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Understanding the 'state of the nation' report of UK primary science education

A baseline report for the Wellcome Trust

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EXECUTIVE SUMMARY

CFE Research with the University of Manchester has been commissioned by Wellcome to monitor and evaluate the impact of its UK-wide Primary Science Campaign. The campaign's vision is that all pupils will experience an exciting, inspiring and relevant science education at primary school that leaves them well-prepared to progress further in science, and well-informed about science in their everyday lives. A key part of the campaign is Explorify; this is a free resource of engaging, creative science activities for all primary school teachers. It has been designed to stimulate curiosity, discussion and debate and is intended to support teachers to encourage children to think like scientists.

In 2017 research was undertaken by CFE and The University of Manchester to examine how science is taught across the UK, including the number of hours it is taught for and attitudes towards science. The 2017 research captured the baseline position from which the outcomes and impacts of the Primary Science Campaign will be determined, and were reported in the *'State of the Nation' report of UK primary science education*[1]. This new report presents findings from the qualitative baseline research and summarises emerging themes from interviews with a cross-section of school staff to explore the reasons behind the *State of the Nation* findings, including what factors affect decisions about science teaching in schools across the UK. Throughout the report, quantitative data from the 2017 research is presented alongside qualitative description to further elucidate the findings and inform the strategic direction of the campaign.

Method for this study

The data presented in this report was captured via two means:

- **UK-wide surveys of Science Leaders and teachers:** (1) A computer-assisted telephone interview of **902** Science Leaders (or those responsible for science in their schools) undertaken between November 2016 and January 2017. (2) An online survey of 1,010 teachers undertaken between December 2016 and March 2017. The full findings of these surveys were reported in the *'State of the Nation' report of UK primary science education* designed as baseline research for the Wellcome Primary Science Campaign. The findings of this survey are provided within this report for context and were previously published in more detail[2].
- **50 depth interviews from 34 schools:** Qualitative research with a cross-section of schools undertaken to explore the survey findings for science teaching across the UK. Interviews with a variety of staff to elicit a range of perspectives including Headteachers and Science Leaders (or those responsible for leading science in school including World Around us coordinators in Northern Ireland) and classroom teachers with responsibility for teaching science (a full breakdown of interviewees by school is in Appendix 1) during the Spring and Summer terms of 2018.

[1] https://wellcome.ac.uk/sites/default/files/state-of-the-nation-report-of-uk-science-education.pdf
[2] https://wellcome.ac.uk/sites/default/files/state-of-the-nation-report-of-uk-science-education.pdf

Key findings

The importance of science

Respondents to the 2017 science leadership and teaching surveys indicated **how important** they thought certain subjects were to the Senior Leadership Team of their school:

- **83%** think **English** is '**very important**' and 11% 'important'
- **84%** think **maths** is '**very important**' and 11% 'important'
- **30%** think **science** is '**very important**' and 50% 'important'

The interviews reflect these survey findings with **two-thirds** of interviewees who believe that science **does not have equal importance with English and Maths** in their school. Of these, when compared to other subjects, **half of interviewees rank science as the third most important subject in schools** (after English and maths), with the remainder considering science to be equally important to other curriculum subjects.

The **passion of a Headteacher or Science Leader in science** was often perceived to be **pivotal in raising and sustaining science's profile across the school**.

All interviewees view science as an important subject for pupils to study at school allowing pupils to develop a wide range of skills which can also be applied in other subjects.

Leadership of science

In the 2017 science leadership survey **91% of UK schools had a Science Leader**, however through the interviews it was clear the role they play varies considerably by school.

51% of **Science Leaders get specific release time to lead science** in addition to planning their own lessons. One-third take 10 hours (or less) a year, one-third take 11-20 hours and one-third take more than 21 hours of release time per year (science leadership survey). During the interviews Science Leaders who do not receive release time report **using their planning, preparation and assessment time to lead science or undertake work out of school hours**.

52% of respondents to the science leadership survey had **undertaken external Continuing Professional Development lasting (CPD)** one day or more **in the previous year** to help them lead or develop science throughout their school. These findings were confirmed during the interviews.

During the interviews very few teachers reported recently undertaking external CPD to teach science although most had undertaken it at some point in their career. **Almost all teachers** reported they **had either received support to teach science or knew who to ask if it was needed** with many referencing their Science Leader. This mostly

reflects the findings from the 2017 teacher survey. The extent to which teachers feel **supported** by their school to teach science was as follows:

- **15%** 'strongly agree'
- **50%** 'agree'
- **24%** 'neither agree nor disagree'
- **9%** 'disagree'
- **2%** 'strongly disagree'

Teaching science

Most interviewees believe their **school offers a broad and balanced curriculum**, but strongly caveated that this was **within certain constraints** such as the importance given to English and Maths and the wide variety of other subjects taught in the curriculum limiting the time available to any one subject.

Hours of teaching

Across the UK, science is delivered weekly to most year groups, ranging from 77% in Reception to 87% in Year 6 **either** through **standalone lessons**, **cross-curricular** work or a **mix of both** (as reported in the science leadership survey).

During the science leadership survey **Standalone lessons** are more prevalent for older year groups (around 40% deliver standalone lessons and a further 44% deliver a mix of standalone and cross-curricular to **years 3-6**). Younger pupils are more likely to receive cross-curricular work (this was especially true of Reception, in which **59%** of weekly lessons are delivered through **cross-curricular work only**).

On average, science is **taught weekly** for an **average of 1.4 hours** (1 hour and 24 minutes) as reported across both surveys. Younger year groups receive fewer hours of weekly lessons with the amount of science taught increasing as pupils become older. Across year groups, **an average of 58% of classes are not receiving two hours of weekly science**.

Science is taught across schools in a **wide variety of ways** (as reported in the science leadership survey). The majority of schools teach some form of science weekly and around two-thirds combine this with other types of activity such as dedicated science weeks, science days and visits. Across all of these, methods science is taught on average for **1.7** hours a week (1 hour and 42 minutes – as reported across both surveys). Younger year groups receive on average fewer hours. Across year groups on average **54% of classes are not receiving the equivalent of two hours of science per week**.

Half of those interviewed similarly estimate they spend 2 hours or more a week teaching science. The remaining interviewees report less than two hours a week or are unable to estimate the time as there is no set time allocated to science often due to the cross-

curricular nature of their topic work. **Where science is timetabled there is still a degree of flexibility in the number of hours, when, and how this is delivered**.

Across almost all schools interviewed **in England and Wales,** the amount of **time that is spent teaching science is usually decided at a whole school level**, with either the Headteacher or Science Leader stating the number of hours that it should be taught each week. Within **Northern Ireland and Scotland** the interviews suggest that usually the **time spent teaching science is decided at the teacher level** due to the cross-curricular nature of the curriculum and therefore science teaching.

During the interviews, there were **mixed views regarding the impact of cross-curricular teaching**. When delivered effectively it allows teachers to cover more than one topic/subject area at a time increasing the time that is spent on subjects. However, **where science is *only* taught through cross-curricular lessons** there is **the potential for this to lead to a reduction in the number of hours of science taught** as teachers can focus the lesson on their subject of interest.

An additional factor reported to influence the amount of science taught was the perception that literacy and numeracy are always prioritised.

Methods of teaching

During the interviews it was clear that **the decision of how science is taught is made by individual teachers.** Headteachers and Science Leaders acknowledge that there are different teaching styles and methods, and most make a conscious decision to **allow teachers to deliver science teaching in their own way, unless quality is assessed as poor**.

Across both the science leadership and teaching surveys, respondents report that different activities are undertaken with pupils when teaching science[3]:

	'Always'	'Frequently'
You arrange for **pupils** to **design their own science investigations** when applicable	15%	38%
You **demonstrate science investigations** to pupils when applicable	32%	41%
You teach science by **encouraging pupils to do investigations**	33%	50%
You arrange for **pupils to record data** or observations from science investigations	37%	44%
You encourage **pupils to interpret their science data** or observations	40%	42%

[3] Response options to this survey question were 'always', 'frequently'. 'occasionally', 'never', 'don't know' and 'not applicable'.

The interviews highlighted how the **frequency of practical lessons varies** across schools, with some practicals being undertaken regularly in lessons whilst in other instances teachers recognised this needed to be improved across the school. Within schools the **formal 'writing up' of investigations** is sometimes **described as time consuming and can take away the 'fun' of investigations**, although some teachers said that they find different ways to collect and evidence learning.

Science resources

Respondents to the science leadership survey answered a series of statements about the suitability of science resources in their school.

58%	47%	41%
of schools have science equipment suitable for different ages	of schools have a good range of science equipment to carry out hands-on science investigations	of schools have appropriate budget for resources

Most interviewees describe how their school either has 'plenty' of resources to teach science or has 'fairly' good resources. There are **many examples of alternative solutions** to sourcing resources including securing funding, loaning equipment and using cheap/free alternatives. However such solutions are strongly dependent on the drive of the Science Leader or teacher.

Confidence and enjoyment teaching science

Respondents to both surveys were asked to state to what extent they 'agree' or 'disagree' with confidence statements about teaching and assessing science. Just under **one-third** (32%) **'strongly agree'** that they are **confident in teaching science**. Less than one-quarter (**23%**) of respondents **'strongly agree' or 'agree'** that they are **concerned that they might not be able to answer children's questions about science**.

Most interviewees report they are very confident in teaching science (most interviewees were Science Leaders or senior leaders in the school). However, **few report that all teachers in their school are confident** which in part explains the mixed confidence levels found in the baseline survey.

Confidence is often **influenced by teacher's experience in teaching** or through **having a science background.** Level of confidence does appear to have an impact on science delivery in the classroom.

Interviewees report that **a lack of confidence can have an impact** on whether teachers choose to deliver **practical hands-on investigations** or – with cross-curricular work – **the number of hours dedicated to this**. This is sometimes due to a lack of confidence in a specific topic area and feeling unconfident in dealing with any problems that may arise.

Barriers and improvements

Barriers to teaching science are varied. The **two main barriers** discussed during the interviews **are a lack of time and resources** to deliver science in the way they would like. Time is focused on planning practical investigations or cross-curricular work, setting up practical investigations and sourcing and organising resources. Some schools refer to a lack of equipment whilst others highlight a lack of electronic resources, lesson plans or access to external speakers.

In Northern Ireland and Scotland interviewees describe **the curriculum for primary science as "vague"** and open to interpretation making **it difficult to know what needs to be taught and to what level**.

Increasing the importance of science across a school is seen as a key solution to address some of these barriers. The role of the Science Leader is also key in improving confidence and teaching across a school, but presents a challenge to some schools where budget constraints are said to prevent giving Science Leaders release time to do their role.

CHAPTER 1. INTRODUCTION AND METHODOLOGY

This section introduces the aims and objectives of the study, summarises the research methods implemented, and provides contextual information on science teaching throughout the UK.

1.1 Aims and objectives of the overall evaluation

CFE Research with the University of Manchester has been commissioned by Wellcome to undertake monitoring and evaluation of its Primary Science Campaign. The campaign's vision is that all pupils will experience an exciting, inspiring and relevant science education at primary school that leaves them well-prepared to progress further in science, and well-informed about science in their everyday lives. A key part of the campaign is Explorify[4]; this is a free resource of engaging, creative science activities for all primary school teachers. It has been designed to stimulate curiosity, discussion and debate and is intended to support teachers to encourage children to think like scientists. Explorify launched in autumn 2017 following a pilot in spring of that year.

CFE with the University of Manchester was commissioned to explore the nature of science delivery across the UK and evaluate the impact of the campaign until 2021. Specifically, our research activity focusses on three over-arching objectives:

- Monitoring awareness and the geographical reach of the campaign across UK schools to examine the national picture at each time point.
- Measuring the impact of the campaign on the profile, quality and quantity of science teaching in primary schools, in particular the average number of hours taught per week by classroom teachers on either a discrete or cross-curricular basis.
- Examining how the campaign is bringing about changes within schools and the nature of the impacts on subject leaders, classroom teachers and on pupils and schools as a whole.

1.2 About this study

In 2017 research was undertaken by CFE and The University of Manchester to examine how science is taught across the UK, including the number of hours it is taught for and attitudes towards science. The 2017 research captured the baseline position from which the outcomes and impacts of the Primary Science Campaign will be determined, and were reported in the *'State of the Nation' report of UK primary science education*[5]. This new report presents findings from the qualitative baseline research and summarises emerging themes from interviews with a cross-section of school staff to explore the reasons behind the *State of the Nation* findings, including what factors affect decisions about science

[4] https://explorify.wellcome.ac.uk/
[5] https://wellcome.ac.uk/sites/default/files/state-of-the-nation-report-of-uk-science-education.pdf

teaching in schools across the UK. Throughout the report, quantitative data from the 2017 research is presented alongside qualitative description to further elucidate the findings and inform the strategic direction of the campaign.

The terminology used to refer to pupils' year groups differs throughout the UK. For consistency, we have adopted the English and Welsh terminology of year groups and key stages throughout the report. The equivalent year groups for Scotland and Northern Ireland are summarised in Table 1 for information:

Table 1: Year groups by country

Age during school year	Key stage	England and Wales	Northern Ireland	Scotland
4-5	Foundation	Reception/Foundation	Year 1/P1	P1
5-6	Key Stage 1	Year 1	Year 2/P2	P2
6-7		Year 2	Year 3/P3	P3
7-8	Key Stage 2	Year 3	Year 4/P4	P4
8-9		Year 4	Year 5/P5	P5
9-10		Year 5	Year 6/P6	P6
10-11		Year 6	Year 7/P7	P7

1.3 Context

Science teaching varies throughout the UK. In England, the National Curriculum dictates the programmes of study year-by-year for Key stages 1 and 2[6]. However, schools can introduce additional content within the relevant key stage and can also extend it. The National Curriculum for science aims to equip young people with: (i) scientific knowledge and conceptual understanding; (ii) an understanding of the nature, processes and methods of science; and (iii) the scientific knowledge required to understand the issues and implications of science.[7] The Early Years Foundation Stage Framework[8] outlines the requirements for Reception pupils with science being delivered through the *Understanding the World* programme on a cross-curricular basis.

