

Subjects Matter

A report from the Institute of Physics



December 2020

iop.org

IOP Institute of Physics

Contents

- 03 Foreword
- 04 Executive summary
- 06 Recommendations
- 08 The role of education in a high-value economy
- 10 Developing excellent subject teaching
- 18 Opportunities to improve provision
- 24 A systematic approach
- 30 Conclusion
- 31 Appendix A: Fuller logic model
- 32 Appendix B: Acknowledgements
- 33 Endnotes

Foreword



Subject knowledge matters. Teachers with strong knowledge of their specialist subject can explain clearly, can spot and remedy misconceptions, and most importantly of all, can reach into a deep reservoir of knowledge beyond the confines of the curriculum, to inspire

young people in their subject. This is true for all teachers, primary as well as secondary.

Subject expertise is an important part of the professional identity of teachers. When the National Science Learning Centre (now STEM Learning) was founded in 2004, the motivation was not only to underpin young people's learning, but also to boost the professional pride of teachers through their subject expertise. This is true of all subjects, not only science.

I well recall, as a young teacher fresh from university, thinking I knew my subject well – but soon finding I had to work long hours every evening to really understand it, because it isn't until you have to teach a topic that you find out how well you have mastered it. Securing teachers' subject knowledge means much more than initial teacher education (ITE) alone: it is a career-long process of renewal through systematic, continuing professional development (CPD).

CPD sustains teachers' professional pride, keeps them up-to-date in developments in their subjects and gives them new ideas for pedagogy. There is clear evidence that securing teachers' subject knowledge also helps to secure and retain them in the profession – such an important thing to do when we have teacher shortages.

Subject-specific CPD should be the entitlement of all teachers, whatever stage they are at in their career, as it is in many of the countries that lead the world in education, such as Finland, Canada and Singapore, where I have seen at first hand the way CPD is embedded in teachers' professional expectations.

This report is rooted in the discussions that went on at the symposium on 22 January 2020 which the IOP hosted and I was privileged to chair. The symposium included experts and stakeholders from across education, and the message was clear: the UK needs an effective, systematic approach to teachers' CPD, with a clear entitlement to a minimum of 35 hours a year of which at least half should be subject specific. That is the proposition set out in this report and backed by compelling evidence.

The future of the UK lies in the young people in schools and colleges today, and that means it lies in the hands of their teachers, because teacher quality is the most important single factor in the success of any education system. The Covid-19 pandemic has exposed and accentuated the inequalities in educational opportunities between different socioeconomic groups and different parts of the country. A critical factor in addressing these inequalities is to level up the quality of teaching to ensure that all young people experience the best. A systematic approach to CPD is a critical part of securing such equality. I hope everyone with influence over educational policymaking will read this report and hear its key message.

Sir John Holman

Emeritus Professor of Chemistry, University of York

Executive summary

The UK Government is seeking to boost economic growth and ‘level up’ opportunity in all parts of the UK.

Progress towards these goals can be propelled by increasing the flow of well-educated students moving from our schools into employment or continued education with valuable knowledge, understanding and abilities; equally, progress will be hindered if we do not take steps now to increase the pool of talent in the workforce and education system.

Subjects are at the heart of students’ learning in a knowledge-rich curriculum. For students to have the best experience of subjects – to excel while at school and to aspire to further success in the future – teachers themselves need to have excellent knowledge and understanding of their subject and how to teach it.

