Brunel University London is a world-class university based in Uxbridge, West London, and was established in 1966. Our mission has always been to combine academic rigour with the practical, entrepreneurial and imaginative approach pioneered by our namesake Isambard Kingdom Brunel.
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Ensuring that we have the right skills and knowledge in the UK to support the growth of our high-value sectors is a key determinant of our future ability to compete and succeed – but we have a pipeline issue.

There is real concern among British businesses that the STEM skills shortages we are already seeing will increase in the coming years, acting as a brake on growth and limiting our success in industries with high growth potential.

Businesses know the importance of improving our education and skills systems and the need to develop young people who are rigorous, rounded and grounded – as set out in our report *First Steps*. Getting the core of English, maths and science right is central to making this happen. These provide the building blocks for learning and success in other subjects, and for all pathways of study, but there is a risk that some of these core skills – especially science – are being allowed to fall between the cracks.

It is essential we build the right skills base if we’re to support a rebalancing towards those high-value, high-skill activities that will underpin our role in the global marketplace.

And this means taking a step back to look at the root of the problem. We are not seeing enough young people pursuing further study or careers in science, technology, engineering or maths – and this is an attitude that is in many cases embedded at primary school. Too many young people are already ‘switched off’ to science by age 11, something which only gets worse as they progress through the education system.

This needs to change – we need to excite and enthuse young people about these subjects and the opportunities they present from an early age, and support this all the way through to secondary school and beyond. If we do not work to solve the issues at their source, anything later down the line will only be a temporary fix, and this is not enough.

Ensuring we have high quality primary science education, that we support teachers in developing the skills and knowledge that they need, and that science professionals from both businesses and universities are engaging with schools must be a priority.

It is clear that we have some way to go in fixing the pipeline for STEM skills – but quality primary science education is a clear and important part of this solution.

Employers, universities, government and schools need to work together to ensure science education is a priority, and that young people are receiving the engaging and inspiring lessons needed to spark their interest, and prepare them for ‘tomorrow’s world’.

*Katja Hall*
Deputy Director-General, CBI
Few people would disagree that far too few of our young people are studying STEM subjects at school and beyond. Our pipeline of scientists, engineers and technologists is simply insufficient to meet the needs of employers and is limiting our capacity to compete effectively in an increasingly competitive global market. We need an education system that inspires interest and enthusiasm for the sciences and that offers good advice and guidance on the fulfilling career opportunities open to those with STEM qualifications.

As you can read in this report, here at Brunel University London we are taking actions that will contribute to ‘generating the spark’, with initiatives to help address the shortage of highly qualified STEM teachers, to support current teachers, to enable more young people to undertake practical science in high-quality facilities, and to create networks of primary science leaders - to name but a few. These are all strong indications of how seriously we take the pipeline issue.

For good reasons, primacy is given in the report to science and maths education but these of course provide the essential foundation of engineering and technology. The need for talent within engineering and ICT companies is even more acute than it is in the science-based sectors; and for many young – and even very young – people it is engineering thinking and ICT applications that spark their interest.

It also is clear that we need to break out of the entrenched viewpoints which depict science subjects as being ‘boring’ or ‘just too difficult’. This is a broader cultural issue – careless talk about ‘hard’ and ‘easy’ is a sure way of blunting some young people’s ambitions and deterring those who lack confidence.

We need a clear message: STEM graduates are highly sought after in the workplace, and a STEM qualification opens many doors that might otherwise be closed.

There have been impressive arrays of initiatives in recent years to address the STEM pipeline issue, which have been vital to prepare the ground and enable us to identify what works. But now we need something much bigger and bolder. On their own, the recommendations of this report - important as they are - will not be sufficient to make the transformation we need. So I would like to take this opportunity to implore the next Prime Minister to address this issue head-on. We need a fully co-ordinated national campaign which is not just backed and launched by the Prime Minister but also directly driven from Downing Street.

With all of us who have a direct interest in this issue - all sectors of education, professional bodies, business, the CBI and employer representatives, think tanks, the third sector as well as Government - all working together under a single umbrella, with proper co-ordination, and a clear timetable, we really can crack this problem. The rewards for doing so will be transformative – no less than a stronger economy, a fairer society and a brighter future.

Professor Julia Buckingham
Vice Chancellor and President, Brunel University London

We commend the CBI for producing this important and timely report, which we are delighted to support.
Executive summary

**We are not yet delivering the pipeline of science skills we need**

The UK’s ability to grow and succeed in the future will rely on ensuring that we have the skills and knowledge needed for our high value sectors to thrive. Many of these sectors rely on a supply of science skills, at both graduate and technician level. But there is a pipeline issue – shortages are appearing that may hold our economy back – despite the fact that science offers a route into interesting and well-paid jobs. In this report we look at how to address this issue earlier in the school system – as too many pupils are switched off to science by the age of 11. We review existing evidence and report on a new survey of primary school teachers, conducted for this report.

**Primary schools are critical to ensuring progress, by creating space for quality science teaching**

Teaching science at primary schools presents a specific set of challenges, including finding curriculum time, the level of priority given to science, the confidence of generalist primary teachers to teach science, and a relative lack of professional development around the subject. Our survey shows that over half of teachers in England report science becoming less important in the curriculum, with many schools setting aside too little teaching time. Given the importance of the subject, it is time for action – but this should not be driven by a return to testing.

**Recommendations:**

- Set a target for the UK’s schools to be the best in Europe - and in the top five worldwide - by 2020 in science.
- Develop a new science education strategy covering all levels of education – primary, secondary and tertiary.
- Primary schools should ensure that professional development for science is of a high standard, and that it is undertaken on a regular basis.
- All primary schools should have a subject leader for science in place to drive a continual focus on the subject.