The position in Wales is broadly comparable, although the Foundation Phase Framework[9] covers Reception and Key Stage 1 with the National Curriculum for science in Wales[10] adopted at Key Stage 2.[11] This is supported by a non-statutory Skills Framework for 3-19 year olds in Wales to provide guidance and continuity throughout the various stages. In the Foundation Phase, science is similarly taught through *Knowledge and Understanding of the World* which equips children to embrace science. Pupils at Key Stage 2 are then given the opportunity to build on the skills, knowledge and understanding acquired to apply

[6] Excluding academies
[7] Department for Education (2015). *National curriculum in England: science programmes of study. London: DfE.*
[8] Department for Education (2017). *Statutory framework for the early years foundation stage.* London: DfE
[9] Welsh Assembly Government (2015). *Foundation Phase Framework*. Cardiff: Welsh Assembly Government.
[10] The Welsh Curriculum is currently under review.
[11] Welsh Assembly Government (2008). *Science in the National Curriculum for Wales Key Stages 2-4*. Cardiff: Welsh Assembly Government.

science in everyday life, including current issues. Activities should foster creativity and curiosity, and be interesting, enjoyable and relevant to young people.

By contrast, the Curriculum for Excellence in Scotland comprises a broad general education from the early years to age 18. It emphasises inter-disciplinary or cross-curricular learning, skills development and encouraging personal achievement. The curriculum is intended to develop four capacities in all young people: successful learners, confident individuals, responsible citizens and effective contributors.[12]

The position in Northern Ireland is similar, with science forming part of the 'World Around Us' area of learning. The revised Northern Ireland Curriculum covers the Foundation Stage (Years 1 and 2), Key stage 1 (years 3 and 4) and Key Stage 2 (Years 5, 6 and 7), and is set out in six Areas of Learning with science as part of the 'world around us' area. There is an expectation that teachers integrate learning to make relevant connections for children. It is intended that the learning opportunities presented through the Northern Ireland Curriculum help young people to develop cross-curricular skills (which include communication, and using maths and ICT) and thinking skills and personal capabilities. These include: thinking, problem-solving and decision-making; self-management; working with others; and managing information.[13]

As of August 2014, teachers in Scotland have been mandated to engage in professional learning, self-evaluate the learning, and maintain a record of the learning by the General Teaching Council for Scotland as a condition of their registration.[14] This is intended to help maintain and improve the quality of teachers in order to enhance the impact they have on pupils' learning, and provides teachers with a responsibility to consider their development needs and an entitlement to a system of supportive professional review and development. There is no such requirement for teachers in England, Wales and Scotland.

1.4 Method for this study

The data presented in this report was captured via two means:

UK-wide survey of Science Leaders and teachers

A computer-assisted telephone interview of **902** Science Leaders (or other senior leaders where there was either no Science Leader in the school or they were unavailable at the time of interview) was undertaken to obtain data relating to the strategic direction of science. A database of schools in the UK was compiled and a random stratified sample derived to ensure it was representative of the population from which it was derived. The surveys were undertaken between November 2016 and January 2017. This research was undertaken as part of a larger baseline study which included an online survey of 1,010 teachers and 2,444 pupils. The full findings of these surveys were reported in the *'State of the Nation' report of*

[12] Scottish Government: Curriculum for Excellence (Available from: http://www.gov.scot/Topics/Education/Schools/curriculum)
[13] Council for the Curriculum Examinations and Assessment (2007). The Northern Ireland Curriculum Primary. Belfast: CCEA.
[14] The General Teaching Council for Scotland (2014). *Professional Update Guidance Notes*. Edinburgh: GTC Scotland.

UK primary science education designed as baseline research for the Wellcome Primary Science Campaign. Key findings from this study are summarised throughout this report.

Qualitative depth interviews

Qualitative research with a cross-section of schools was undertaken to explore science teaching across the UK and involved interviews with a variety of staff to elicit a range of perspectives including:

- Headteachers or senior leaders Science Leaders or someone with responsibility for leading science in a school (including World Around Us coordinators)
- Teachers with responsibility for teaching science to their classes

Where possible, interviews were undertaken with all participants to facilitate triangulation, although in some instances individuals undertook two roles in a school or other school staff did not wish to participate. Schools were initially selected through the sample of Science Leaders who participated in the baseline survey. This enabled selection on school characteristics and on time spent teaching science and the importance afforded to the subject in a school to ensure diversity in the sample. Schools that had participated in Explorify were removed to ensure this did not skew the baseline qualitative findings. Alternative methods were used to recruit staff in schools to increase the sample of schools interviewed, including working with organisations who support science in schools, directly approaching schools, and working through other alternative networks. Due to the method of recruitment the views of those who took part in depth interviews may not reflect the teacher population as a whole.

In total 50 semi-structured interviews were undertaken with staff in schools during the Spring and Summer terms of 2018 (a full breakdown of interviewees by school is in Appendix 1). Throughout the interviewing period additional questions were added to the topic guide to explore emerging themes. The key characteristics of those responding are outlined below and highlight a mix of different countries and roles in schools. In total 34 schools were represented in the study (16 schools were recruited via contacts who responded to our baseline study). In 11 schools more than 1 interview was undertaken.

Country	Number of interviews		Role	Number of interviews
England	24			
Wales	11		Headteacher	13
Northern Ireland	10		Science Leader	24
Scotland	5		Classroom teacher	13

Analysis

Depth interviews produce a significant volume of qualitative data. For this study, a coding frame was applied to transcripts and cross-checked for consistency using NVivo. This led to the generation of a series of themes on which to build an understanding of the overarching and interlocking issues. Sample attributes were assigned to transcripts based

on the school and individual level characteristics of interviewees to interrogate differences by sub-group. Due to the semi-structured nature of the interviews no inferences can be drawn about the scale or frequency of particular attitudes or opinions. Therefore within the report we have not quantified the number of responses to a particular theme. To aid the reader we have provided an assessment as to the proportion of interviewees who have commented under a given theme; however, please note that other interviewees may also hold this opinion or undertake these activities but did not describe this during the interview.

1.5 About the report

This report presents the findings from the qualitative research. Differences in the findings by role and country have been explored. Following this introduction, the report is structured in three main chapters: **Chapter 2** considers how science is led in a school and the support given to teachers; **Chapter 3** explores what influences the teaching methods and number of hours of teaching undertaken, attitudes towards science and barriers faced; and **Chapter 4** provides the conclusions on the report.

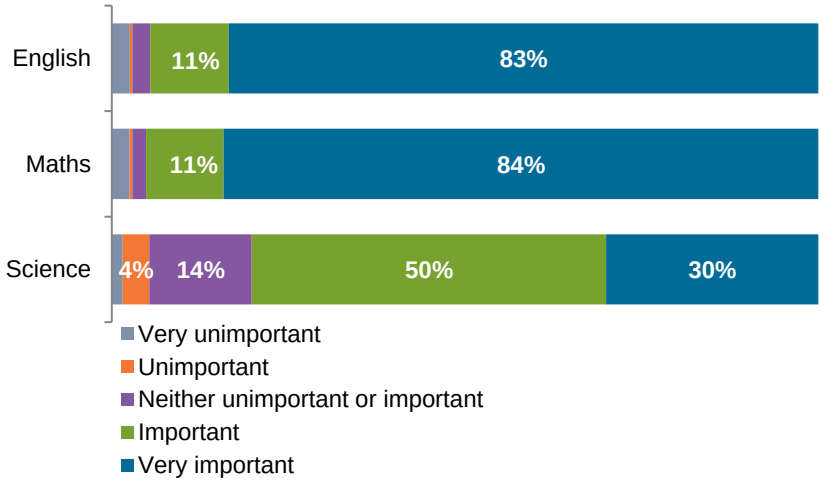
CHAPTER 2. LEADING SCIENCE IN PRIMARY SCHOOLS

This section explores the importance of science in schools and how science is led and prioritised.

2.1 The importance of science

Respondents to the 2017 baseline surveys were asked how important they think certain subjects are to their school's Senior Leadership Team. The majority (95%) state that both English and maths are 'very important' or 'important', whilst only 80% consider that their school views science in the same way. Only one-third (30%) think science is 'very important' compared with 83% for English and 84% for maths. A further 14% state it is 'neither important nor important'.

Figure 1: The perceived importance of subjects in school as reported in the Science Leadership and teaching surveys. Unweighted base=1,905.



Through the depth interviews it was clear that participants believed that science is important, reiterating the findings above. All interviewees believed that science was an important subject for pupils to study at school for a wide variety of reasons. Interviewees highlighted the wide range of skills that were developed through science and how these could be applied within other subjects. They also described how other subjects could be integrated into science. Not only does it allow children to learn thinking and investigation skills, interviewees highlighted the way in which it also can improve literacy and numeracy:

> *"A lot of the skills that the children are learning in other subjects can be put to use in science. It's a really good, practical context for your literacy skills, your maths skills, your technology skills, all of those things come together in science. Children can see why we learn to measure things. When you do this, you need to be able to measure and find out what's happening. Then, to have an understanding of the system and the way things work and why things happen the way they do in the world around them. They're the kind of things that they see happening every day and take for granted."*
>
> — **Science Leader, Scotland**

Interviewees also described that science was important for pupils to enable them to understand the world around them and why things happen. A small number of interviewees also explained the importance of pupils understanding the range of jobs available to them especially in science, technology, engineering and maths (STEM) careers.

Interviewees in Wales also described that science was important as their school used to be held to account through the teacher assessments as part of the Core Subject Indicators (CSI). CSIs measure achievement in English, Welsh, maths and science and was published. However, since 2017 there is no longer a requirement for schools in Wales to publish these results.

Comparing science to other subjects

Respondents had mixed views regarding the importance of science in schools when compared to other subjects. This was also observed within the same school, for example with Headteachers stating 'very important' and others in the school disagreeing. For example, one paired interview, a Headteacher highlighted the importance of science in the school. However, the Science Leader felt that as teaching time was not monitored in the school that science lessons could be dropped if additional classroom time was needed for numeracy or literacy as these subjects remained more important.

Approximately one third of interviewees believed that science has equal importance with English and maths in their school.

> *"I would put it up there with English and maths, for me it's a core subject because it straddles English and maths. It's combined skills and it's particularly important in thinking skills."*
>
> — **Science Leader, England**

The remaining interviewees reported that science was of lower importance when compared to English and maths. This reflects the baseline survey findings whereby 30% of participants report that science is very important in their school compared with 83% for English and 84% for maths.

> *"Definitely maths and English, there will be more time spent on that. At the end of the day if they can't read they can't partake in their science experiments, they need to have a firm grasp of the concept of numbers."*
>
> — **Science Leader, Northern Ireland**

When comparing science to the other subjects taught in school there were mixed views as to whether science was equally or more important. Approximately half of interviewees believe that science ranks as the third most important subject in schools (behind English and maths, and the Welsh language in some Welsh schools) but above all other subjects. In a few instances this was seen as equal to PE and/or ICT but still above other subjects.

> *"It sits below literacy and numeracy and it sits above everything else, with the possible exception of PE. PE gets the same amount of time as science, and then also there's that massive government expenditure on PE that's making it rise even further."*
>
> — **Headteacher, England**

The remaining interviewees described how science was on par with the other subjects taught in a school (often excluding English and maths). They describe how all subjects are important in the curriculum and that all should receive adequate time and attention in a school.

> *"Maths, literacy, science, ICT, the creative subjects, they're all just as important as each other… Children have different strengths in different areas, if you only teach one because that's what you think is important, you end up turning children off education."*
>
> — **Headteacher, England**

Influences on the importance of science

When exploring the importance of science in a school, interviewees reported a variety of different influences. The passion of a Headteacher or Science Leader in science was often seen as pivotal in raising its importance across the school. Having someone who is either dedicated or passionate about science ensures that the school continues to prioritise this subject within the school, especially when there are so many competing pressures and the variety of subjects taught in a school are so broad.

> *"I think our Science Leader is very strong, she's part of the senior management. So, I think she also pushes that. I think our school leadership have decided that it is a priority."*
>
> — **Teacher, England**

> *"If I didn't have an interest in science and keep pressing for it to be high priority and try to get my spokes in, it wouldn't be placed high up on the school's development plan. You very much need the support of the principal and senior staff and management team to have that high priority in the school."*
>
> — **Science Leader, Northern Ireland**

Another influence reported by interviewees in Welsh schools was the teacher assessment of science (as part of the CSI) and how this ensures science is seen as a priority. However, it is necessary to restate the fact that this form of assessment should not be considered as a formal assessment process such as SATs[15][16]. In countries where science is no longer externally assessed, this was reported as a reason for the *reduction* in the importance of science as a priority. Some interviewees therefore suggested that the role of science could potentially change through organisations such as Ofsted[17] monitoring science in primary schools and still expecting to see an adequate amount of time spent on science as part of the curriculum.

Another potential influence are the pupils themselves. Some teachers are sometimes driven by wanting to ensure that pupils find science lessons (or all lessons) interesting with science providing opportunities for practical outdoor learning which pupils enjoy.