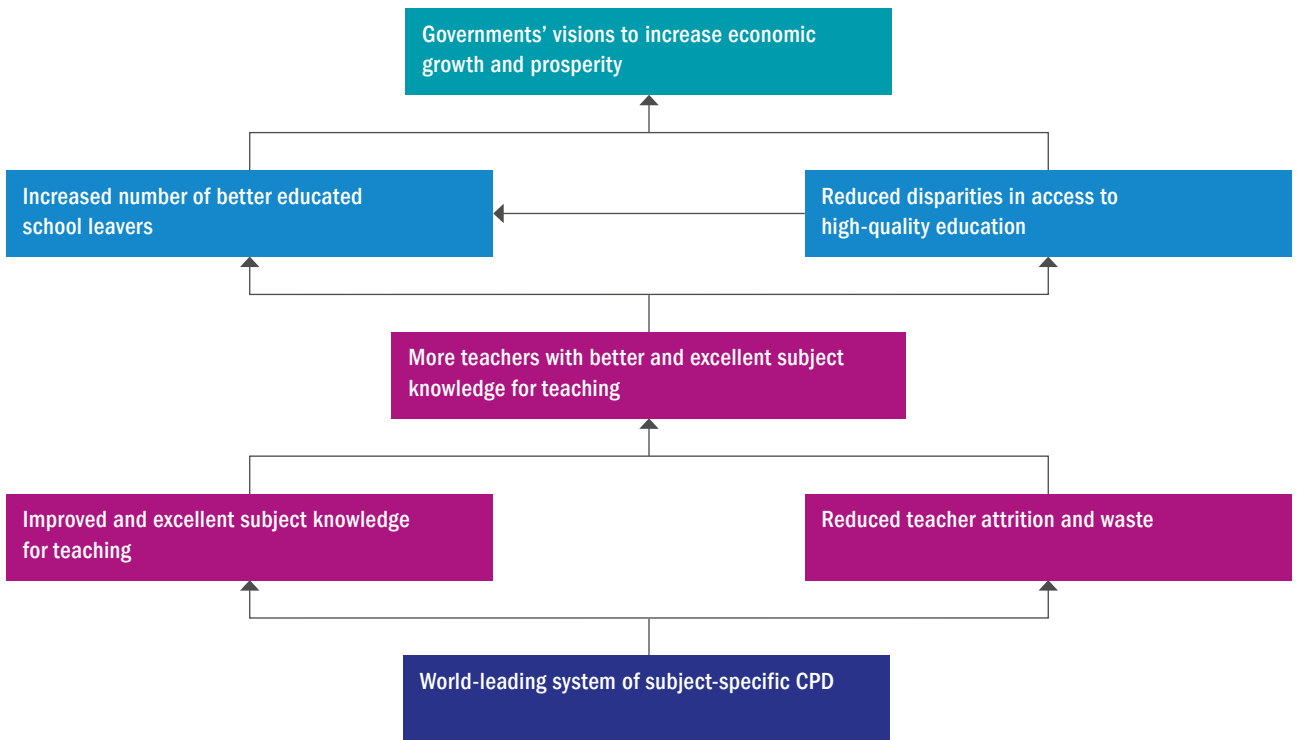
The development and retention of excellent teachers is a career-long process requiring high-quality, subject-specific professional learning which starts in ITE, is built upon early in their careers and continues throughout their professional lives. A common feature of the world’s best education systems is substantial investment in teachers’ CPD, but levels of investment and participation in CPD are relatively low in the UK. In addition, while some excellent subject-specific CPD programmes exist across the nations of the UK, these

are often limited to a few targeted subjects, forming a patchwork with little linkage between them, and rely on short-term funding cycles.

We call on the governments of the UK to invest in creating a more confident, engaged teaching profession, through a sustained world-class system of subject-specific CPD for all teachers. Such a system will help to increase the quality of teaching in our primary and secondary schools and contribute to improved outcomes for all students. This report sets out the case for such a system and offers advice and recommendations about how existing provision can be built upon and strengthened.

By investing in the teaching workforce of today, we can better equip more students with the knowledge, understanding and abilities that will fuel the industries of tomorrow. The nation already has a critical skills deficit, serious teacher recruitment and retention challenges, and ingrained inequality. Investment in the teaching workforce is needed now if we are to achieve the aim of being a knowledge-based economy driven by research and innovation during the coming decade.

Figure 1. Investment in subject-specific CPD will contribute to economic growth through improving teaching quality and therefore improving educational outcomes. A fuller logic model can be found in Appendix A



Recommendations

Governments should:

1. Improve professional standards through a systematic approach to developing teachers' subject knowledge for teaching* by:

- acknowledging the essential role of teachers' subject knowledge for teaching in driving improvements to overall teaching quality
- establishing an expert advisory group to develop and implement a national strategy to provide subject-specific CPD** in each school subject with the aim of improving student experiences and outcomes
- developing existing standards, frameworks and qualifications to clearly articulate the required subject knowledge for teaching in each subject.

