 and 2013

Year	Report	Key recommendations
2013	<p>Ofsted: <i>Maintaining Curiosity: A survey into science education in schools</i></p> <p>ofsted.gov.uk/resources/maintaining-curiosity-survey-science-education-schools</p>	<p>Primary schools should:</p> <ul style="list-style-type: none"> • provide sufficient curriculum time to develop good scientific enquiry skills as well as knowledge • provide subject-specific continuing professional development (CPD) for teachers and science leaders • monitor pupils' progress in science regularly • use assessment to plan lessons that build on pupils' prior science knowledge and provide feedback to improve progress • allow pupils enough time to secure their understanding of the science concepts they are studying and to complete investigations.
2013	<p>SCORE: <i>Resourcing Practical Science in Primary Schools</i></p> <p>score-education.org/media/11808/score_resourcing_primary.pdf</p>	<p>Each school should have a designated science leader who has access to science-specific CPD.</p> <p>The government must keep to its commitment to encourage more people to train to become primary science specialist teachers.</p>
2012	<p><i>Developing a Future: Policies for science and research</i> (Liberal Democrat Spokesman's Paper)</p> <p>researchprofessional.com/media/pdf/SciencePolicy3989.pdf</p>	<p>The Liberal Democrats will ensure that all primary schools have a science specialist to support other teachers in their knowledge of and confidence in science.</p>
2011	<p>Department for Education: <i>Training Our Next Generation of Outstanding Teachers: Implementation plan</i></p> <p>www.gov.uk/government/uploads/system/uploads/attachment_data/file/181154/DFE-00083-2011.pdf</p>	<p>More schools should be able to employ primary teachers that they can deploy as specialist subject teachers in the sciences, mathematics, languages or other subjects. For the allocation of initial teacher training places from 2012/13, the Training and Development Agency for Schools will prioritise primary courses that offer a specialism, particularly in the sciences, mathematics or modern languages. For 2013/14 the Department for Education expects to adjust financial incentives for trainees to favour trainees on specialist primary courses (and who have a good A level in mathematics, a science or a language) over those on generalist courses.</p>

Year	Report	Key recommendations
2011	Ofsted: <i>Successful Science</i> ofsted.gov.uk/resources/successful-science	Primary schools should: <ul style="list-style-type: none"> ensure that pupils are engaged in scientific enquiry and develop enquiry skills provide CPD to support and extend teachers' knowledge, understanding and skills in science and their confidence in teaching it develop the role of the science coordinator to provide effective, sustained leadership.
2010	Royal Society: <i>Science and Mathematics Education 5–14</i> (State of the nation report) royalsociety.org/education/policy/state-of-nation	The Department for Education should: <ul style="list-style-type: none"> increase the number of science specialist teachers to ensure that every child has access to a high-quality science education continue to improve professional standards through subject-specific CPD.
2010	Campaign for Science and Engineering: <i>Education and Skills</i> (CaSE Working Paper) sciencecampaign.org.uk/documents/2010/CaSEEducationSkills.pdf	All primary schools should have both a mathematics specialist and a science specialist with relevant graduate-level qualifications or additional training.
2008	Ofsted: <i>Success in Science</i> ofsted.gov.uk/resources/success-science	Primary schools should: <ul style="list-style-type: none"> provide CPD to support and extend, where necessary, teachers' knowledge and understanding of science and their confidence in teaching it ensure that pupils receive a balanced programme of science education that includes a significant focus on scientific enquiry.
2003	Parliamentary Office of Science and Technology: <i>Primary Science</i> (POSTnote no. 202) www.parliament.uk/business/publications/research/briefing-papers/POST-PN-202/primary-scienceseptember-2003	This POSTnote suggests that primary science may be improved by: <ul style="list-style-type: none"> providing training for primary teachers to improve their scientific knowledge and confidence encouraging school managers to see science as a priority area.

Appendix 2

Primary Science Specialist Programme

How can we revive primary science?

The Wellcome Trust has worked with the National Science Learning Centre to develop an intensive continuing professional development (CPD) programme designed to develop the subject knowledge, pedagogical concept knowledge and skills that are needed to successfully lead and develop primary science in a school, as defined in the box to the right. The CPD programme takes place over one year and currently comprises:

- three residential periods at the National Science Learning Centre, focused on developing subject knowledge and pedagogical content knowledge
- five days developing leadership skills, delivered in local partnerships
- six twilight sessions
- online learning and reporting.

We have commissioned a study by the University of York and the Institute for Effective Education to test whether the CPD is having its intended impacts. This is a randomised controlled trial, supported by additional qualitative analyses, and is due to be completed in November 2014.

Definition of a Primary Science Leader's Expertise

Subject knowledge

A primary science leader should have a deep understanding of the scientific concepts within the Key Stage 1 (KS1) and KS2 national curriculum, supported by a working understanding of the scientific concepts within the KS3 national curriculum. A primary science leader should be confident in their use of scientific vocabulary and know how to research science topics and guide their students to do the same.

Pedagogical content knowledge

A primary science leader should have knowledge of an appropriate range of teaching methods suitable for the content concerned. These should include enquiry-based pedagogies, practical activities, out-of-classroom learning opportunities, group work and problem-solving activities, digital technologies and formative assessment practices. A primary science leader's knowledge should also include an understanding of the key techniques that result in the successful implementation of these pedagogies and how to evaluate the impact of these on their students.

Subject leadership

A primary science leader should have a whole-school vision for science and be able to lead its development by instigating appropriate initiatives, including providing CPD to colleagues, monitoring progress and contributing to the strategic development of learning in their school.

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