**Businesses and universities can do more to support schools – who should be rewarded for building these links**

Despite a wide range of good practice taking place, driven by businesses, universities and schools themselves, links between the three to support science are still too rare. This is disappointing, as the feedback from these schemes is usually positive, and such links can present a solution to issues around staff confidence and professional development, as well as inspiring students. This kind of engagement should be encouraged and incentivised – and businesses and universities need to do more.

*“CBI members see a lack of skills as a threat to competitiveness”*
Recommendations:

- A new Ofsted inspection framework should find space to reward schools for meaningful engagement with the wider community on key subjects like science, especially businesses and universities.
- Businesses and universities need to step up to the challenge too – and ensure that they explicitly consider outreach into primary schools.
- As part of CPD, the potential for teachers to spend some time in businesses and universities to enhance their understanding of the theory and application of science should be developed – and promoted to both schools and professionals.

We can learn lessons from other parts of the curriculum to apply to science

There is a lot of STEM education support from businesses and universities – as they recognise clearly the issues around the talent pipeline, and are committed to helping rectify this issue. But more support is needed for primary schools in particular – tackling the problem early on should be a priority.

Recommendations:

- Assess the success of existing primary school schemes, in search of lessons for science
- The new ‘Careers and Enterprise Company’ should include primary in its thinking, with the next government committing to funding the company for the term of the next Parliament.
Growing STEM skill shortages are a real concern for businesses across the UK, with too few young people choosing science. We need a step-change – but this has to start from primary. A focus on science for this report will help us to identify the key problems... and our survey of teachers will point us towards the key issues.

We are not yet delivering the pipeline of science skills we need.

In an increasingly integrated international economy, the UK’s ability to grow and succeed will rely on our ability to compete on quality through our high-value sectors, and how we use and enhance the best new technology. Much of this means we will need our young people to be grounded in science, with a strong understanding of the subject and ability to learn. Yet we already see skills shortages, especially at technician level.

Yet participation at secondary level remains disappointing. At GCSE level in England, where science remains compulsory, a worryingly low number of young people study separate sciences – with entries falling by 18.6% in biology, 16.8% in chemistry and 14.6% in physics in recent years. At A Level, we see a further drop off, with just 8.8% studying biology, 7.3% chemistry, 5% physics, and 12.4% studying maths in 2013.

Tackling these pipeline issues must be a priority if we are to ensure that the supply of skills matches the demands of the future economy. Engineering UK, for example, have predicted that engineering employers will need nearly 2m people with engineering skills between 2012 and 2022. This alone will mean that we need to double the number of engineering graduates and apprentices entering the industry.

Changing the impression that science is for boys is also a huge challenge. We know that the number of girls and young women pursuing many STEM subjects is lower than that of their male counterparts – resulting in a STEM workforce with a comparatively low representation of women. This is a challenge that many countries face, although the position in the UK is particularly poor. Urgent action is therefore also needed to ensure that the talent pool for STEM industries is attractive to both men and women. Last year, the CBI called on sixth forms and colleges to adopt targets for increasing female participation in science as a part of this solution.
Much of this is set out in the CBI report *Engineering our future: Stepping up the urgency on STEM*, published last year, which calls for a long-term strategy that will address the economy’s growing need for STEM skills – from widening the pipeline through action at secondary school, through to developing joint solutions for ongoing training and aligning funding for higher education with the STEM strategy.5

In this report, we take the analysis back a stage further, as research suggest the roots of our problem lie earlier in the school system – we hope that this will help tackle some of the more fundamental problems which narrow the pipeline of STEM talent.

**We need a step-change – but this has to start from primary**

Research suggests that by the time young people reach secondary school, many have already ‘switched off’ to science subjects – reducing engagement, limiting outcomes and decreasing the number who pursue the study of science to a higher level.6

When we put this in the context of the growing demand for STEM skills, this presents a very concerning picture. Our annual education and skills survey highlights that 39% of firms had difficulties in recruiting staff with STEM skills and knowledge over the last 12 months – and over half were expecting problems in the next three years.7 The problem was particularly acute in sectors such as manufacturing and engineering: sectors critical to the rebalancing of the economy (Exhibit 1).

Provision of apprenticeships and encouragement to choose sciences at 16 will only take us so far in addressing this, as young people’s educational choices are forming well before then. Unless science is exciting, interesting and challenging in primary school, the pipeline will clog long before secondary level. If we do not fix the issues early on, anything else further down the line just becomes a sticking plaster. We need to tackle the cause, not treat the symptoms.

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**Exhibit 1** Difficulty recruiting individuals with STEM skills and knowledge by sector (%)

<table>
<thead>
<tr>
<th></th>
<th>People to train as apprentices</th>
<th>Technician</th>
<th>Graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– currently</td>
<td>26</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>– next three years</td>
<td>35</td>
<td>36</td>
<td>25</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– currently</td>
<td>18</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td>– next three years</td>
<td>36</td>
<td>48</td>
<td>37</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– currently</td>
<td>26</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>– next three years</td>
<td>35</td>
<td>29</td>
<td>38</td>
</tr>
</tbody>
</table>

Source: Gateway to Growth: CBI/Pearson Education and Skills Survey 2014, CBI, 2014

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*Changing the impression that science is for boys is also a huge challenge*
A focus on science for this report will help us to identify the key problems...

This report shines a light on the issues around sciences. While the other elements of STEM study are equally important, the challenges faced in teaching maths, for example, are somewhat different from those affecting the teaching and learning of science at primary school. We must also acknowledge that we ask a lot of primary teachers, who are typically generalists, and that the capacity to do more can be limited. It is important that, in identifying issues, we see them as shared challenges – not points of improvement for primary schools alone.