2.2 Science Leadership in schools

Respondents to the baseline science leadership survey were asked if there was a Science Leader in their school. This is an individual who is responsible for leading science development and teaching in schools either as an individual subject or cross-curricular topic area. In the UK nine out of ten (91%) schools report having a Science Leader. This role is more common in English schools with 95% indicating that there is a nominated Science Leader compared to 88% in Wales, 82% in Northern Ireland and 54% in Scotland. Over four-fifths (86%) of Science Leaders in UK schools are also classroom teachers.

Release time

Just over half (51%) of Science Leaders across the UK get specific release time to lead science in addition to time to plan their own lessons. One-third (30%) of Science Leaders in receipt of release time take 10 hours or less a year and a similar proportion (32%) take between 11 and 20 hours (science leadership survey). The interviews that were conducted with Science Leaders reflect these findings. Of those interviewees that indicted they did receive release time, few receive a formal allocation. Others indicated that they could access ad-hoc time if requested for a specific task or training opportunity to lead science.

> *"If I need it I get it… if I said 'look, I need a day cover to prepare it' if it's something new and I need a day to cover it, I'll get that, it wouldn't be a problem"*
>
> — **Science Leader, Northern Ireland**

[15] National curriculum assessments: key stage 1 and key stage 2 tests know as SATs
[16] https://beta.gov.wales/education-amendments-relating-teacher-assessment-information-wales-regulations-2018
[17] Ofsted is the Office for Standards in Education, Children's Services and Skills which is responsible for inspecting and regulating services that provide education and skills for learners.

Two-thirds of Science Leader interviewees report not receiving any release time for their role. They frequently report using their PPA (planning, preparation and assessment) time or undertaking work in the evenings or weekends:

> *"Budget has been another issue with that. In the past I might have got, maybe a day to do something, maybe once every couple of terms. Not now. It does make a difference, makes things harder. I have a number of roles within the school. A lot of times it is done during your weekends, holidays."*
>
> — **Science Leader, Northern Ireland**

Another interviewee reported how they used time allocated to them as part of being on the Senior Leadership Team to assist them in delivering their Science Leader role. A classroom teacher who was not a senior leader highlighted the difficulties of not having time:

> *"I'm a classroom teacher full-time, so I don't wander the corridors. An SLT is regular in the corridors, popping in and seeing what's going on. I haven't got the time to do that right now and I think people are very aware of that. I know I need to observe lessons, it's just very tricky to get the time to do that."*
>
> — **Science Leader, England**

Science Leaders reported that they would benefit from having additional time to do their role either through reducing the time they spend out of hours working or to allow them to fully lead science in their school. Although not explicitly asked, one Headteacher reported how they would like to increase the importance placed on the Science Leader role to enable them the time to become a subject expert:

> *"Schools can only generally afford to give that sort of money for the people that are leading English and maths, and we're no different… I would love to get to the point where all subject leaders are told, 'We value that role as a subject leader. You will be paid a TLR[18], and we will give you time to do that role and execute those responsibilities well in the time you've got in school.' At the moment, subject leaders, especially for foundation subjects like geography, they get no money, no time, they're supposed to do it after school… Subject leadership, for some we want to be the end goal. We want subject specialists[19] that understand their subjects inside out, understand how they should be taught, believe in what the research tells them about how they should be taught, and be able to execute that daily for their classes as well as across the school."*
>
> — **Headteacher, England**

Another Headteacher spoke about the importance of having a dedicated Science Leader and giving them the responsibility and time to develop science teaching and activities in the school. This has allowed the Science Leader to drive up the importance of science in the

[18] A TLR is a Teaching and Learning Responsibility payment which can be awarded to teachers who take on extra responsibility
[19] For a definition of a Science Leader see Wellcome Trust (2017), Defining Primary Science Expertise https://wellcome.ac.uk/sites/default/files/defining-primary-science-expertise.pdf

school and has been aligned with other activities in the school. The Science Leader recently organised a science week for the whole school, where everyone got involved in science learning. The week-long campaign also incorporated Sport Relief, which was an opportunity to educate everyone on how the body works.

Role of a Science Leader

The role a Science Leader plays in a school varies considerably across schools. This is influenced by the time they have available to do the role, the level of involvement in science by the headteacher, the size of the school, the confidence of teachers in the school to deliver science teaching and the interpretation of the role itself. In a small number of schools the Science Leader role is relatively new or is evolving.

The most common roles that Science Leaders perform include:

— Ensuring delivery of the full curriculum across the whole school and across year groups, and helping teachers to review their planning.

> *"What I try to ensure as the coordinator is that there's progression from P1 through to P7. So, the children can experience a full range of the curriculum… I look at the term planning and the scheme."*
>
> — **Science Leader, Northern Ireland**

— Organise and share resources to teach science with teachers in the school – this most commonly includes sourcing science equipment and electronic resources. In a couple of examples this has also included creating packs that include all the resources needed to run an investigation or enquiry. This is to assist with lesson planning and reduce the time needed by teachers to organise resources.

> *"Building little packs to enable staff to go out [with pupils] and study pond life, minibeasts or insect life. I put together eight or nine different packs so the staff can pick up these packs and go off and do a minibeast or insect study [with their class]."*
>
> — **Science Leader, England**

— Provide one-to-one advice and support to teachers in science. As part of this some Science Leaders also report modelling lessons for teachers.

> *"Because I'm leader, I'm the first point of contact to ask any questions. They ask 'What should I do here?', 'How should I introduce this?', 'What should I do about this subject?' and so forth, I look for resources and aid them on how to implement an experiment."*
>
> — **Science Leader, Wales**

— Facilitating the sharing of information, either by the Science Leader undertaking research and then sharing this with staff, sharing their own knowledge, or organising staff meetings where staff can support each other. There are also examples of Science Leaders delivering staff training sessions for groups of teachers.

— Monitoring and providing feedback on the teaching of science through lesson observations, examining pupils' books, talking to pupils about science lessons and undertaking audits of staff skills within the school.

> *"I look at the progress being made by pupils to check they're still on track and making good progress. I write the schemes of work in regards to science teaching [to cover examination levels] from level two up to level five to ensure the pupils have the correct provision. I attend moderation to work with the other schools in the cluster."*
>
> — **Science Leader, Wales**

— Engaging with external organisations and individuals to bring expertise into the school on specific aspects of the curriculum. As well as providing specialised knowledge to pupils, external organisations often are able to bring in specialised equipment (e.g. when studying planets) to enhance the quality of the experience which the school would not have been able to access otherwise.

— Identifying and sharing science CPD opportunities for teachers, or attending science CPD sessions and cascading the learning to colleagues.

Those Science Leaders in Northern Ireland are typically the World Around Us Co-ordinator, responsible for the entire World Around Us curriculum, although during interviews there were some instances in which this was not the case and this was a standalone Science Leader role.

Headteachers report different levels of involvement with science. A small number reported being the Science Leader themselves although most had a Science Leader within their school. Headteachers (who were not Science Leaders) have a varying degree of involvement in science within their school with some regularly meeting with their subject leaders or checking lesson/curriculum coverage themselves. Others design the overall curriculum for the school with the Science Leader being responsible for implementation and delivery.

> *"I meet with all of my subject leads every fortnight… I want them to be able to evaluate what the need is within their subjects… I want them to make those judgements about that element of self-evaluation and then for them to make judgements about what is needed to be done… The support which I think is the most powerful is the support she gets by having access to me and other senior leaders to ask, enquire and check if she wants to"*
>
> — **Headteacher, England**

> *"It starts off with me. Everything gets trickled down for our senior leadership team and myself and my deputy. We all sit and work things out and outline our vision for how we want planning to be created, how we want lessons taught, what we want children to achieve at the end of it. That information gets filtered down to the staff and curriculum leaders. We then hand over responsibility to monitor and evaluate it and report back. We talk directly to the teachers… We give people accountability as well as giving them some empowerment for the decision making. The vision is ours, but how they get to that vision is up to them. That's how we empower our staff.*
>
> — **Headteacher, England**

Science CPD for Science Leaders

In the science leadership survey just over half (52%) of all Science Leaders state they had undertaken external CPD lasting one day or more to help them lead or develop science throughout their school. During the interviews only a small number of Science Leaders reported they had recently undertaken Science Leadership training. Around half of Science Leaders interviewed reported they had undertaken Science Leadership training at some point in their career but not for a long time. About one-quarter of Science Leaders reported they had undertaken no Science Leadership training throughout their career.

> *"I feel like if the school had enough money to send me on courses, that would be fine and I'm sure I would have been sent on one straightaway if that was the case. I appreciate that isn't the situation…I don't feel like I know what I'm doing, I just feel like I'm kind of winging it and it's going okay so far, you know?… For me it's not so much subject knowledge, its managing people. That's the bit that's the most tricky."*
>
> — **Science Leader, England**

When asked what the Science Leadership training included many were unable to recall the content of the training or the impact this had on their role. A small number of those receiving training described the training as more focused on teaching science rather than leadership of the subject. A minority also described how they had undertaken training in science as part of their degree or teacher training alongside generic leadership training (for example for middle leaders).

> *"My training is that I'm a Biology graduate with my PGCE in teaching. I am a science trained teacher, I've been on a middle manager course."*
>
> — **Science Leader, England**

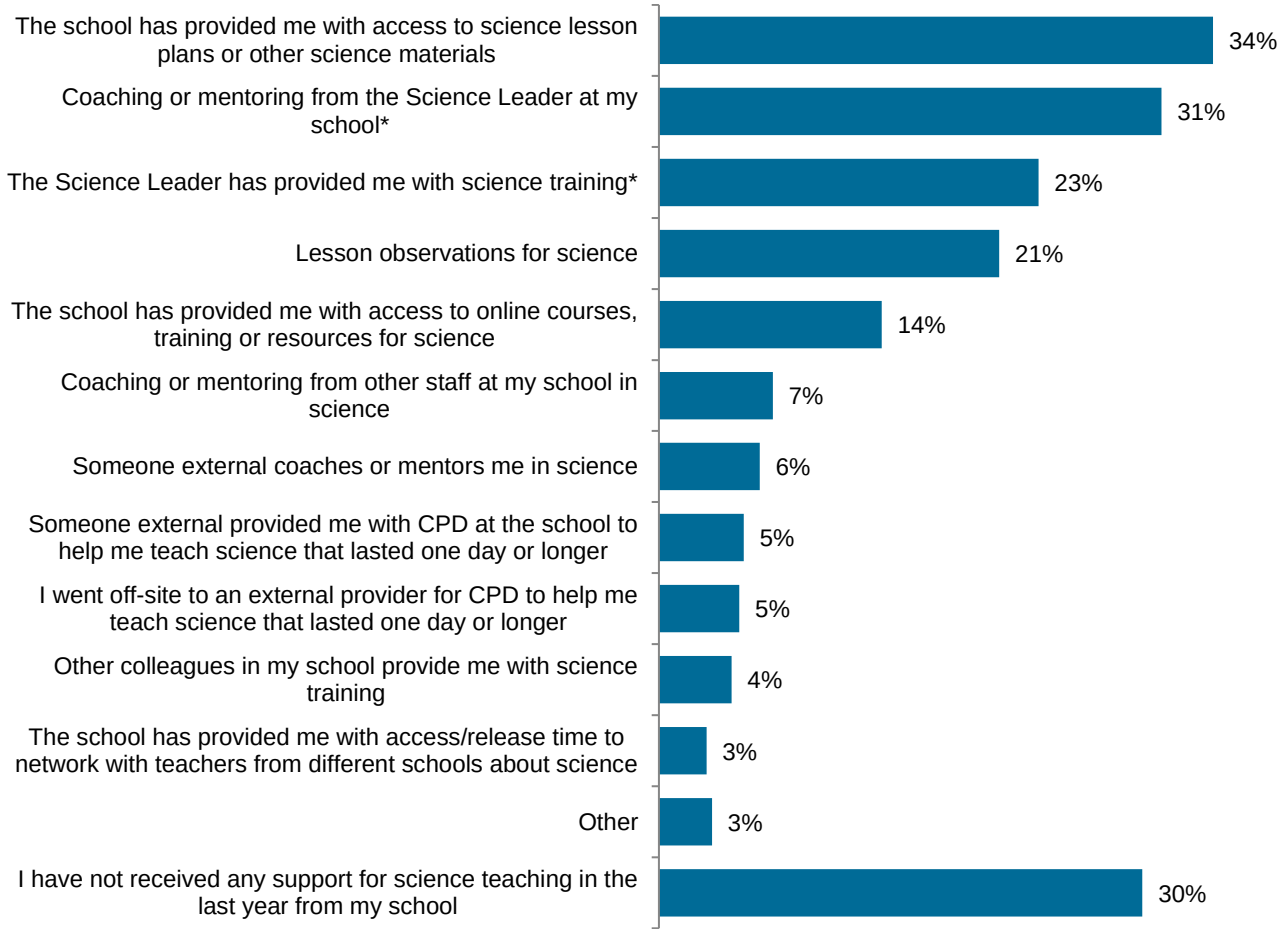
Examples of the outcomes from this training include: increasing the understanding of the science curriculum and assessment, more widespread use of science investigations within the school and an increased ability to challenge more able pupils, and being able to better lead science in the school.

> *"I did a one year Primary Science Specialist course [funded through an ENTHUSE award]… It made you look at how you were teaching, how the other staff were teaching within the school… It was just, it was an overhaul of the way that I was looking at science. It made me more aware of the other staffs' needs. It's always nice to meet with other people and have new ideas."*
>
> — **Science Leader, England**

Support to teach science

Respondents to the baseline teaching survey were asked to state what support their school had given them to improve their science teaching in the last 12 months. The most frequently cited support was: providing access to lesson plans and materials (34%), coaching or mentoring from their Science Leader (31%), science training from their Science Leader (23%), and lesson observations (21%). Just under one-third (30%) had not received any support.

