Report summary

Maintaining curiosity

A survey into science education in schools

Physicians take an oath that commits them to 'first do no harm'. The best science teachers, seen as part of this survey, set out to 'first maintain curiosity' in their pupils. The most successful schools visited during this survey had adopted this as a key principle in teaching science and this not only fostered enthusiasm for the subject in their pupils but helped them to fulfil their potential.

We need better science education to secure a strong foundation for a successful and technological society. The new National Curriculum for 2014 sets out why we teach science in schools:

> 'A high-quality science education provides the foundations for understanding the world through the specific disciplines of biology, chemistry and physics. Science has changed our lives and is vital to the world's future prosperity, and all pupils should be taught essential aspects of the knowledge, methods, processes and uses of science. Through building up a body of key foundational knowledge and concepts, pupils should be encouraged to recognise the power of rational explanation and develop a sense of excitement and curiosity about natural phenomena. They should be encouraged to understand how science can be used to explain what is occurring, predict how things will behave, and analyse causes.'[1]

This report highlights the importance of teaching science for understanding. For pupils to achieve well in science, they must not only acquire the necessary knowledge, but also understand its value, enjoy the experience of working scientifically, and sustain their interest in learning it. Pupils in schools need to discover the concepts revealed through observing scientific phenomena and conducting experimental investigations for themselves. Then they are more likely to continue to study science and use that learning for work, for family, and to contribute as informed citizens.

[1] National Curriculum in England: science programmes of study, Department for Education, 2013; www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study.

The report also reflects and explores the concerns often voiced by employers, higher education, and the scientific community's professional bodies, that too many school leavers are not well-enough equipped scientifically with practical, investigative and analytical skills. These are vital if young people are to flourish in a technological world and to contribute to economic development. The government's review of GCSE and A-level qualifications provides a timely opportunity to ensure that the skills of scientific enquiry are assessed as an integral part of these qualifications.

The report is set out in three sections. Part A describes primary provision, Part B secondary provision, and Part C explains evidence-based factors that promote achievement in science. Inspectors visited 91 primary and 89 secondary schools, including 53 with sixth forms, and six special schools, between summer 2010 and spring 2013. The best teaching in these schools:

- was driven by determined subject leadership that put scientific enquiry at the heart of science teaching and coupled it with substantial expertise in how pupils learn science
- set out to sustain pupils' natural curiosity, so that they were eager to learn the subject content as well as develop the necessary investigative skills
- was informed by accurate and timely assessment of how well pupils were developing their understanding of science concepts, and their skills in analysis and interpretation so that teaching could respond to and extend pupils' learning.

The majority of the teachers observed were skilful in teaching interesting science lessons and inspectors judged the majority of the lessons (69%) they saw as good or outstanding. However, a minority of the secondary schools visited were preoccupied with test and examination results as ends in themselves at Key Stage 4, rather than aiming to establish pupils' understanding and application of scientific ideas through practical enquiry-based approaches to learning.

Where disadvantaged pupils study academic GCSEs, they achieve as well as other pupils when teachers hold the same high expectations for all. GCSEs provide the greatest range of routes for pupils to access further science study at 16. However, too few 16-year-old girls continue studying physics nationally. Not enough subject leaders analyse why pupils of both genders either continue or stop studying science subjects after the age of 16. Uninspiring teaching was one reason pupils gave to inspectors to explain why they did not wish to continue studying science. Another was not seeing the purpose of what they were studying, other than to collect examination grades.

There were common weaknesses in a significant minority of lessons in both the primary and secondary schools visited:

- activities did not match each pupil's prior learning, so that some pupils wasted time or did not complete work
- pupils became disengaged from learning and more able pupils in particular were not given work that was challenging enough
- teachers failed to provide pupils with feedback that really helped them to improve their work.

In nearly half of the primary schools visited senior leaders were not setting targets for science and were not tracking pupils' progress in the subject. This was because they no longer saw science as a priority, despite its place as a core subject in the National Curriculum.

A very low proportion of the subject leaders in the survey had received specific professional development in providing leadership for science. However, schools that had provided science-specific professional development were much more likely to be judged as outstanding in their overall effectiveness of science.

Key findings

- In the best schools visited, teachers ensured that pupils understood the 'big ideas' of science.[2] They made sure that pupils mastered the investigative and practical skills that underpin the development of scientific knowledge and could discover for themselves the relevance and usefulness of those ideas.
- Attainment in science up to 2012 has risen year by year at all key stages, and girls attained better than boys at all key stages. Despite this, too many girls do not continue to study physics or related subjects at 16.
- Leaders in the schools visited were not monitoring and evaluating the reasons why their pupils, both boys and girls, pursued routes other than science at 16.
- Science achievement in the schools visited was highest when individual pupils were involved in fully planning, carrying out and evaluating investigations that they had, in some part, suggested themselves.
- Although the quality of teaching was at least good in the majority of the schools visited, lessons in both primary and secondary schools often lacked sufficient differentiation to allow pupils, especially the more able, to build on their prior learning and make good progress.

[2] For a useful, school-level cataloguing of the 'big ideas', see: W Harlen (ed) *Principles and big ideas of science education*, Association for Science Education, 2010; www.ase.org.uk/bookshop/books-for-subject-leaders/.

- The quality of feedback to pupils on how they might improve their science understanding was a common area for improvement in the primary and secondary schools visited, regardless of the school's overall effectiveness in science.
- Teachers who coupled good literacy teaching with interesting and imaginative science contexts helped pupils make good progress in both subjects.
- A significant minority of leaders in the primary schools visited were failing to ensure full coverage of the science National Curriculum. They did not track pupils' progress in science effectively and were not setting challenging targets for improvement in science. For these leaders, science was no longer a priority.
- The effectiveness of science in both the primary and secondary schools visited was much more likely to be outstanding when teachers and subject leaders had received science-specific training. However, most of the primary teachers had not received such training, and most of the science leaders in both phases had not received leadership training that was specific to science.
- Timetables in a significant minority of the primary and secondary schools visited did not allow enough time for teaching science through regular, enquiry-based learning. This limited pupils' opportunities to develop the practical skills necessary for future work in science, technology or engineering. This included restricting science to irregular 'science days' in primary schools, and limiting the teaching time for the three separate science GCSEs to the same amount as for a double science award in secondary schools.
- In most of the schools visited, pupils from Key Stage 1 to Key Stage 4 had limited opportunities to work independently, particularly to develop their individual manipulative skills in practical work, because teachers only required them to work in pairs or small groups.

Main report published November 2013
www.ofsted.gov.uk/resources/130135

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No. 130135