A key issue for this report is creating learning that inspires, and creates both understanding and excitement. However, the study of science also helps with developing skills and behaviours such as reasoning, analysis and curiosity that are valuable across all industries and fields of study. These are the kind of behaviours that our education system should be nurturing in all children, to support them on their wider educational journey. They are highly prized by industry, and consistently cited by employers as amongst the most important factors they consider when recruiting.8

...and our survey of teachers will point us towards the key issues

The CBI has worked closely with teachers and school leaders as part of our schools campaign, as we believe it is always best to get feedback from those on the "shop floor" of the education system. Improving education is a business imperative – for both economic and social inclusion reasons. The practical realities of this challenge are best understood by teachers, so we asked them for their views in a survey of 260 primary school teachers, designed to help us understand what the specific issues holding back science in primary schools are. We surveyed teachers from across England, Scotland and Wales – receiving responses from a mix of Key Stage 1 and 2 teachers,9 with a range of teaching experience (Exhibits 2 and 3).
Unless science is exciting, interesting and challenging in primary school, the pipeline will clog long before secondary level.
CHAPTER 2

Primary schools are critical to ensuring progress, by creating space for quality science teaching

The importance of science education at primary schools is widely understood, and the challenges that we face are, in many cases, not new. But their importance is growing with time, something which leads to greater concern when teachers report that science is now seen as a less important part of the curriculum in many parts of the UK.

- The need to enthuse and excite young people about science is critical...
- ...but science is not a real priority within the school curriculum
- Ensuring teachers have the confidence they need to deliver the subject is key...
- ...so professional development for science must be up to scratch

The need to enthuse and excite young people about science is critical...
While many of the challenges in science education at primary school revolve around the roles of the curriculum, examinations, and teacher knowledge and development, one of the most important factors narrowing the pipeline of young people into science study and careers is the attitude and perceptions of children themselves.

Research suggests that by the time children finish primary school, many have already decided that science study is not something they are interested in pursuing post-16. We can see this attitude toward science study carrying through – with children also deciding that the idea of working in STEM industries does not appeal. It seems clear that young peoples’ attitudes towards science are formed in early primary school – and then feed through into the later stages of education and adult life.

Negative attitudes to science are often attributed to the perception that it is not interesting or exciting, and a lack of awareness of the opportunities it can present - given its growing importance to the UK’s economy. Linking the curriculum and learning at school to real life problems and solutions that primary pupils can grasp would help to support the development of this knowledge and more positive attitudes.

This sense of a need for practicality is reflected in the experiences of primary school teachers. As Exhibit 4 shows, when asked what would help pupils to become more engaged in science, some 74% of those we surveyed pointed towards more experiments and practical content, followed by linking learning to real life (63%), more visits and trips outside of the classroom (51%), and interaction with individuals working in the field (31%).

In chapter 3 of this report, we explore some of the good practice being undertaken by universities and businesses to inspire young people about the opportunities of science study and to engage them in their learning of these subjects. But it is clear there is more to be done.
Exhibit 4  Ways to make pupils more engaged in science lessons (%)

<table>
<thead>
<tr>
<th>Method</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>More experiments and practical content</td>
<td>74</td>
</tr>
<tr>
<td>More opportunities for visits or trips</td>
<td>51</td>
</tr>
<tr>
<td>More interaction with individuals and businesses working in the field</td>
<td>33</td>
</tr>
<tr>
<td>Linking topics to real-life situations and the world they live in</td>
<td>19</td>
</tr>
<tr>
<td>More confident teaching</td>
<td>9</td>
</tr>
<tr>
<td>Nothing – pupils already very engaged</td>
<td></td>
</tr>
</tbody>
</table>

We need to ensure that the practical elements of science – often the most exciting and engaging parts of the subject for young people – do not get squeezed out, as is already happening in secondary schools in England. The removal of practical assessment from the final grading of science A-Levels and GCSEs in England is a damaging step, and we welcome recent statements from politicians about reconsidering the change. At a time when we should be encouraging more young people to consider science, there is a very real danger that this will further reduce the number of young men and women pursuing STEM study.

Shifting the attitudes of young women in particular must be a priority, as this is the group within which the drop-off in interest is most acute – feeding through to the higher stages of education, with a lower percentage of girls undertaking study in most areas of STEM; particularly physics and maths.

For example, in 2014 the proportion of entries in separate science GCSEs showed boys made up a higher proportion for each of biology, chemistry and physics – with the difference being most pronounced for the latter two subjects. At A Level, this disparity is even greater, with only 21% of entrants into physics being female candidates. Despite the progress that is being made, it is still not enough.

This issue has been a focus of attention for some time, and in more recent years we have seen a push from government, industry and academia to widen the pipeline of girls and women into science industries. The ‘Your Life’ campaign is one example of where the government is attempting to make this a priority – with employers pledging to work to inspire the next generation of scientists and engineers, particularly girls.

Ensuring that this is a focus from primary school onwards will be key to addressing our pipeline issue.

...but science is not a real priority within the school curriculum

While the new national curriculum in England, as in other parts of the UK, has been designed to allow teachers the freedom to determine to a greater extent how and what they teach to their classes, the CBI and others have been concerned that schools require more support to prioritise science amongst the breadth of content that needs to be covered, and that teacher preparation to deliver the content is not yet good enough.

Changes in curricula around the whole UK have increasingly contributed to greater freedom for schools to manage how they teach. This is welcome, but a by-product of this can be to remove previous guarantees of the place of science in the curriculum, without necessarily putting in place replacement support.