Figure 2: Support received to improve science teaching in the last 12 months as reported in the teaching survey (excluding Science Leaders). Unweighted base=833, those with a * base =723.



Many of the areas reported above were highlighted earlier in chapter 2. This again highlights the variety of support provided to teachers in schools. In interviews almost all teachers reported they had either received support or knew who to ask if it was needed. Matched interviews in schools were also consistent with the supportive remit of the Science Leader (i.e. to share knowledge and ask for support). Only one teacher reported

not receiving support although again highlighted the challenge of the Science Leader not receiving release time from their role:

> *"With the development of subject leaders, I guess, it's hoped that we will be supported, but at the moment I wouldn't really say we are… they haven't done anything. There's been no direct science activity in terms of a staff meeting or anything… having a subject coordinator is above and beyond, so if you do need day-to-day stuff and you're not given release time to do it, some people might be a little bit reluctant to do extra in their own time when actually they didn't really want to be that anyway."*
>
> — **Teacher, England**

The responses from teachers about how their school supports them to teach science mirror the interviews with the Science Leaders. Interviewees frequently highlighted that they could ask the Science Leader for support when required.

> *"I've got the science coordinator, he's very supportive, and if I've ever got questions or concerns, or I'm a bit unsure, he'll sit and go through them with me. I know I can speak to any of the other teachers for ideas or help, or knowledge, or resources."*
>
> — **Teacher, England**

In a small number of instances (teacher) interviewees also report drawing on the support of other teachers in their school or other schools.

> *"The head's very good at supporting us. Considering she's the head of three schools, she's brilliant… We actually bring all the books down to staff meetings, so the three schools can see our books. We have a look at our science books and discuss good practice as well, as a federation[20], before we go to the high-schools to take our work… Before we were a federation, I was up here on my own. I was left on my own to teach all subjects. I had no support, nobody to bounce ideas off. Since being a federation, the last six or seven years, we've got more of a support system in place."*
>
> — **Teacher, Wales**

Some Science Leader interviewees (and one teacher) indicated the positive impact of having the support of a teaching assistant. This was valued particularly as an additional resource to aid in setting up classrooms for practical investigations.

External training

As with Science Leaders we found little evidence of teachers having undertaken recent science training. Most teachers reported receiving training at some point throughout their career, but many spoke of cuts in funding or a lack of courses which has led to them not recently receiving training, which reflects the findings from the baseline survey.

[20] A federation is where there is a single governing body governing more than one school.

> *"Not for a number of years, there used to be lots of training available when our county council had the educational advisors. Now we don't have those science advisors available, so there's little available now."*
>
> — **Headteacher, Wales**

> *"We don't get sent out on any courses. The Science Leader possibly does but as staff we don't. The Science Lead does deliver staff meetings. Often she'll focus on scientific inquiry and how to develop those skills as opposed to science knowledge."*
>
> — **Teacher, England**

Where Science Leaders did undertake recent science training they indicated that they cascaded their learning to teachers through internal CPD, staff meetings or one-to-one support which was reiterated by teachers.

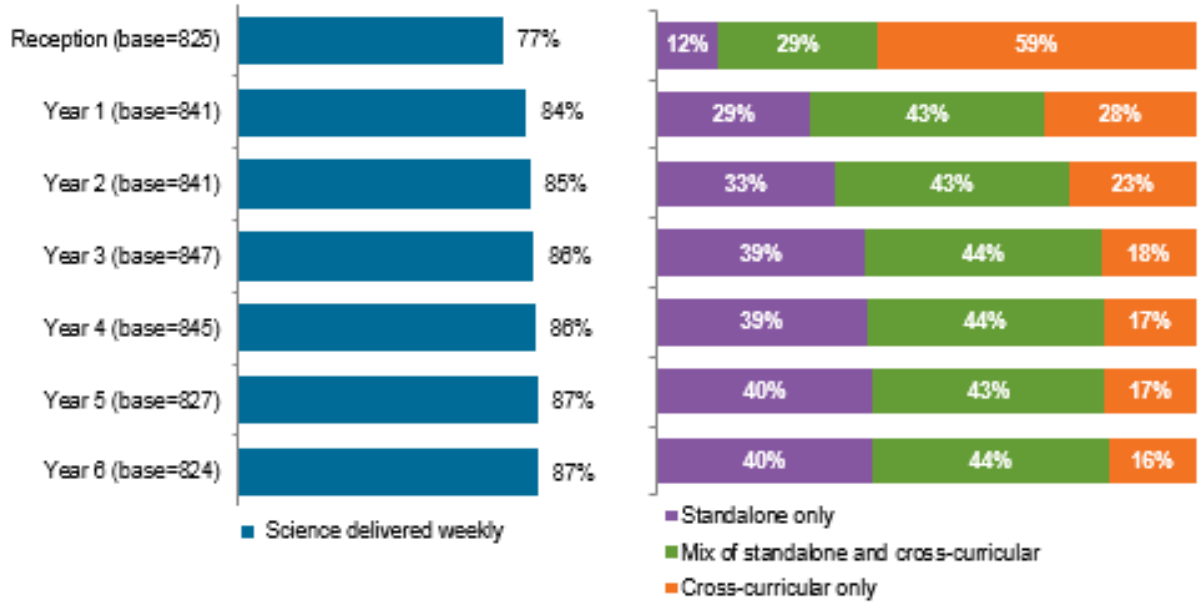
CHAPTER 3. THE DELIVERY OF SCIENCE

This section explores how science is taught in UK primary schools. It examines the overall delivery model and hours of teaching by year group.

3.1 Weekly science teaching

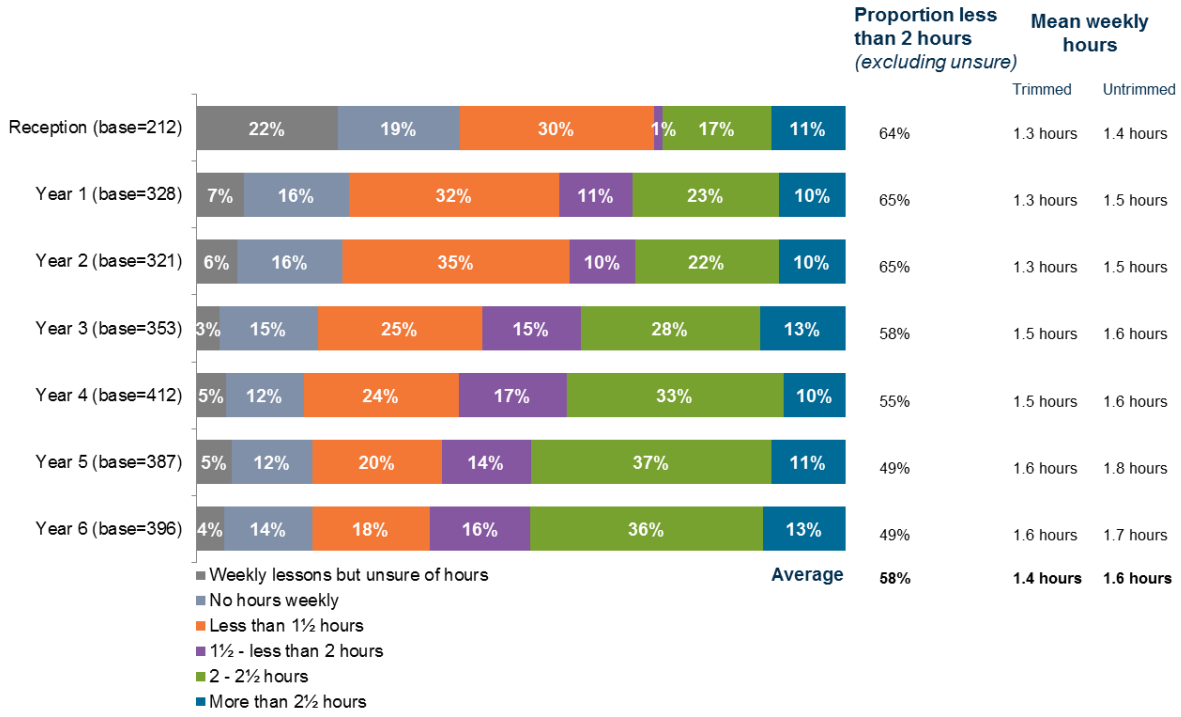
Respondents to the science leadership survey were asked whether their school taught science weekly either as an individual subject or as part of cross-curricular work. Across UK schools a high proportion of year groups are taught science weekly; this is more common in Years 1-6 when compared to Reception. Standalone lessons are more prevalent for older year groups with younger pupils (especially Reception) more likely to receive cross-curricular work.

Figure 3: Weekly science delivery by year group and mode of delivery as reported in the science leadership survey



Those participants (in the science leadership and teaching surveys) who taught science weekly as either standalone lessons or as part of cross-curricular work were asked how many hours of science they teach each week. On average, science is taught in this way weekly for 1.4 hours a week (1 hour and 24 minutes) and 58% of classes receive less than 2 hours a week. Younger year groups received fewer hours of weekly lessons with the amount of science taught increasing as pupils become older.

Figure 4: Hours of weekly science delivery by year group as reported in the science leadership and teaching surveys[21]



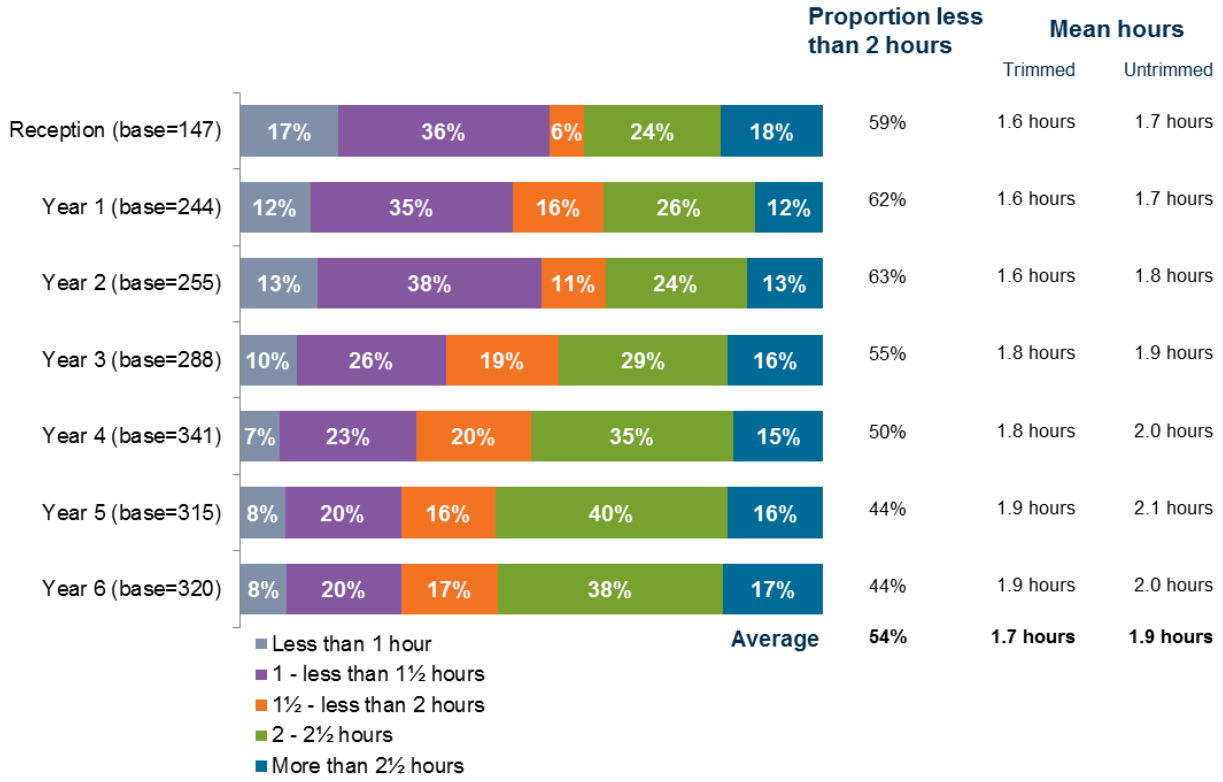
3.2 Hours teaching science

Science is taught across the school year in a wide variety of ways. The majority of schools (during the science leadership and teacher surveys) report how they teach some form of science weekly, although most combine this with other types of activity such as dedicated science weeks, science days and visits. Combining data from the science leadership and teacher surveys on these various methods, on average pupils across all year groups receive between 1.6 and 1.9 hours of science a week[22]. On average, science is taught for 1.7 hours a week (1 hour and 42 minutes). The mean hours taught each week show that Key Stage 2 pupils receive a slightly higher number of hours of science than Key Stage 1 pupils.

[21] A trimmed mean at 5% was used to calculate these figures. This excludes 5% of responses in the sample (2.5% of cases from the lower end of the scale and 2.5% from the higher end of the scale) to prevent the mean being skewed by schools with extremely high or low figures. This ensures that the mean more accurately reflects the majority of schools in the sample. This analysis could not be split by country due to low base sizes.

[22] This was averaged across 39 weeks a year.

Figure 5: Average number of hours of science delivery per week by year group as reported in the Science Leadership and teaching surveys



The findings from interviews conducted with Headteachers, Science Leaders and teachers reflect this baseline data. Half of all interviewees report allocating approximately two hours or more to science teaching a week. The remaining interviewees report either less than two hours a week or are unable to estimate the time as there is either no set time allocated to science or due to the cross-curricular nature of their topic work.