2. Fund, develop and implement a national system of subject-specific CPD in each subject that:

- takes a long-term approach, with the target of increasing the number of better educated school leavers and contributing to economic recovery and growth
- reduces social and regional disparities in access to high-quality teaching for students
- is accessible to all teachers and addresses all types of need based on their experience, career stage and subject background
- enables schools and teachers to make informed choices and to plan for several years of professional learning
- builds on existing policies, programmes and evidence-based practice
- includes an integrated programme of robust evaluation, informed by experts, to drive improvement and strengthen the evidence of impact and what works.

3. Establish an entitlement for teachers which ensures that at least half of their professional learning is subject-specific in a way that:

- reinforces the importance of subject knowledge for teaching and its continued improvement
- ensures senior leaders in all schools allocate time for teachers to engage in subject-specific CPD to drive improvements in subject teaching
- contributes to a teachers' entitlement of at least 35 hours of CPD per year
- spurs a sector-wide culture change that improves the perception of the value and importance of subject-specific professional learning.

* We are using the term 'subject knowledge for teaching' as a description of knowledge that is broader than simply content knowledge; it includes: substantive (content) knowledge, disciplinary knowledge and pedagogic content knowledge (PCK).

** In this report, we consider subject-specific CPD to refer to any form of CPD that improves any or all of the dimensions of teachers' subject knowledge for teaching.



IOP symposium: Developing a high-quality CPD system

On 22 January 2020, the IOP convened a symposium at its London headquarters, to discuss the future of subject-specific CPD. The symposium was chaired by Professor Sir John Holman and was underpinned by a paper and presentation from Professor Rob Coe of Durham University. Participants included experts and major stakeholders in the world of CPD, including teachers, senior figures in subject and charitable organisations, academics, government officials and CPD providers. (A full list of participants can be seen in Appendix B.) It is the first time this century that such a wide-ranging group has come together to discuss this essential aspect of teacher development and professionalism.

The aim was to examine the case for subject-specific CPD and to work up a consensus view on how best to provide for the needs of students and teachers. The discussions resulted in agreement that there is a need for high-quality subject-specific CPD and that this should be provided for all subjects through nationally supported programmes. The recommendations opposite emerged from the discussions on the day and were broadly supported by the participants.

The role of education in a high-value economy

We are on the cusp of a new industrial era, powered by knowledge, technology and innovation.

Governments all over the world recognise the potential of these developments to shape the social and economic futures of their countries and are investing heavily in their education and research systems to help create and capture more of the societal benefits that will come from knowledge-rich economies.

Boosting economic growth through education

Governments' visions to increase productivity and economic growth depend on more, better educated school students across the UK progressing into productive employment or further and higher education

and training, and realising their full potential. Confident, engaged, well-trained teachers are essential for equipping students with the secure foundations of knowledge needed to make the most of their next step in life.

Education is indispensable to economic development.¹ The role of education in raising incomes has been outlined by various economists,^{2,3,4} and according to research by the Organisation for Economic Co-operation and Development (OECD),⁵ public economic returns are positive for investment at every educational level, primarily due to greater taxes and contributions provided from the higher salaries of more educated



and better trained individuals. Each additional year of education has a significant influence on GDP, with the estimated impact varying between 18%⁶ and 35%⁷ higher GDP per capita. A growth model analysis demonstrates that education may also increase economic growth by increasing productivity, with a significant proportion of this overall productivity growth being attributable to increased education levels of the national workforce.⁸

Accordingly, the UK nations invest heavily in their education systems, with education representing the second-largest element of public service spending in the UK (after health).⁹ This commitment reflects the importance of education in boosting productivity and long-term economic growth more than a decade after the global financial crisis and is all the more significant as we prepare for the long-term economic and social impacts of Covid-19.