At present, in England, there are no requirements placed on schools to allocate a specific number of hours per week to teaching any particular subject, but guidance on timetabling from the Qualifications and Curriculum Authority published in 2002 recommended that one and a half hours per week at KS1 be spent on science teaching and 2 hours at KS2. Our survey suggests that these aspirations are not being met in large parts of England’s primary education system, as Exhibits 5 and 6 show.
When asked how much time was set aside for teaching science in the classroom per week, we found that the majority of teachers (76%) dedicated 1 or 2 hours per week to this subject. There is, however, significant variation between individual schools. It is encouraging to see that nearly 1 in 5 primary school teachers surveyed commit three hours or more to teaching science each week. However, over a third of those teaching KS2 are not providing the minimum recommended two hours of science education per week. And over 1 in 20 schools – at both KS1 and KS2 – provide less than one hour of science education a week.

There are also regional differences reflecting, perhaps, the different priorities placed on science in the different parts of the UK (Exhibit 7).

It is right that schools have the freedoms to design and deliver engaging science lessons – and one hour of inspiring teaching is clearly better than two hours of poor quality teaching. But if we are to tackle the STEM crisis which is already acting as a brake on economic growth, and encourage more young people to pursue rewarding, exciting careers in STEM industries, then all primary schools in every part of the UK need to aspire to match the very best in teaching science – in both quantity and quality. And many teachers would welcome this, with nearly a third of the teachers surveyed wanting to see more time dedicated to teaching science in primary schools (Exhibit 8).
In England in particular, teachers identified that science had become less of a priority over the past five years. The drivers of this change are relatively clear and were well intentioned, as they relate to the desire to give schools freedom over curricula and avoid schools becoming “SATs factories”. This is an ambition shared by the CBI.

The removal of SAT assessments for science in 2009 was welcomed by schools, as the pressure to focus on examination outcomes (and the preparation that comes along with them) was seen to inhibit the ability for teachers to teach sciences in the most exciting and innovative manner they could.19

At the time, the feeling was that science would not lose position in the curriculum. In practice however, this seems to have become the case. The removal of statutory testing at the end of Key Stage 2 has helped schools and teachers avoid unnecessary revision and has encouraged more innovative lessons.20 But the Wellcome Trust, the CBI and others believe that many primary schools now do not recognise science as a core subject, as they do with English and maths – and as such do not treat it as one.21

Indeed, over half of those that we surveyed said that science had become less of a priority at primary school over the last five years. This is a deeply troubling statistic (Exhibit 9, page 16).

Comments from respondents to our survey set out how science is being “squeezed out with numeracy and literacy pressures” and that it is has been “forced to take a back seat, when it should be treated with equal importance”.

Business would not want to see the return of the unnecessary external assessment of science in primary schools – exams are not the answer – but we do need more work to ensure that science education is not allowed to fade into the background.

These concerns in England are echoed by Ofsted, who have already shared their fear that many subjects – including science – have been deprioritised as a result of an unwavering focus on the important core of English and maths.22

While these subjects are vitally important as building blocks for success in other subjects and for future learning, they provide only a part of the broad and balanced curriculum that we should be looking to provide for children in this country, and there is room in the curriculum for both.

“

The pressure to focus on examination outcomes was seen to inhibit the ability of teachers to teach science in the most exciting and innovative manner

“
Exhibit 9

DO YOU THINK THAT THE TEACHING OF SCIENCE HAS BECOME MORE OR LESS OF A PRIORITY IN THE PRIMARY SCHOOL CURRICULUM OVER THE LAST 5 YEARS?
The situation in England in this regard is in stark contrast with Scotland, where only 25% of the teachers we spoke to thought that science had become less of a priority. This perhaps supports the view that the removal of statutory testing of science at the end of Key Stage 2 in England has resulted in science becoming less of a priority in English primary schools.

As we set out in First Steps, the CBI’s 2012 report on education reform, sciences should be seen alongside maths and English as core subjects: only when young people reach a sufficient standard in them can they make substantive progress in their studies and wider life. We need to ensure that science is treated by schools and teachers in this way, even if the subject does not require the testing that literacy and numeracy do.

The government have recently stated their ambition to improve performance in English and maths – with the aim for England’s schools to be the best in Europe, and in the top 5 in PISA rankings worldwide, for these subjects by 2020. While climbing rankings in international tests should not be seen as an end point in itself, seeing such improvements as a result of wider improvements in the education system would be welcome. We should therefore extend this ambition to include science – not only a core subject area, but also the other area of PISA testing. This would send a clear signal of the value placed upon science, alongside English and maths.

By setting such a clear and ambitious outcome measure, the government would send an unambiguous message to schools of the vital importance of science without undermining the freedoms and flexibilities that are a key part of any successful school system. It would also reassure businesses that government understands the critical importance of science – and STEM subjects more broadly – to the economy.

Recommendation:

- Set a target for the UK’s schools to be the best in Europe - and in the top five worldwide - by 2020 in science.

To underpin this new target, the government in England needs to develop a new science education strategy, while devolved governments need to refresh their approach too. These strategies should cover all levels of education – primary, secondary and tertiary – and encompass both academic and vocational pathways. The new strategy for England should incorporate the relevant parts of existing strategies and action plans – such as the relevant actions from the Perkins Review, the ‘Your Life’ campaign and the ‘Science and Innovation Strategy’ – but have a strong focus on primary. The aim of the strategy should be to provide a single, coherent approach to supporting science education in England and expanding the pipeline of young men and women into STEM study at a higher level and into STEM careers.