> *"For the younger ones, they're involved in practical science all the time, even though it might not be timetabled as such. When they're doing exploratory play and things like that, they're constantly floating, sinking, filling, pouring, capacity, all those kind of things. They learn about mixtures when painting. There's a massive amount of science that they're actually doing without us actually saying, 'Right, this is your half hour of science this week.' It's difficult to put a figure on it."*
>
> — **Science Leader, Scotland**

Within some schools, teachers and Science Leaders report that slightly less time is spent on science in Key Stage 1 when compared to Key Stage 2. Interviews with teachers indicate that additional time is added into science lessons to allow them to plan and write up their investigations. This may explain the slight increase in time allocated to older year groups in the baseline study.

> *"Our Headteacher has instructed that Wednesday afternoons, two hours for key stage two, an hour and a half for key stage one and foundation, are specifically for the teaching of science."*
>
> — **Science Leader, Northern Ireland**

However, across schools there was evidence that where hours of science delivery are specified or timetabled, there remains a large degree of flexibility in how much, when, and how science is delivered. It is therefore not necessarily the case that an individual teacher or school will deliver science exactly as timetabled.

> *"Strictly speaking, officially, on the timetable it is one afternoon, which would translate to two hours* [for Key Stage 2] *... Key Stage 1 will probably have an hour, hour and a half ... This week I've had a whole day in year five for science, and one and half days in year three."*
>
> — **Science Leader, England**

> *"I give a guide but then it's up to the members of staff, they have the freedom to take it where they want to take it. I've always said to them if a lesson's going well, don't stop and think, 'My hour's up.' If the children are with it, go with it, get their experience, get them excited, and work with it."*
>
> — **Headteacher, Wales**

> *"That's hard to say for science, because there's no set time to do it. You integrate it into each thing you're doing. For example, we had a lot of snow last week, so all our literacy and numeracy was taken through measuring the depth of snow, and where it drifted. Our entire curriculum was science-based last week, but we may not do it again for another month."*
>
> — **Headteacher, Scotland**

Influences on the time spent teaching science

Directed by the school

Across almost all schools in England and Wales the amount of time that is spent teaching science is usually decided at a whole school level; either the Headteacher or Science Leader has specified the number of hours that it should be taught each week. This can be dependent on the passion and drive of the individual Headteacher or Science Leader and the importance placed on science.

The amount of time allocated to science is often influenced by science being taught as a standalone subject in England and Wales and overall leads to a higher number of hours being taught. In the science leadership and teacher baseline survey, on average across all year groups, science was taught for 1 hour 48 minutes per week in England and 1 hour 42 minutes in Wales compared with 1 hour 24 minutes in Scotland and 1 hour and 6 minutes in Northern Ireland. Within Northern Ireland and Scotland the interviews suggest that the time spent teaching science is often decided at the teacher level. Sometimes the Science Leader tries to check how much science is being taught within topic areas or blocks but in other instances this does not happen, or as indicated above is difficult to quantify.

Cross-curricular work

Interviewees were asked to describe the impact that cross-curricular teaching of science has on the amount of science taught. There were split views about the impact this had, with some highlighting how they thought it reduced the time spent teaching science whereas others thought it had increased it, or at least had no detrimental impact.

Where cross-curricular teaching worked well, interviewees described how it allowed them to cover more than one topic/subject area at a time increasing the time that was spent on a subject and allowing links across subjects to be made.

> *"Especially lower down the school, it's all cross curricular based, so they link it in with topics to draw those parallels to other subjects and create a web of knowledge rather than just a line of science and a line of English. It's so interlinked."*
>
> — **Headteacher, England**

Interviewees from Scotland and Northern Ireland highlight that the greater flexibility provided to teachers through teaching science as part of the World Around Us presents a risk in the number of hours of science taught. Those who are passionate about science might focus more on science that someone who is more confident or passionate about history or geography.

> *"Some topics are more history-based, but then some topics are science-based, as well… but a good teacher will turn any topic into a science lesson. Again, if you're not interested, you just leave it out… we have a push through science week, but some people don't do science at all, or very little. They just pay lip service to it."*
>
> — **Teacher, Northern Ireland**

> *"I probably do more than would normally be the case, because it's my specialism. Instead of it being a once a week drop-in, it's integrated across my curriculum."*
>
> — **Headteacher, Scotland**

There were examples across schools where science was successfully integrated into other subjects alongside being taught as a standalone subject or through topic work. One Headteacher spoke about how, alongside teaching science as a standalone subject, they merge aspects of science learning into other subjects. They do this by planning at the beginning of each academic year which topics teachers should cover each week. The Headteacher gave one example where recently the main topic was literacy. This included scientific writing and was done in addition to the two hours a week spent for science teaching. Overall, this helps the school to achieve a broad and balanced curriculum.

Interviewees described the opportunities that pupils had in developing their literacy and numeracy skills within science lessons. In some instances, teachers were able to deliver further science learning through English and maths lessons. Teaching science could also improve literacy and numeracy skills and in some instances English and maths lessons

were used to write up parts of an investigation such as creating a graph of their results. As one Science Leader describes below they wanted to write up science investigations in a dedicated maths class as it combines the two subjects:

> *"Some things I try to make them more cross-curricular, sometimes I'm trying to teach them to do a bar graph and although that's part of the science assessment I'm saying 'can we not do that in maths classes?'"*
>
> — **Science Leader, Wales**

There were however a small number of examples where interviewees had reduced the practical nature of some science lessons to try and teach more English and maths. This highlights that although science is still being taught the quality of that lesson may change.

> *"What you get now is the literacy and numeracy people coming in and saying, 'You can raise your literacy targets by infusing more literacy into your World Around Us'. Instead of doing an investigation, we'll do a comprehension based on the topic, or we'll do a piece of writing based on the topic, or we'll do a piece of maths based on the topic. That's at the exclusion of a good piece of science. Between the subject itself being diluted, and then people trying to raise literacy and numeracy through that subject, the amount of content that's actually being delivered is reduced."*
>
> — **Teacher, Northern Ireland**

Curriculum and assessment

As with the example quoted above, there were examples throughout the interviews where the importance placed on English and maths was seen to be detrimental to the delivery of science teaching.

> *"That was the guidance we were given to try and keep two hours of science at least within our curriculum… there are so many extra pressures now with particularly English and maths, and trying to improve standards on that, it has impacted finding that time."*
>
> — **Science Leader, England**

In England the formal assessment of English and maths, and the examinations that go with these can lead to instances where science teaching is cancelled. Other assessments such as Transfer Tests (in Northern Ireland) and teacher assessments for other subjects also led to this.

> *"If I was just classroom teaching other things come in and maybe science would be pushed to the side… If you've got pressure to finish a task in language or maths, 'Oh, we'll finish it this afternoon' when I should be doing science."*
>
> — **Science Leader, Wales**

This was seen as less of a problem in Wales as science is included alongside English and maths within the CSI assessment process so is still viewed as important (and until recently there was a requirement for this to be published for each school), although English and

maths was still sometimes seen as the priority. A small number of interviewees outside of Wales also highlighted how the teacher assessment of science in their school led to its importance being raised[23].

> *"In Wales it's equal anyway, because we are a core subject. So, we've got Maths, science and English and Welsh as core subjects in Wales. It's measured in our standards, so, our school's performance is measured on pupils' standards in science."*
>
> — **Headteacher, Wales**

> *"We try and give a little bit more time than we would to history and geography, and things like that, because we don't formally assess those every half term."*
>
> — **Science Leader, England**

The removal of science from formal assessments in England and Wales (SATs) was also referred to as reducing the importance placed on it as a subject

A number of interviewees across the UK outlined that curriculum content dictated the amount of science that was taught with views that this was either positive (due to the varied content they needed to cover) or negative as very little was specified. Within Welsh schools the number of hours of science undertaken was influenced by the Welsh Government's new recommendation of 2 hours or more a week outlined in 2017.[24]

Other factors

A wide range of other factors were reported by one or two interviewees as to what influences teaching time in their school (areas reported as barriers are explored further in this chapter):

— School inspections and what they expect to see in a school

> *"There's a shift in Ofsted, where less so they're looking at outcomes for English and maths and more so now looking at curriculum design and breadth. We make sure we're teaching all of the subjects. In our Year 5 and Year 6 next year, we'll be moving away from topic-based curriculum and looking more at teaching discrete subjects."*
>
> — **Headteacher, England**

— Science materials and equipment available to teach topic areas can reduce or increase teaching time

— Pupil-led classes where topics of interest are directed by pupil choice can influence the ability to teach science (dependent on the topic chosen)

— Positive support from governors

[23] Within England teacher assessment of Science is required. However this was infrequently referred to during the interviews.
[24] Estyn (2017) Science and design and technology at key stage 2: https://www.estyn.gov.wales/sites/default/files/documents/Science%20and%20design%20and%20technology%20%28004%29.pdf

> *"There's a really good level of support from governors, the chair of governors is an ex-secondary science teacher, and her husband literally was a rocket scientist. When she retired she used to come in and help in the school."*
>
> — **Headteacher, England**

Broad and balanced curriculum

Interviewees were asked to reflect on the subjects they teach and highlight if overall they thought they were delivering a broad and balanced curriculum to pupils. Interviewees for the most part felt that they did deliver a broad and balanced curriculum *within* the current constraints placed on them. However, this was strongly caveated by the constraints of the importance given to other subjects and the wide variety of subjects in the curriculum.

> *"I think our curriculum as a whole is broad and balanced but I couldn't be sure we're covering the essential science we need to. Certainly, from speaking to grammar school teachers, the knowledge and the content they would have been used to Year 8s (11 year olds) knowing isn't there but our pupils are gaining experiences in other things too that wouldn't have been available under the old curriculum, specifically within science."*
>
> — **Headteacher, Northern Ireland**

A small proportion also reported that they did not have a balanced curriculum due to not enough time being dedicated to teach science or competing priorities.

> *"No, not at all because it negates the children that might not excel in literacy, but might have that logical, systematic way of thinking… It's always the ones that might not be as academic in maths and literacy that might have to do the extra work that miss the science lesson because of the targets of SATs. Sometimes they miss out on those things they're genuinely interested in."*
>
> — **Teacher, England**

3.3 How science is taught

Almost universally interviewees indicated that teachers make the final decision for methods of delivering science teaching. Headteachers and Science Leaders acknowledge that there are different teaching methods, and most make a conscious decision to allow teachers to teach in their own way.

> *"Different teachers won't necessarily teach in the same way as I would. It's not how you get there that's important. I don't want my teachers to be clones of each other. I want them to use good practice."*
>
> — **Headteacher, England**

Teachers agree that they are given autonomy over delivery methods, and in practice use the Science Leaders, colleagues, any whole school plans or the curriculum to help them determine the best approach.

> *"Teacher level, really. Everyone's given the autonomy to take that subject and interpret it how they want to deliver it."*
>
> — **Teacher, England**

> *"It's a mixture. Sometimes if I'm not sure I will speak to our coordinator and say, 'I want to do this, this is what I'm thinking, will that work?' Sometimes I'll talk to other teachers who've taught Year 3 and 4, not just in this school, but some of my friends are teachers, so we pass ideas backwards and forwards, and talk about what has and hasn't worked for the different subject areas."*
>
> — **Teacher, England**

The only exceptions to teacher-led methods were where Science Leaders required teaching quality to be improved amongst teachers. In these instances, the Science Leader provided a range of supportive activities for example providing lesson plans and one-to-one support. One Headteacher stated:

> *"We went through the toolkit that a teacher would have and how to structure lessons. Teachers have had lessons 'taught to them'. When I've seen someone teach a particularly good lesson, the teacher then replicated that in the staff meeting and taught the staff like they were in the class, but was able to come out of character to go through things like, 'This is why I'm doing this at this point. This is what this has done. This is the work the children produced.'"*
>
> — **Headteacher, England**

One Science Leader talked about an audit they undertook on the teaching of all subjects at the school. The audit revealed that the teaching of science was the most underdeveloped in the school – where teachers were not covering all aspects of the curriculum. As a result, the Science Leader took time to work with colleagues by observing lessons and providing feedback. They also conducted hands-on practical experiments, to give teachers a better understanding of the subject and developed guidance on how to undertake a practical lesson from how to introduce a concept through to how it is recorded. This all helped teachers to improve how they incorporate science into their lesson plans. The added benefit of this work was that the school began to teach science in a more consistent way.

A couple of interviewees also described including pupil discussion when making decisions about science teaching, asking pupils what they want to study. There were also examples where teachers explored a topic area with pupils and assessed their level of knowledge and then planned the lesson content either on the spot or following this first lesson.

Approximately two-thirds of interviewees describe how the topic areas and content for lessons is dictated by the curriculum or the school-level planning. This was not the case where lessons were topic based and the science content was at the discretion of teachers (usually within Northern Ireland or Scotland). In some schools this was coordinated across the school to ensure that science topics were not repeated in different years with other areas being missed. As with teaching hours, some interviewees described how sometimes

the decisions made by individual teachers were influenced by their understanding, interest and confidence.