Levelling up opportunity

Despite this investment, the UK has one of the most regionally unequal economies of any country in the advanced world¹⁰ and is hampered by critical skills shortages¹¹ that are exacerbated by significant disparities in educational outcomes which exist across the regions of the UK and between students with different social and economic backgrounds. Research from the Confederation of British Industry (CBI) found that disparities in educational attainment are the greatest driver of regional variation in productivity across the UK.¹² This is supported by OECD research, which suggests that such regional variations affect those with lower levels of education, in terms of employment rates and salary levels.¹³ Improvements to the education system which enable all students to achieve the best possible outcome will be essential to tackling geographical disparities in productivity and earnings, and 'levelling up' opportunity across the nations and regions of the UK.

Building the workforce of the future

The UK Government has set an ambitious target to increase investment in research and development (R&D) to 2.4% of GDP. The vision this target is intended to underpin – of a prosperous society and sustainable economic growth fuelled by new discoveries, powerful ideas and new industries – will only be realised if increased investment in R&D is mirrored by an equally dramatic increase in the number of skilled people in the workforce. Governments in each nation of the UK are already launching initiatives to support the development of new skills in schools which will prepare young people for the changing world of work,¹⁴ including coding, computer programming and cyber security.¹⁵ Additional investment in high-quality teaching, which produces well-rounded students equipped with a broad set of knowledge and a firm understanding of how to apply it, is a necessary foundation on which to build this workforce of the future.

Targeting investment to improve outcomes

Increased investment in education can address disparities in outcomes and enable more students to realise their full potential. Governments have already shown commitment to providing that investment. However, we see an opportunity to target this investment to improve outcomes more effectively and efficiently through teachers' professional learning in their subject. Greater investment in teachers' professional learning will strengthen our education system and help spur the UK Government's ambitions to accelerate the development of a high-skilled, knowledge-rich economy and ensure that the benefits are more evenly distributed across all nations and regions of the UK.



Disparities in educational attainment are the greatest driver of regional variation in productivity across the UK

Developing excellent subject teaching

The UK Government recognises that ‘great education is fundamental to the success of children, their families and our communities, as well as the success of our country’.¹⁶

Great education systems are built on great teachers. Teaching quality has been shown to be the single most important school-related factor in determining student outcomes (in terms of improved attainment and progression rates)^{17,18} and has a larger influence than, for example, class size or teacher salaries.^{19,20} Targeting investment at ensuring all students have access to high-quality subject teachers is therefore an effective and cost-efficient way of improving educational outcomes.