Recommendation:

- Develop a new science education strategy covering all levels of education – primary, secondary and tertiary.

Ensuring teachers have the confidence they need to deliver the subject is key...

The fact that primary school teachers are generalists means that they have often not studied science subjects past GCSE level themselves. Indeed, research has shown that across 17,000 primary schools in England in 2009, there were only 6000 teachers with both a science degree and specialist science teaching qualifications. Estimates also suggest that just 5% of current primary school teachers hold a science related degree.

This has in part led to a situation in which many teachers lack the confidence that they have in teaching other subjects – particularly in the face of the fast-advancing landscape of science. A perceived lack of subject knowledge on the part of teachers themselves can have a real negative impact on learning.
When we asked teachers about their level of confidence in teaching science, we asked them to rate themselves on a scale of 1-7 (where 7 was very confident, and 1 not at all confident) (Exhibit 10).

Exhibit 10 How confident would you say you are in teaching science? (Where 7 is very confident and 1 not at all confident) (%)

Around one third of teachers rated themselves at 4 or below on our scale – suggesting a lack of confidence in the teaching of this subject. Many of those who fell into this category were those who also held the lowest level of science qualifications – typically GCSE or equivalent. It is promising that 13% felt very confident in teaching science, however more work is clearly needed to ensure that all teachers who teach science are confident in doing do.

A lack of confidence in subject matter can translate into a less than inspiring delivery of the subject, increasing the likelihood of the negative attitudes towards science from children that we discussed earlier in the report.26

The quality of teaching is an incredibly important driver of educational outcomes – as has been well explored and documented. Confidence in, and comfort with, a subject on the part of the teacher has a strong impact on outcomes, as well as on interest in the area of study for young people – so must be a priority for action.27

Intrinsically linked to the issue of confidence is that of continuous professional development (CPD) for teachers. When we asked teachers what would help them to build their confidence in teaching science, 62% called for more professional development focused on science (Exhibit 11).

This has already featured prominently in research into the question of improving science education in primary schools: the role and quality that CPD linked specifically to science has to play in the quality of science education should not be underestimated.

Exhibit 11 What would help build your confidence in teaching science? (%)

These results also show the role that businesses and universities can play in helping to develop teacher confidence in primary science education. This is explored further in chapter 3.
Tomorrow’s world: Inspiring primary scientists
...so professional development for science must be up to scratch

While general professional development is perceived to be of a high quality overall, beneficial to the overall skills and abilities of primary school teachers and indeed something that is invested in highly by schools – there remains a real need for science specific CPD to become more of a focus.

Professional development related to science subjects for primary school teachers is generally seen to be poor.

The 2011 report from Ofsted Successful Science, highlighted that the take-up of science specific CPD was low, as well as being of no better quality than satisfactory in many cases. This is in contract to secondary schools, where the quality of science specific CPD was generally seen to be of much higher quality.

This is particularly concerning as studies from Ofsted into science have shown a strong correlation between provision of CPD in primary schools and the overall effectiveness of science teaching.

The professional development undertaken by primary schools in general has been insufficient to tackle the concerns around teacher confidence in relation to science subjects, with a focus on generic professional development at the expense of subject specific CPD.

Some have suggested that this is linked to the de-prioritisation of science in comparison to English and maths since the removal of end of Key Stage examinations, so it is important that a concerted effort is made to reinvigorate the commitment to a core focus on science study.

**Recommendation:**

• Primary schools should ensure that professional development for science is of a high standard, and that it is undertaken on a regular basis.

Leadership of science has also been observed by Ofsted to be a key concern in many primary schools, with a lack of effective leadership for the subject leading to a decline in its profile. The primary science quality mark (PSQM) is seen to be one way in which schools – who recognise the issue – can ensure that science remains a priority throughout the school, as it requires both reflection on and assessment of provision.

62% of primary school teachers called for more professional development focussed on science

The Campaign for Science and Engineering (CaSE) have recommended that all primary schools should have a science subject leader in place to support other teaching staff members with lesson design and delivery. As Exhibit 11, page 18 shows, approximately two fifths of teachers said that this would build their confidence in teaching science.

Having a clear strategy for science for the whole school, driving a continuing focus on the subject, and supporting CPD for other teachers are just some of the benefits that could come from this initiative – and is something that deserves real consideration.

**Recommendation:**

• All primary schools should have a subject leader for science in place to drive a continual focus on the subject.
Businesses and universities can do more to support schools – who should be rewarded for building these links

If science teaching and support is a vital matter for the whole UK, it is not right to expect hard-pressed primary schools to tackle the issue working alone. Support from industry and the higher education sector is a vital part of the solution.

- There is good practice out there – but the impact is not yet great enough
- There is an appetite from teachers, as well as from business and universities, for this kind of engagement to be scaled up.

With our survey showing that almost a quarter of the teachers we spoke to felt that more support from universities and employers would help to build their confidence in science (Exhibit 11, page 18) and help enthuse and engage pupils (Exhibit 4, page 13), this is an area that needs to be explored and promoted.

It is clear from our survey that teachers are open to working with businesses and universities. Of the teachers surveyed for this report, around three quarters who expressed a view stated that they would like to see increased engagement from businesses around science education at primary school – and over 80% wanted to see increased engagement from universities (Exhibit 12 and 12a).

Only 15% of the teachers we surveyed had received any kind of support from either a university or an employer.
In particular, the teachers we spoke to wanted to see increased support for science from businesses and universities through provision of equipment and use of facilities – with 77% of respondents highlighting this (Exhibit 13).