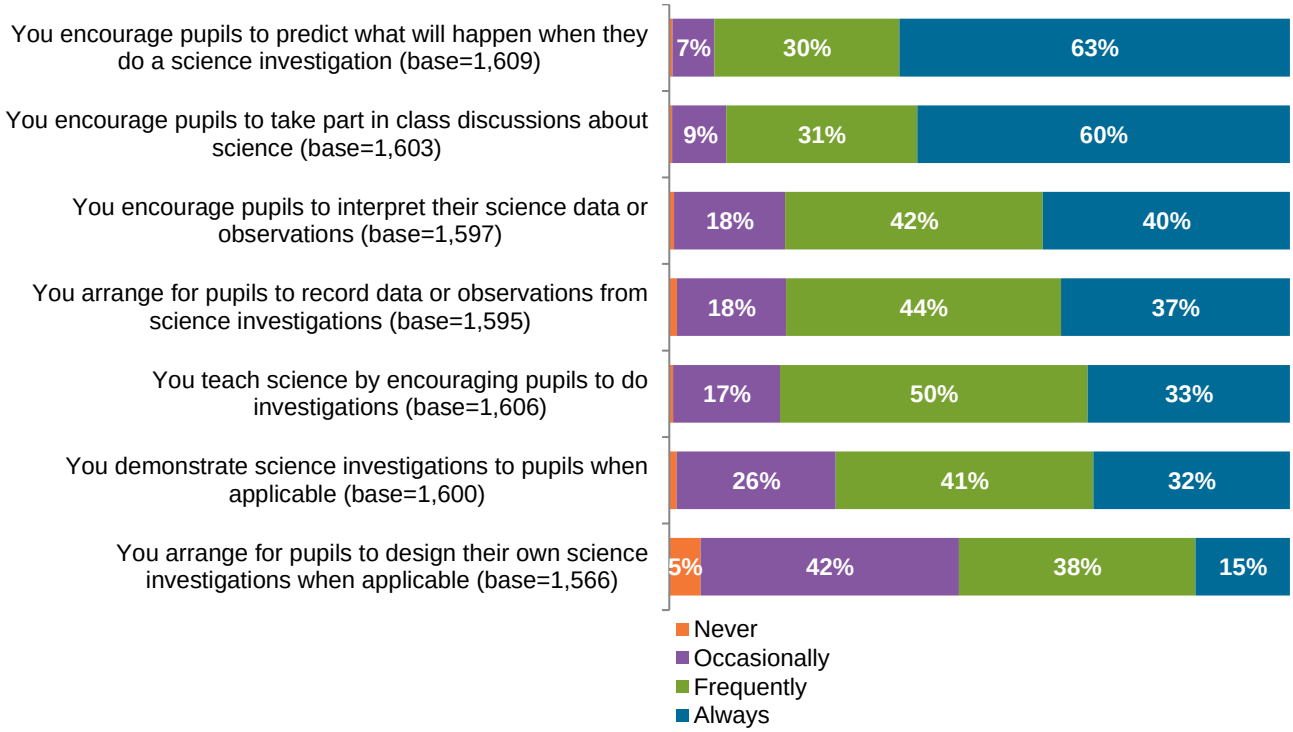
> *"The strands of science should be taught at different year groups and it would be up to the individual teachers themselves to do it. If a teacher's not interested in science or competent, it's very easy for science to be on the back burner."*
>
> — **Teacher, Northern Ireland**

Within a small number of schools, the amount of practical investigations required to be undertaken within classes is specified to ensure practical investigations are undertaken across the school. There are also examples of whole school science activities that are undertaken whereby methods and/or activities are specified. For example, one interviewee wanted their pupils to develop investigation skills in an imaginative way. The school came up with the idea of a crime scene in which the school's trophies were stolen and the pupils had to investigate what had happened and find the culprit. For authenticity, the school got the local police to cordon off the trophy cabinet with police tape. A ransom note was discovered as the first clue and the school converted a classroom into a forensics laboratory. The Science Leader brought in an expert, wearing a white lab coat, who showed pupils how to conduct experiments such as finger-printing and chromatography. This enabled the pupils to conduct the experiments themselves and start their investigations. The school put up an *evidence wall* in the school's entrance hall where everyone could look at the building evidence base. The Science Lead said that "*the children were so on board that they really did think it was real*". The whole exercise was so engaging for the pupils that even parents were keen to get involved.

Teaching methods

Those participants who had responsibility for teaching science in the baseline survey were asked how often they undertook different activities with pupils when teaching science. The majority of respondents (93%) in the baseline surveys 'always' or 'frequently' encourage pupils to predict what will happen when they do science investigations and encourage pupils to take part in class discussions (91%). A much lower proportion state they 'always' or 'frequently' arrange for pupils to design their own science investigations (53%).

Figure 6: Frequency of science delivery methods used in lessons as reported in the Science Leadership and teaching surveys



Interviewees described a wide variety of teaching methods used in science or cross-curricular topic work. Methods varied dependent on topic, pupil age and resources available which reflects the findings from the survey.

Practical science

There were multiple examples of practical science being delivered either through investigations or hands-on experiences for pupils. The frequency of practical lessons varied across schools with some being undertaken regularly in lessons while others stated this could be improved across the school. This was influenced by the time allocated to science lessons and the frequency with which they were delivered.

Teachers highlighted the importance of practical lessons which meet the learning needs of their pupils by allowing them to explore their curiosity and be interactive with their learning. It was also highlighted as a way to make science fun for pupils.

> *"Science lends itself to the learning needs of the pupils, they are inquisitive and there's lots of hands-on experiments to do, its functional learning for pupils, a lot of it isn't too abstract."*
>
> — **Headteacher, Scotland**

There were frequent examples of investigations being undertaken within classes. There were examples of pupil-led investigations across many interviews spanning all age groups. The extent to which these are completely pupil led is dependent on the age of the pupil, with guided activities or practical science through play undertaken with younger pupils.

> *"If I'm teaching younger ones, it might be a bit more guided. We'd probably come up with a plan for the investigation the week before, and with some variables that the children would decide on, but it would be a bit more structured. Again, it depends what subjects we're doing and how confident the children were with their knowledge."*
>
> — **Teacher, England**

> *"Well, the way the science would be taught would be what I call, you know, active learning, but it could be taught through play-based learning and, of course, through practical investigations at key stage 2"*
>
> — **Science Leader, Northern Ireland**

A wide range of different examples were given for science investigations within a class across different subject areas. Many of these examples were undertaken within the classroom but there were also regular examples of outdoor learning either at the school or through trips to undertake investigations (e.g., to rivers or the coast).

One interviewee reported the importance of taking pupils outside of the classroom to learn about nature. The importance of this comes from teachers seeing pupils enjoying being outside and away from sitting in a classroom. It is also an opportunity for pupils to experience natural science, rather than learning it from a book. Outside, the pupils do various simple scientific activities such as look for mini-beasts and measure their own shadows. The Headteacher interviewed stated that this type of approach has had a positive impact on what the pupils have learnt.

Other examples include external visitors and organisations visiting the classroom to undertake investigations which teachers highlighted as being more memorable for pupils. One Science Leader spoke about the benefits of inviting local professionals from STEM businesses to give demonstrations and conduct practical experiments with pupils. The Science Leader says that having someone different and who is an expert in their field has had a very positive effect on the pupils' learning experience. They are now looking at ways in which they can increase the number of professional speakers to the school. Another Science Leader reported that:

> *"There was a deaf paramedic that came in and showed his bluetooth stethoscope and stuff. It's raising the aspirations of our children, so that they know that science is something that's really important and that they can use in the future."*
>
> — **Science Leader at a special school, England**

In a few cases interviewees explain that the 'writing up' of investigations is time consuming and distracts from the 'fun' of investigations. This can impact on the number of investigations that are undertaken as it can take multiple lessons to do properly. However, some teachers report overcoming this requirement. Examples of this include teaching assistants recording group discussions between the teacher and pupils during an investigation, which can be used as evidence; or by undertaking different aspects of an

investigation in a single science lesson rather than the whole process, as one Science Leader describes:

> *"We've actually been taking kit samples within the river, and then collecting the organisms from the river, and then using classification charts to do recording… It's impossible to teach a whole recorded written report for each science lesson. So, as a teacher, you have to judge whether you're going to focus on the planning, or data collection, or interpretation. It may be just once a term, once a half-term, where you'd actually write a full science report out."*
>
> — **Science Leader, England**

This reflects the baseline survey data which shows that pupils do not always interpret or report their data to the same extent as they predict or discuss their activities, which may be because they are not focussing on all aspects of an investigation in any given lesson.

Alongside undertaking investigations, teachers describe how they make lessons more practical by teaching concepts through experience:

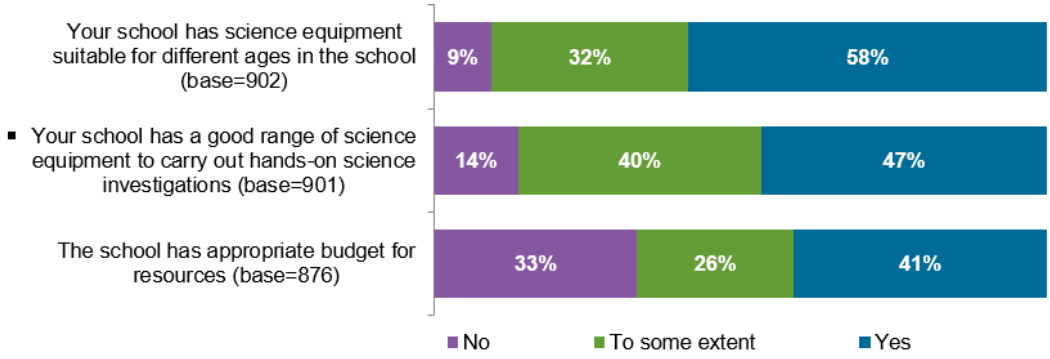
> *"At the minute, one of the classes, they've been learning about rocks and soils. It's a hands-on, with the rocks and the soils, bringing it into the classroom. Then, it's getting them outside the classroom to look up where we've got the rocks, what kind of rocks we've got. How does the natural environment use rocks?"*
>
> — **Headteacher, England**

> *"If we want to teach forces to Year 1, we'll take them to the playground so they can experience forces, pushing, pulling."*
>
> — **Headteacher, England**

3.4 Science resources

When reflecting on the suitability of their schools' science resources, over half (58%) of Science Leaders in the baseline survey consider that the science equipment is suitable for different ages whilst a third (32%) do so to some extent. A further half (47%) deem that their school has a good range of equipment to enable children to carry out hands-on science investigations. However, one-third (33%) disagree that their school has appropriate budget for resources in the school.

Figure 7: Extent of agreement about the suitability of science resources in schools as reported in the science leadership survey



Most interviewees described that their school either has plenty of resources to teach science or has fairly good resources. Interviewees most frequently describe resources as equipment needed to teach science (as highlighted above) whilst also referring to lesson plans, electronic resources to aid teaching and external speakers. Interviewees that refer to having a range of equipment often allude to science cupboards and areas that are well organised and labelled allowing both teachers and pupils to find what is needed.

> *"Whatever the staff need, thermometers and that kind of thing, we top up the resources on an annual basis and see what's being used, what needs buying."*
>
> — **Headteacher, Wales**

Those who refer to having fairly good resources highlight that they have what they need to teach certain subjects or areas, but lack resources for specific subjects or would like more specialised equipment. Some interviewees report that they do not have the resources they require, which is primarily due to budgetary restraints. There are, however, a number of instances where schools are using different solutions to overcome such limitations, which are outlined below:

— Sourcing alternative funding to cover the costs of buying new equipment. For example securing grant funding, applying for awards or liaising with the parent-teacher association to fundraise.

— Sharing resources or loaning equipment from other local schools.

> *"There's a set of little computing robots… They're held centrally at the high school, and then the schools can book in to borrow them with a set of Kindles or iPads that go with them… you can have them in school for a couple of weeks and do a decent topic with them."*
>
> — **Science Leader, Scotland**

— Sourcing low-budget science equipment from local shops or collecting things from the natural environment.

> *"Some of the practical activities we do, we may not have the money to resource those. Then, you just have to adapt. We're looking at rubbish science and science that can be taught through recycled materials and materials we can obtain from [organisation name] which are recycled materials that we can get free."*
>
> — **Science Leader, Northern Ireland**

— Creating home-made resources for pupils and teachers or using alternatives.

> *"A lot of people have gone away and they've put more effort into those areas where they're not as confident to try and find more resources. For example, one person was looking at rocks and soils and was struggling about that, different types of rocks. Somebody suggested to bring in lots of different sweets and they brought in dolly mixture. You've got some that are squashy, some that are hard with a shell around them, some that are layered, like layers of rock. They used the sweets as a way of getting into the different types of rocks and talking about it."*
>
> — **Headteacher, Wales**

Interviewees highlight that the extent to which teachers use imaginative ways to source materials (as opposed to purchasing these) is dependent on the drive and vision of the Science Leader or teacher. A small number of teachers also reported during interview that equipment and materials are not always necessary to teach science well and that high-quality teaching from dedicated teachers is more important. However, budget for resources was still seen as a barrier amongst some interviewees.