Exhibit 13 If business or universities were to provide more support, what would be most helpful/have the greatest impact? (%)

<table>
<thead>
<tr>
<th>Support provided</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support in delivery of lessons/class visits to facilities</td>
<td>62</td>
</tr>
<tr>
<td>Provision of learning materials/lesson plans</td>
<td>55</td>
</tr>
<tr>
<td>Provision of equipment/use of facilities</td>
<td>27</td>
</tr>
<tr>
<td>Support for teacher development</td>
<td>46</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
</tbody>
</table>

This survey also demonstrates the appetite for increased support in all areas – with the lowest (support for teacher development) still being highlighted by almost half of respondents. Teachers themselves are open to this, and we know that businesses and universities are willing – the challenge lies in how we make this happen.

This is where we can learn from existing practice. Looking to other areas of STEM study can give us some more ideas of how we can increase levels of quality engagement from both higher education and business.

There is good practice out there – but the impact is not yet great enough

Our annual education and skills survey showed that 80% of businesses engage with schools or colleges more generally, from offering work experience and careers guidance, to supporting employees in acting as governors and engaging in curriculum development.36

While 4 out of 5 businesses had links with schools or colleges, only a minority of these organised links at a primary level.37 This is something that needs to be scaled up – and engagement around science is one area where businesses have a lot to contribute. Universities also provide support to schools and young people, through partnerships, opening up campuses for school visits, and supporting teacher development.

Despite this good base of business effort, the lack of business engagement at primary was clear from our survey - only 15% of the teachers we surveyed had received any kind of support from either a university or an employer. This is not good enough – it is time to step up. Companies and universities need to do more – but the Ofsted framework should also reflect the value that schools can generate from building these links.

Where engagement had taken place, our survey identified the forms it has taken. The type of interaction varied, with 59% saying that they had received support with lesson planning or provision of learning materials, 62% receiving support from professionals with delivery of lessons or class visits, 56% through provision of materials or use of facilities, and 59% receiving support for teacher development (Exhibit 14, page 24).
Exhibit 14  What support have you received from either businesses or universities around science? (%)

- Support for teacher development: 59
- Provision of equipment/use of facilities: 59
- Provision of learning materials/lesson plans: 59
- Support in delivery of lessons/class visits to facilities: 59

For each of these kinds of engagement, we see a different level of experience when looking at interaction with businesses compared to universities, suggesting that the different groups can offer different benefits to primary schools in this field – and highlighting the need for support from both.

Of those who said that they received support from universities around science, support for teacher development was most prevalent (67%) – whereas the most common kind of support experienced by those who said they had engaged with businesses was through provision of learning materials or lesson plans (73%) (Exhibit 15 and 15a).

Many business provide learning materials...

Provision of learning materials to support teachers with lesson planning can be valuable if linked to curriculum content, particularly in the face of concerns about confidence and more in-depth subject knowledge.

Organisations such as the Primary Science Teaching Trust and Association for Science Education have worked to make these materials more readily accessible to teachers – but businesses are also playing their part, with employers such as Siemens providing free to use curriculum linked materials to schools in order to support teachers and to make science more exciting for young people (Case study 1).
CASE STUDY 1: SIEMENS

As one of the world’s major engineering companies, employing almost 14,000 staff in the UK, Siemens is dedicated to helping enrich and enhance STEM teaching and learning in schools in the UK.

The Siemens Education website offers free, stimulating and unique resources that help to bring STEM subjects to life at Key Stage 2 and above – including curriculum linked schemes of work and lesson plans, interactive game play, and tasks and challenges. Siemens have also developed an interactive learning tool to help pupils at KS2 understand how technology helps medical professionals to detect illness and save lives – helping to further pupils’ understanding of the human body.

Find out more at www.siemens.co.uk/education

...while businesses and universities alike can provide practical support in delivering science lessons

In addition to providing materials, the benefits of practical support in delivering science lessons or offering opportunities for young people to visit facilities can be invaluable.

Hearing about the realities of science in research or in industry from those involved can be particularly inspiring for young people – as can seeing things that they have been taught about in lessons being used or applied in the real world.
The benefits of practical support in delivering science lessons or offering opportunities for young people can be invaluable.

CASE STUDY 2: BAE SYSTEMS ROADSHOW

The BAE Systems Schools Roadshow uses theatre-in-education to engage young people in STEM, often making it more memorable and powerful than standard teaching materials. It is designed to promote STEM subjects in school and to encourage more young people to pursue these subjects at a higher level and grow the potential pipeline available for careers in engineering and manufacturing. In 2014 and 2015 it has a focus on the Physics curriculum and bringing it to life with live experiments.

The roadshow is aimed at years 6 and 7 – that transition between primary and secondary school where many young people lose interest in science.

The main character in the roadshow is a girl as the main character and the storyline reinforces a message that STEM subjects and STEM careers are for young women as well as young men.

They work in partnership with the Royal Air Force in delivering the roadshow in order to extend the reach beyond their own sites to larger urban conurbations and schools with larger numbers of ethnic minority students. In 2015 it will reach 65,000 young people.

Teacher feedback suggests it has a powerful impact reinforcing the messages they give about the importance of STEM subjects, and as well as being enjoyed by children, the feedback reports show that it is particularly successful in engaging girls.
It is clear that employers and universities can have a big role in helping to generate enthusiasm and interest in science amongst young people – and the BAE Systems Schools roadshow is a great example of this (Case study 2). But this kind of engagement is not currently a priority for schools. As we set out in our response to the recent Ofsted consultation on reforming the framework for inspection, we need to see the importance of employer engagement expressed more prominently – at primary as well as at secondary level – and covered in more detail in the inspection handbooks. This is too important an issue to let fall by the way-side.

Jaguar Land Rover’s ‘Girls in the Know’ programme and its expansion to include primary school children is another good example of how businesses can work with schools to inspire more young pupils to think about STEM careers from an earlier age, and the focus on girls is particularly important given the pipeline issue.

The recent announcement of the creation of a STEM Outreach Lab at Brunel University London is a great example of where we are seeing universities step up to the mark to support science education (Case study 3, page 29). This kind of investment can help emphasise the excitement that science can bring by delivering lessons and experiences in a way which primary schools are just not able to do.

While care must be taken to ensure that the offering for schools in this space is clear, we must also keep the door open for exciting initiatives that offer real potential to revolutionise the way young people look at sciences.

Recommendations:

- A new Ofsted inspection framework should find space to reward schools for meaningful engagement with the wider community on key subjects like science, especially businesses and universities.
- Businesses and universities need to step up to the challenge too – and ensure that they explicitly consider outreach into primary schools.

Teacher development is critical – and here universities are leading the way

It is clear that teachers want to interact with professionals and academics active in science to help further develop their knowledge and skills in this field – and to improve the quality of science lessons for young children.

Combining this kind of subject-specific CPD with a continued focus on the development of wider teaching skills will help to increase the confidence of many teachers in relation to teaching science at primary schools – tackling many of the issues that we have discussed in this report. Grants, such as those offered by the Royal Society, can help finance this (Case study 4, page 29).

Being better able to link science teaching to real life examples will also serve to help engage young people in their learning of the topic – and we would hope to see this carried through into the later stages of education.

The idea of integrating a teaching qualification with higher science study, as is currently being explored by Brunel University London with their MSCi with QTS (qualified teacher status) programme, is something that should be learnt from and built upon.
We should encourage employers and universities to be more open to the idea of teachers coming into their workplaces to better understand the realities of science.
CASE STUDY 3: STEM OUTREACH LAB – BRUNEL UNIVERSITY LONDON

Brunel University London have been awarded a £5 million grant from the Higher Education Funding Council for England to further their work in re-balancing the gender gap in STEM careers and encouraging young people to choose STEM subjects at university. As well as refurbishing facilities and growing the intake for their programmes, there is a real focus on widening the pipeline into these subjects and STEM industries.

At the heart of these new facilities will be Brunel University London’s innovative STEM Outreach Lab, due to open in September 2015. This will benefit some 30,000 young people a year, both on and off campus – harnessing the enthusiasm of students themselves to generate that interest and inspiration young children need. Brunel’s strategy is to recruit a small army of Brunel Student STEM Ambassadors who will be paid to teach activities such as welding with chocolate, robot racing, science busking and deliver STEM careers talks to school pupils aged 11 to 14 both in schools and at Brunel University London. The centre is already getting strong support from business and will include a Fujitsu ‘Innovation Hub’.

This kind of co-ordinated approach – widening opportunity and participation for STEM subjects at all stages of education – will be key to tackling the skills shortages this country faces in both the short and long terms.

We should also work to encourage employers and universities to be more open to the idea of teachers coming in to their facilities and workplaces to better understand the realities of science, particularly for those primary school teachers who do not have a high level of specialist knowledge.

The idea of this kind of professional development should be explored more closely, working with scientific societies, employers, universities and the profession to discover how this could be most valuably enacted.

Recommendation:

- As part of CPD, the potential for teachers to spend some time in businesses and universities to enhance their understanding of the theory and application of science should be developed – and promoted to both schools and professionals.

CASE STUDY 4: ROYAL SOCIETY PARTNERSHIP GRANTS

The Royal Society offers grants to primary and secondary schools for STEM projects run in partnership with professional scientists and engineers.

As well as providing funding for specialist equipment and opportunities for class visits, and generating enthusiasm among pupils for science subjects, this scheme offers an interesting source of professional development for teachers.

By allowing schools to work alongside practising scientists and engineers, they can better keep up to date with the latest developments in science, as well as being more aware of how science education can be linked to real life examples.

Building these relationships with businesses and universities can also help to raise and shape the aspirations of pupils as they progress through their education – inspiring them about the possibilities of science.

Source: https://royalsociety.org/education/partnership/
We can learn lessons from other parts of the curriculum to apply to science

- **Maths and computing are subjects which have lessons to offer and challenges of their own**
- **We can do more to scale up provision that already exists to support schools and guide students**

Maths and computing are subjects which have lessons to offer and challenges of their own

Maths, alongside English, is a core subject which underpins progress throughout other subjects and areas of learning. A good knowledge of maths has a significant impact on a young person’s employment prospects and - for business – the focus on driving up numeracy skills at primary must continue. In our annual education and skills survey, businesses consistently cite improving numeracy and literacy as a priority.

Despite this focus, there remain some issues – such as comparatively low levels of take up of maths post-16 in comparison to other successful education systems.\(^4\) While levels of take up vary across the UK – with 27% of students in upper secondary studying advanced maths in Scotland, compared to just 13% in England – this still lags well behind the participation rates we see in some other countries.\(^5\)

Like science, a key factor is the quality of maths teaching. If we were better able to engage and excite young children in maths study at primary level, this is something that could continue to support their maths learning as they progress through the education system.

We need to make maths exciting. This has been recognised, and the following case studies show some of the real-life work that has been undertaken (Case study 5 and 6). We need to grow this engagement in maths, and apply a similar energy in science.

Computing, too, has lessons to offer. The recent introduction of computing to the primary school curriculum in England, while welcome, has presented schools with sharp capability difficulties – this is something that teachers have simply not been trained to do in the past. Yet we are already we are seeing efforts from industry, sector bodies and universities to support skills development in primary school teachers to help boost their ability to deliver this challenging subject.