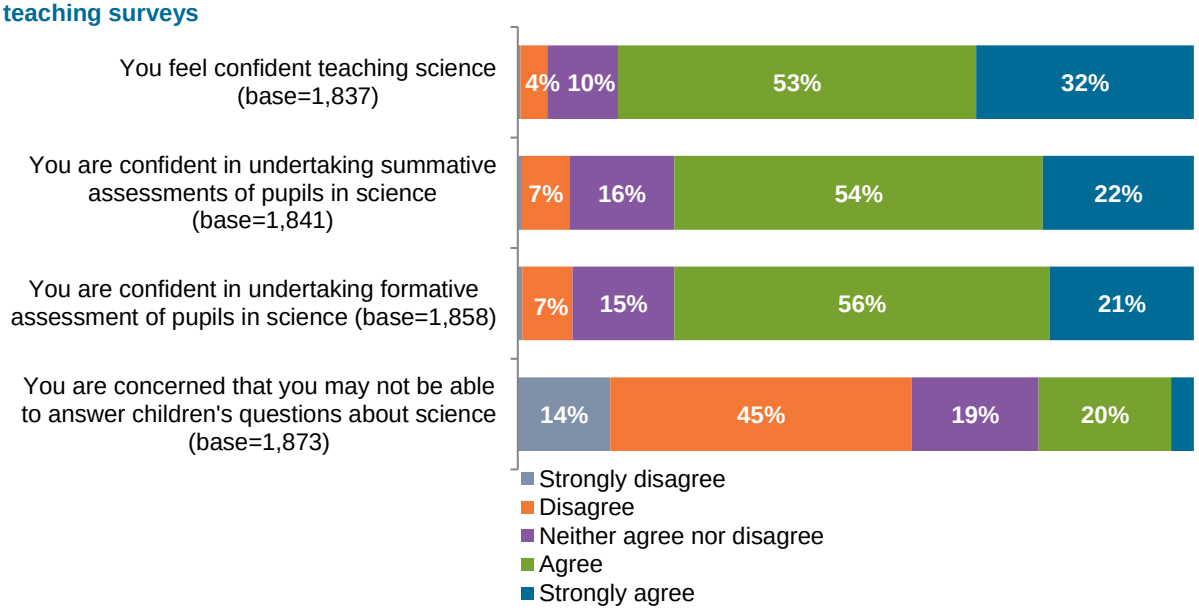
> *"Equipment and resourcing is not a barrier. For primary science, you can get most of the stuff yourself, and bring it in. It's about being bothered to do it. I've taught in much smaller schools, with much tighter budgets, and seen better science being done than in some of the bigger schools. Yes, they might have a well-stocked science cupboard, but that doesn't mean to say that good science is being taught. In my very first school we had limited science equipment, but that school won the [award name]. That was a tiny four teacher school in the middle of nowhere. It had zero budget, but it was doing good science because there were people who were committed to it."*
>
> — **Teacher, Northern Ireland**

A number of interviewees described how they engage with a variety of organisations in their respective countries to access resources and teach science, particularly through the use of external speakers. In some instances, budget dictates the extent of work or support they can access through these organisations. Interviewees highlight how this support can be expensive, especially when school budgets are tight, and often prevents them from accessing this more (references to bursaries to overcome this barrier were not mentioned by interviewees). There were also examples of where schools gained support from parents with a science background.

3.5 Confidence

Respondents to both the science leadership and teacher surveys were asked to state to what extent they 'agree' or 'disagree' with confidence statements about teaching and assessing science. Just under one-third (32%) 'strongly agree' that they are confident in teaching science, with a slightly lower proportion providing the same response in regard to their confidence undertaking summative assessments (22%) and formative assessments (21%). Less than one-quarter (23%) of respondents 'strongly agree' or 'agree' that they are concerned that they might not be able to answer children's questions about science.

Figure 8: Extent of agreement about confidence teaching science as reported in the Science Leadership and teaching surveys



Interviews with teachers confirmed this finding, with a high proportion reporting that they are confident teaching science and a low proportion stating they have mixed confidence levels. Further investigation shows that those who have mixed confidence levels report either feeling moderately confident or very confident in some topic areas and not in others.

> *"I'm going to go middle. I feel like I can cover everything, I can teach it, but then I always feel like there's something I'm missing… Things like concrete examples of how to frame things like bias and reliability and, yes, kind of, good exemplars of how to reflect upon your own hypothesis."*
>
> — **Science Leader, Wales**

Amongst those teachers who are very confident, a number explain that their confidence would be temporarily knocked if they needed to teach science to a different year group.

> *"Pretty confident. I think if you asked me to change year groups, I might have a little dip whilst I get my head round the new curriculum for that group."*
>
> — **Teacher, England**

Amongst those who are confident the two most common influencing factors are having a science background – through A levels/Advanced Highers or a degree – or through having

years of experience teaching science. However, one respondent highlights that a science background does not always lead to an individual feeling confident in teaching science and that experience was more important.

> *"I feel quite confident because I've done A-level biology and physics and taught science four afternoons a week for, probably, fifteen, sixteen years."*
>
> — **Headteacher, Wales**

> *"Science was one of my main subjects when I was doing a BA but I didn't necessarily walk out of there feeling confident in science. I had more ideas to do with the work but I didn't feel particularly confident. I think a lot of that does come from experience and in a small school, people are required to step in and cover which keeps everybody fresh. I'd like to say that I'd be confident to teach science."*
>
> — **Headteacher, England**

In line with this, nearly one-third of teachers interviewed emphasise that confidence is influenced by being prepared and having access to teaching resources. Therefore, even if required to teach a topic or area of science that they were less familiar with, providing that they were appropriately prepared, they would still feel confident.

> *"It probably impacts more on my planning, because I'll spend longer making sure I'm confident and clear on what I need to be saying and explaining, and making sure that I have all the background knowledge for the children. It has more impact on how long I'll spend doing additional research and resource-gathering."*
>
> — **Teacher, England**

Other influencers include their general interest in science, which for some was influenced by good science teaching when they were at school, their enjoyment of undertaking practical lessons and undertaking CPD.

> *"I've always had an interest, even as a child outside with nature and things. I like animals, flowers, plants, I've always had that interest. When I was in secondary school we had very good science teachers there and that gave me an interest as well and confidence that I can do practical work. When I was at my teacher training college, I chose a new subject area, biology and science, and we had training in that for teaching primary science."*
>
> — **Teacher, Northern Ireland**

When reflecting on their colleagues' confidence levels, only a small proportion of interviewees state that all teachers in the school are confident in teaching science. Nearly two-thirds of interviewees indicated that at least one teacher in their school is not confident and in most cases a number of teachers lack confidence, which in part explains the mixed confidence levels found in the baseline surveys.

> *"We don't have anybody who would have any issues. Actually, I probably have got a staff that is quite scientifically, mathematically based. I've got quite a lot of mature teachers, people who've had other careers before they came into teaching."*
>
> — **Headteacher, England**

> *"I would say it's [confidence] quite low. That's one of the reasons I was put there. The classroom management is different to your maths and languages, and also if you were to ask me about the geography I'd say mine was low. Maybe because I do it [science] more now and they do it less. I know there's one teacher at our school and she'll still run investigations because she likes it."*
>
> — **Science Leader, Wales**

Lack of confidence

During the interviews, teachers highlight that aspects of science that may be more difficult to deliver, and therefore where teachers may lack confidence, are often those that involve more abstract concepts, which can be difficult to translate to children in meaningful and understandable ways as the quotation below demonstrates.

> *"Chemistry they [the teachers] find it harder to understand. There's a lot of abstract concepts. Even talking about dissolving, you put sugar in a water solution, just to say it's disappeared, that's not good enough. How would you prove it's still there?"*
>
> — **Science Leader, England**

> *"When it's hands-on, it's far easier to teach because we've got resources. When it's more conceptual, that's when it's more difficult, I think, for the staff."*
>
> — **Headteacher, England**

As outlined above, knowledge and experience help to improve teachers' confidence levels. Conversely, a lack of knowledge and experience hampers teachers' confidence. Echoing the baseline survey findings, Science Leaders explain that teachers' lack of confidence in teaching science impacts on their ability to deal with children's questions to the point that in some instances they avoid encouraging pupils to ask questions.

> *"A lot of people try and stop children from asking questions or avoid them altogether, which I'm trying to steer them away from and embrace it. I've been organising science week recently, which is coming up, and trying to make people feel more comfortable in teaching science practically as well as theoretically, which a lot of people aren't confident in doing."*
>
> — **Science Leader, England**

Interviewees discuss a number of ways in which they have increased their own confidence or that of their staff. Examples they spoke about using include self-teaching, CPD courses or training, and obtaining support from other colleagues or the Science Leader. Giving teachers the ability to experience investigations themselves away from the classroom is

seen as an important type of training opportunity to encourage them to utilise these in classes more through them experiencing the learning gained through this method. Linked to this is teachers being reminded that there is not necessarily a 'right way' and encouraging the trial of different approaches towards investigations.

> *"I've been on a few courses with Techniquest, showing you how to do experiments with the children, to get that information that you need… They give you opportunity to do the experiments yourself beforehand, and they give you all the lesson plans. Doing the volcanoes experiments, they let you have the opportunity to do it, and you don't tend to do that in schools as teachers. You have to do it in your own spare time. On these courses, you get to chat to other teachers and actually experience doing the experiments. That really benefitted me and helped with my confidence."*
>
> — **Teacher, Wales**

Science Leaders have a key role to play in encouraging teachers to share ideas, modelling lessons and turning a lack of confidence into motivation to find new ways to engage children.

> *"We give them a lot of time to come out of the classroom when necessary, and go and work with teachers on developing that confidence and skill. Some people don't know what they don't know. Other people are willing to give it a go but aren't quite doing it right. There are others that will know it but might not be delivering it right. Basically, science is not one that we'll be doing swaps with. We want everyone to be competent at teaching science, the same as maths, and the same as English."*
>
> — **Headteacher, England**

Interviewees report that a lack of confidence can have an impact on whether teachers choose to deliver practical hands-on investigations or – with cross-curricular work – the number of hours dedicated to teaching science. This is sometimes due to a lack of confidence in a specific topic area and feeling unconfident in dealing with any problems that may arise.

> *"If you haven't got the background information or the confidence to teach it, then you're not going to be able to get it across effectively. Anybody can read up on it but it's like every subject, history, geography, if you're not 100% sure and comfortable with it, it does affect your ability to teach the subject, yes."*
>
> — **Teacher, Wales**

As one participant explains, embracing the notion that things go wrong and using this as part of the learning experience for children is important.

> *"I love to see children's reaction to [science] reactions but I love to see things going wrong or when I don't know the answer, or I won't tell them the answer. They always expect me to know what's going to happen in an experiment and it's getting them to see that scientists don't always know the answer. They don't know what they're dealing with to begin with and that there's not always one right answer."*
>
> — **Headteacher, Northern Ireland**

3.6 Enjoyment of teaching science

The majority of teachers (91%) responding to the baseline survey report that they enjoy teaching science. Depth interviewees echo this finding with most indicating that science is a subject they enjoy teaching. When asked to reflect on which aspects of science they particularly enjoy, nearly half of teachers report that they enjoy teaching the practical aspect of science (irrelevant of the subject area), undertaking investigations and teaching outside. This is followed by biology (reported by nearly one-third). A much smaller proportion report physics and only a small number mention chemistry, where this was their academic background. Less than one-third report they like teaching all science topics.

> *"I love doing the practical, and I love the enquiry base of it. You really can go from very simple data. For example, today, we're combining it with our healthy eating, and healthy body, teaching. The children have been taking peak flow meters of everybody that comes into school. We've been recording it, and our maths will be built on that next week. We'll be looking at what is happening to our bodies when we exercise, and how we can improve our peak flow by exercising more, by doing more cardio."*
>
> — **Headteacher, Scotland**

However, it is not always the topics themselves which drive this enjoyment. Teachers report that their enjoyment of the subject is influenced primarily by their children's reactions. For example, delivering lessons about plants, animals and habitats lends itself to outdoor learning which teachers say is universally liked by children, therefore teachers enjoy this too.

> *"Some of those, you can get outside and do outdoor learning. Children love being outside with science. It's not something you can just do in a classroom, they've got to be out there hunting for mini beasts, catching things, standing outside to get their shadows and measuring things like that. That's a valuable thing for us to do because we want to try and encourage our children to do a lot more outdoor learning than just being sat in the classroom all the time."*
>
> — **Headteacher, Wales**

> *"You can see their interest and their fascination. It makes it exciting for you as well."*
>
> — **Teacher, England**

In a small number of cases interviewees mention that their own positive experiences in school also can influence the extent to which they enjoy teaching the subject.

3.7 Barriers to teaching science and ways to overcome them

Barriers to delivering science in school were explored through the qualitative interviews as well as ways of overcoming them and raising the importance of science in a school. Interviewees report two primary barriers: a lack of time and resources to deliver science in the way they would like to.

> *"I've been so literacy and numeracy focused. If I had incorporated more science teaching it would have been through those two subjects but I haven't had the time to prep that. You can't pull that prep out of the hat in one night if it's going to be properly cross curricula. You could say we're going to measure our heartbeat after we've run around the playground but that's not properly. It takes hours, weeks, months to get it right"*
>
> — **Headteacher, Northern Ireland**

When discussing time, the focus is on the time involved in planning practical investigations, effectively planning cross-curricular work (especially in Northern Ireland and Scotland) to ensure all aspects of science are sufficiently covered, time to set up practical investigations, lack of support from teaching assistants to organise equipment and help with large class sizes, and having time to source and organise resources (equipment and teaching resources).

> *"The thing about it is, your science lessons are the most time consuming lessons, in terms of preparation that you do… If you're doing good, hands on actual activities, it takes far more time than any others, say, like, numeracy or ITC lessons… in terms of getting the resources together."*
>
> — **Science Leader, Northern Ireland**

> *"No primary schools have a science technician, or an ICT technician. If they had one person at every school whose primary job was to get equipment ready for this, then more would be done. Teachers don't have time to get things ready, teaching an hour lesson, and then clearing it all away, and then assess it and mark it."*
>
> — **Headteacher, Scotland**

Interviewees report a range of strategies to overcome these issues, such as Science Leaders sharing lesson plans or creating investigation packs for teachers. Another interviewee highlights how they used the support of a teaching assistant in their school who would help to sort out equipment before the lesson and help to clear it away. However this was rare, and other interviewees report their school does not have the budget for teaching assistant support.

Linked strongly to this is a feeling amongst some teachers that there is a lack of resources in a school to teach science. Some teachers refer to a lack of equipment while others highlight a lack of electronic resources, lesson plans or access to external speakers. Again budgetary constraints partially drive this, but time to navigate websites and find resources

is also a driver. Teachers suggest that having access to lesson plans or ideas for investigations that are clearly linked to the curriculum would be appreciated, and for some teachers this may improve their confidence and knowledge in teaching. As highlighted previously teachers are being creative to avoid a lack of money impacting on science teaching. Ideas included using everyday objects, recycling materials or borrowing resources.