The ‘Barefoot Computing’ project is one example of where different groups have stepped up to the challenge to support teacher development – providing not only free practical resources, but also computer science workshops.\(^6\) There is no reason that similar sorts of programmes cannot be a success in science more widely.

**Recommendation:**

- Assess the success of existing primary school schemes, in search of lessons for science.
CASE STUDY 5: THE JAGUAR MATHS IN MOTION CHALLENGE FOR SCHOOLS

The Jaguar Maths in Motion Challenge is the UK’s largest maths based project and has engaged more than one million young people over the past decade at both primary and secondary level.

Linked to elements of the maths curriculum, the challenge motivates students and teachers as well as helping to place maths in a real-life context.

Covering a wide range of basic maths skills – including some that are practical - the challenge motivates students and teachers as well as helping to place maths education into a real-life context.

Using tried and tested Cloud-based software that simulates the setting up of a racing car, small teams of students complete a series of STEM tasks to produce a ‘virtual’ car which enters a competitive race. Successful teams compete with other schools to win a place in the national final.

Find out more at www.mathschallenge.co.uk

CASE STUDY 6: ENHANCING MATHEMATICAL LEARNING THROUGH TALK – BRUNEL UNIVERSITY LONDON

The ‘Enhancing Mathematical Learning through Talk’ project being run by Brunel University London aims to develop both the subject knowledge and pedagogical expertise of KS1 teachers, working with over 30 schools from the London boroughs of Wandsworth and Merton.

These aims are being achieved by offering professional development in two interacting strands with subject knowledge sessions encouraging thinking in depth about mathematical concepts and the pedagogical sessions focusing on the use of language in mathematics in order to enhance children’s mathematical reasoning.

The central theme in this case is to encourage ‘mathematical talk’ and discussion in the classroom. During professional development sessions, teachers are provided with a toolkit of what contributes to high quality classroom interaction based on research evidence, key readings and resources to help promote mathematical talk and the active engagement of children.

There is a high level of enthusiasm and active participation amongst teachers, very good attendance at CPD sessions, and appreciation of the opportunities.

For more information, please contact Professor Valsa Koshy: valsa.koshy@brunel.ac.uk
We can do more to scale up provision that already exists to support schools and guide students

The work of the science community and of both higher education and business sectors to improve standards and outcomes for young people has clearly had a substantial impact on the landscape – but the continued presence of many of the issues we have observed shows us that there is still more work to be done. This is particularly notable in primary – where few teachers have experience of the support on offer, and report a lessening of the importance of science in the curriculum.

Examples from across industry and universities throughout this report have given us an insight into the fact that there is already a vast array of work going on in this space – with programmes and schemes available at all levels of education intended to support delivery, generate interest and inspire young people about sciences.

While this engagement and investment is to be supported and encouraged, we need to work harder to simplify and help all parties navigate the landscape – ensuring that the best examples are promoted and learnt from: rolling out best practice to ensure that all young children in all primary schools are benefitting from these opportunities.

One initiative that has the potential to support this agenda is the ‘Primary Futures’ programme from the Education and Employers Taskforce – which brings inspiring speakers from industry into the classroom, sparking the interest of young people in different careers and sectors.43

Another important programme is STEMNET, which is more prevalent in secondary schools, but also works with primary schools across the country to help link young people and their teachers to STEM professionals in the area. Utilising this programme helps to inspire and excite students about these subjects, and also provides a level of support for teachers – providing knowledge about applications of STEM in industry or research.44

In the secondary landscape, there is currently a lot of attention being paid to mapping the extent of activity, and exploring how we can bring some coherence to the system through the remit of the newly created ‘Careers and Enterprise Company’ in England. Part of the responsibility of this new body will be to help build a bridge between the world of business and schools – supporting and facilitating the creation of relationships in relation to careers guidance and work inspiration.45 We believe that, working with national schemes such as Primary Futures and STEMNET, the company has the potential to change the game on meaningful engagement with the teaching of science.

Many of the barriers to building links between businesses and schools at secondary level are exactly the same as those faced at primary level: confusion over the range of programmes on offer; uncertainty over how to make contact; lack of interest on one side or the other; lack of time or resources; specific regional challenges; and lack of incentives in the system to focus on business-school engagement. This issue needs a long term solution, and a commitment to seeing this solution through will be required. The next government should, therefore, underpin the role of the company and allow it to focus on primary as well as secondary support – addressing the current lack of coverage.

Recommendation:

- The new ‘Careers and Enterprise Company’ should include primary in its thinking, with the next government committing to funding the company for the term of the next Parliament.
Summary of recommendations

• Set a target for the UK’s schools to be the best in Europe - and in the top five worldwide - by 2020 in science.
• Develop a new science education strategy covering all levels of education – primary, secondary and tertiary.
• Primary schools should ensure that professional development for science is of a high standard, and that it is undertaken on a regular basis.
• All primary schools should have a subject leader for science in place to drive a continual focus on the subject.
• A new Ofsted inspection framework should find space to reward schools for meaningful engagement with the wider community on key subjects like science, especially businesses and universities.
• Businesses and universities need to step up to the challenge too – and ensure that they explicitly consider outreach into primary schools.
• As part of CPD, the potential for teachers to spend some time in businesses and universities to enhance their understanding of the theory and application of science should be developed – and promoted to both schools and professionals.
• Assess the success of existing primary school schemes, in search of lessons for science.
• The new ‘Careers and Enterprise Company’ should include primary in its thinking, with the next government committing to funding this for the term of the next Parliament.
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