> *"Using whatever money that we do have so that schools aren't doubling up on resources when we could be sharing. I think that will be more and more the case, schools buying things between them and timetabling so they can share it."*
>
> — **Science Leader, Scotland**

A small number of interviewees discuss teachers' lack of interest in science as a key barrier and how the decrease in the perceived importance of science in schools has led to a lack of motivation. This is seen as a separate and distinct issue from teacher confidence, which some schools also perceive to be affecting science teaching, especially where there is the flexibility in the curriculum to focus on other subject areas. Some teachers also describe a lack of subject knowledge as a barrier to teaching science.

> *"It's not about teachers' lack of ability, or confidence, or whether they have a degree in the subject. I think, in an awful lot of cases, it's a resourcing issue, a time issue, and then just down to people actually being bothered. If you want to do it, you can. It takes a bit of effort… Most people don't have a primary maths degree, but they can teach good maths. That doesn't seem to be an issue… It's about time management. There's never going to be enough time. I know I look at my lessons and think, 'I wish I could have a bit more time to do this.' Sometimes you've just got to roll with it. It's not going to be perfect, so you've just got to do it. We've got plenty of resources."*
>
> — **Teacher, Northern Ireland**

> *"I'd say probably subject knowledge of individuals because, of course, science is so varied… I'm not a scientist, and I've never had a science degree. So, I feel like I'm lagging behind those teachers who have a science degree."*
>
> — **Science Leader, Wales**

As previously highlighted, being able to access training opportunities was seen as a way to improve confidence or skills and knowledge amongst teachers. However, the general consensus from interviewees was that a lack of funding often prevented this alongside a lack of CPD opportunities for teachers.

A number of interviewees highlight that the importance of science needs to be raised across the school itself. This is seen as a challenge in some schools where English and maths dominates teaching, especially in the years pupils are being assessed via SATs. A number of interviewees report that a lack of government assessment or agenda towards primary science teaching also affects this. However, in Wales one interviewee (from a mainstream primary school) explains how having to ensure pupils are ready for teacher

assessment impacts on the practical nature of science taught in classes as the focus is more on assessment than practical science skills.

Interviewees hope that an increased level of importance placed on science would motivate teachers and staff to prioritise the subject. Headteachers and Science Leaders discuss using Science Week or prominent displays to increase the profile and importance of science and deliver this message to children, parents and staff.

> *"We put up a whole school science display in the middle of the hall to remind people that it's whole school, and it's current, and all the staff have to display this terms work to make sure that they are doing it."*
>
> — **Science Leader, England**

However, this is reliant on a whole school approach which is supported by the Headteacher. The role of an individual Science Leader who has the time and passion to drive and improve science across the school is also seen as a solution to raising the importance of science. However, one Headteacher explained that budget restraints meant that they were unable to give their Science Leader release-time to effectively carry out this role.

> *"Possibly a stronger Science coordinator, and that is down to the teacher who's in charge of that subject. I think probably if you got someone that was passionate about the subject, they're more likely to promote it and encourage it rather than someone who's got the Science coordinator's job but who doesn't really want it, but nobody else wanted it."*
>
> — **Teacher, England**

Interviewees in Northern Ireland and Scotland explain that the curriculum for primary science is "vague" and open to interpretation making it difficult to know what needs to be taught and to what level. There is a sense that not having a full understanding of the outcomes that are required can inhibit delivery as it means leaders are unsure what training and resources are needed. As outlined earlier in this chapter, this also affects the amount of time spent on teaching science.

> *"I think the difficulty is knowing the level of the children's understanding that's expected of the curriculum. If we're doing genetics, to what level do they need to understand genetics? Picking that apart for the different age groups."*
>
> — **Science Lead – Scotland**

> *"It's very difficult to know what the goals are, what the curriculum part of it is. The new curriculums are so vague. The government says, 'You can take it in any direction' but then when they come into schools, what they want to see is actual data and actual written evidence… They can't say, 'you have freedom, but we're going to test you on the scheme.'"*
>
> — **Headteacher, Scotland**

Having greater clarity of the curriculum areas is seen as something that would help improve teachers' confidence that they are teaching the correct aspects of science. Welsh interviewees also report that curriculum changes mean that teachers are unsure of what will be required in the future.

For smaller schools, having mixed age classes creates difficulties in ensuring that lessons are differentiated and are not too repetitive as children progress through the school. This is seen to take more time to plan.

> *"There are only 78 children at the moment here. That also has its complications. Some topics, you know, might be more suitable for, say, Year 6 pupils but we're doing it with the Year 4 pupils because they can be in the same class. It's a matter of being able to differentiate that so that they all get something out of it."*
>
> — **Headteacher, Wales**

CHAPTER 4. CONCLUSIONS

This section summarises the key conclusions emerging in relation to the leadership and delivery of science in UK primary schools.

4.1 Science leadership

Science is viewed as an important subject in schools. Interviewees highlight how the wide range of skills that are developed through the subject can be applied to other subjects which allows children to develop critical thinking and investigation skills, and can improve literacy and numeracy. However, two-thirds of interviewees describe how science is seen as less important than English and maths. There are various drivers on the importance that is placed on science within a school including: the passion and drive of a Headteacher or Science Leader, the teacher assessment of science as part of CSI (as indicated in Wales) or teachers wanting to ensure pupils enjoy learning through the practical subject. When compared to other subjects, approximately half of interviewees rank science as the third most important subject in schools (after English and Maths) but above most other subjects with the exception sometimes of PE or ICT. The remaining interviewees described how science was on par with the other subjects taught in a school (often excluding English and maths) as all subjects are important in the curriculum.

Although Science Leaders are common in schools, the role they play varies considerably across schools. This is influenced by the time they have available to do the role, the level of involvement in science by the Headteacher, the size of the school, the confidence of teachers in the school and the interpretation of the role itself. Release time to undertake the role is often limited, in some instances none is given and sometimes there is then the expectation that this is done using PPA time or out of school hours. This can hinder the work the Science Leader is able to do in a school and the perceived importance of the role. Overall teachers report feeling supported to teach science and are able to ask the Science Leaders questions. However, the regularity of lesson observations and monitoring of teaching is limited.

External training for science is infrequently mentioned by both Science Leaders and teachers. Although most Science Leaders report some form of training this was often undertaken a long time ago and has not been updated. Of those Science Leaders that indicated they had experienced training they reported that the content focused on teacher science rather than leadership of the subject. This also reflects the views of teachers who reported that their Science Leader usually attending training (on how to teach science) and feeds this back to the school.

4.2 Teaching science

Hours of teaching

There is variation in the number of hours spent teaching science across schools. Approximately half of depth interviewees estimate they spend 2 hours or more a week teaching science. However, there is evidence that where hours of science delivery are specified or timetabled, there still remains a large degree of flexibility in how much, when, and how this is delivered. Within England and Wales the amount of science taught in a week is usually decided at the whole school level and links to having standalone science lessons. Within Northern Ireland and Scotland the time spent teaching science is often devolved to the teacher level, although in some instances the Science Leader tries to monitor how much is being taught within topic areas or blocks. The level of detail in science curricula is seen to influence what is taught, especially amongst less confident teachers. The external assessment of English and maths is also seen to reduce the importance placed on science.

Where executed effectively interviewees describe how cross-curricular teaching allows teachers to cover more than one topic/subject area at a time increasing the time that is spent on subjects, although the planning for this method of teaching takes longer. However, where science is only taught through cross-curricular lessons there is the potential for this to lead to a reduction in the number of hours of science taught. There are examples across schools where science is successfully integrated into other subjects alongside being taught as a standalone subject or through topic work, although in some instances this can reduce the practical aspect of science lessons.

Overall, over two-thirds of interviewees state that they think their school offers a broad and balanced curriculum, but most strongly caveated this by the constraints of the importance given to other subjects and the variety of subjects in the curriculum.

Methods of teaching

Almost universally, the decision for how science is taught is made by individual teachers. Headteachers and Science Leaders acknowledge that there are different teaching styles and methods, and most make a conscious decision to allow teachers to deliver in their own way, unless quality is assessed as poor. Schools describe how the topic areas and content for lessons is primarily dictated by the curriculum or school-level planning, however, this is not the case where lessons are topic based and science content is at the discretion of teachers (usually within Northern Ireland or Scotland).

There is evidence of a wide variety of teaching methods used in science or cross-curricular topic work which reflects the findings from the baseline survey. Decisions around which teaching methods to use are often dependent on the topic being taught, the age group of the pupils and the time and resources available. There are multiple examples of practical science being delivered in schools either through investigations or hands-on experiences

for pupils. The frequency of practical lessons varies with some being undertaken regularly in lessons whilst in other instances teachers agreed that the frequency needs to be improved across the school.

A wide range of examples are given for practical science investigations and enquiry within all topic areas. Many are undertaken within the classroom, within the school grounds or on school trips. Other examples include external visitors and organisations visiting the classroom to undertake investigations, which teachers highlight as being more memorable for pupils. Within schools the formal 'writing up' of investigations is sometimes described as time consuming and can take away the 'fun' of investigations, although some teachers find different ways to collect and evidence learning.

Using resources

Most interviewees describe how their school either has 'plenty' of resources to teach science or has 'fairly' good resources. Resources were described as being equipment to teach alongside lesson plans, electronic resources and external speakers. Some schools struggle to obtain the resources they need, primarily due to budgetary reasons, however, there are many examples of innovative or alternative solutions to this including securing funding, loaning equipment and using cheap/free alternatives. However, such solutions are strongly dependent on the drive of the Science Leader or teacher.

4.3 Confidence and enjoyment teaching science

A high proportion of interviewees report they are very confident in teaching science and a lower proportion state they had mixed confidence levels. Confidence is often influenced by a teacher's experience in teaching or through having a science background. Only a small proportion report that all teachers in their school are confident. Most highlight at least one member of staff who is not confident and in most cases a number of teachers, which in part explains the mixed confidence levels found in the baseline survey. Interviewees discuss how confidence can impact on whether teachers choose to deliver practical hands-on investigations or – with cross-curricular work – the number of hours dedicated to this.

Teachers have increased their own confidence or that of their staff, through self-teaching, CPD courses or training, and obtaining support from other colleagues or the Science Leader. Giving teachers the opportunity to experience practical investigations themselves is seen as a very important type of training, as is being reminded that there is not necessarily a 'right way' and encouraging the trial of approaches. Science Leaders play a key role in encouraging teachers to share ideas and model lessons.

Most interviewees enjoy teaching science and it is the practical nature of the subject they enjoy. Certain topic areas are also reported as being more enjoyable and is often linked to their academic background. However, it is not always the topics themselves which drive this enjoyment rather the environment within which they are delivered. For example, lessons about plants, animals and habitats lend themselves to outdoor learning which most

teachers say is universally liked by children so is something they enjoy too as they like to see the children's reactions.

4.4 Barriers and improvements

The barriers to teaching science in schools are varied. The two main barriers are a lack of time and resources to deliver science in the way they would like. Time is needed to plan practical investigations or cross-curricular work, set up practical investigations and to source and organise resources. Some schools refer to a lack of equipment whilst others highlight a lack of electronic resources, lesson plans or access to external speakers. Again budgetary constraints partially drive this, but time to navigate various organisation websites and find resources is also a driver.

A lack of interest in science teaching is seen as a barrier to teaching, and as a separate and distinct issue from teacher confidence and a lack of subject knowledge, all of which can also have an impact. In Northern Ireland and Scotland interviewees describe that the curriculum for primary science is "vague" and open to interpretation making it difficult to know what needs to be taught and to what level. Having greater clarity is seen as something which would help improve teachers' confidence in knowing they are teaching the correct aspects of science.

Increasing the importance of science across a school is suggested as a key solution to address some of these barriers. It is hoped that an increased importance could then motivate teachers and staff to prioritise science as a subject. However, this is reliant on a whole school approach supported by the Headteacher. The role of the Science Leader is also key in improving confidence and teaching across a school, but presents a challenge to some schools where budget constraints prevent giving Science leaders release time to do their role.

Interviewees suggest that having access to lessons plans or ideas for investigations that are clearly linked to the curriculum could help improve confidence and knowledge in teaching. Being able to access training opportunities is also referred to as a way to increase confidence and knowledge but a lack of funding often prevents this. There are examples of where schools were not allowing a lack of money to prevent science teaching. Ideas included using everyday objects, recycling materials or borrowing resources so that they were able to deliver practical lessons for their children. It is clear from the research that the drivers in each school for teaching science are unique and dependent on strong leadership and the motivation, confidence and knowledge of teachers.

APPENDIX 1

Breakdown of depth interviews undertaken by school are shown in the table below:

School	Country	Headteacher	Science Leader	Teacher
School 1	England		1	1
School 2	England		1	
School 3	England		1	
School 4	England	1	1	
School 5	England		1	
School 6	England	1	1	1
School 7	England	1	1	
School 8	England		1	
School 9	England	1	1	1
School 10	England	1	1	1
School 11	England	1		2
School 12	England		1	1
School 13	Northern Ireland		1	
School 14	Northern Ireland		1	
School 15	Northern Ireland		1	
School 16	Northern Ireland		1	
School 17	Northern Ireland		1	
School 18	Northern Ireland		1	
School 19	Northern Ireland			1
School 20	Northern Ireland	1		
School 21	Northern Ireland		1	
School 22	Northern Ireland			1
School 23	Scotland	1		
School 24	Scotland		1	
School 25	Scotland	1	1	
School 26	Scotland	1		
School 27	Wales	1		
School 28	Wales	1		
School 29	Wales	1	1	1
School 30	Wales		1	1
School 31	Wales		1	
School 32	Wales			1
School 33	Wales		1	
School 34	Wales			1
	Total	**13**	**24**	**13**

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