Investing in professional development

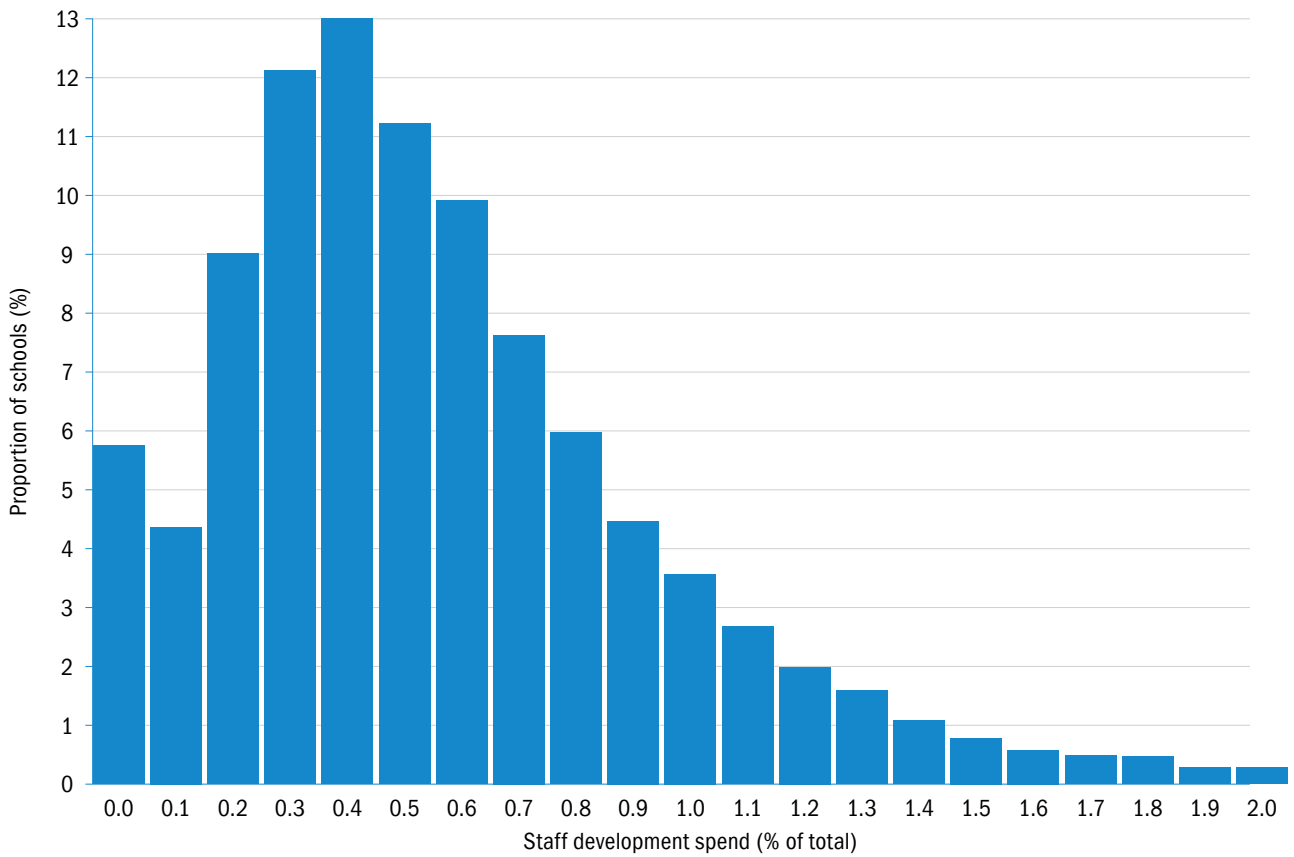
Attaining the highest possible professional standards requires teachers to possess considerable specialist knowledge and expertise. Other similarly demanding and high-value professions, such as the legal and medical professions, have well-established systems of professional development, which are recognised as critical to the continued competency of their professionals and form a part of their licence to practice.

A common feature of the world’s best education systems is substantial investment in teachers’ professional development: it is estimated that 10% of teachers’ working time is dedicated to professional development in the world’s best-performing school systems,²¹ with teachers in countries such as Singapore entitled to 100 hours of professional development per year.²² Studies have shown a correlation between funding for continuing training for teachers and higher and better qualifications for pupils in the short term, and higher growth, employment and positive externalities in the longer term.²³

However, investment in teachers’ professional learning is an area of comparative weakness in the UK. While overall education expenditure compares well with international figures (and England and Scotland are among 17 of 38 OECD jurisdictions in which some form of professional learning for teachers is compulsory²⁴), the proportion of school funding allocated to teachers’ development in maintained schools in England fell to just 0.55% in 2018/19, the lowest it has been since 2011/12.²⁵ In addition, CPD expenditure varies greatly between schools and local authorities (see figure 2 for the distribution of expenditure on CPD), with the highest expenditure-per-student in England being nearly ten times greater than the lowest (£97 compared with £10).²⁶ As a result, according to the Teaching and Learning International Survey (TALIS),²⁷ teachers in England engaged in less CPD overall and are less likely to engage in subject-specific CPD than in most other high-performing countries. Just under 50% of teachers in England had participated in curriculum-related CPD in the 12 months before TALIS, whereas almost 90% of teachers in Shanghai and 80% of teachers in Singapore had done so.²⁸

A nationally coordinated system of subject-specific CPD would ensure that all teachers can access professional learning to help improve teaching quality across the UK and address inconsistencies in investment.

Figure 2. Distribution of staff development expenditure as a proportion of total school expenditure in England, 2019.
Reproduced with permission from SchoolDash



A note on national education systems

Education is a devolved matter. Policies and outcomes vary across the nations of the UK. However, many of the concerns are broadly similar and, in each nation, there are ways in which the provision of subject-specific CPD can be improved. In this report, we give examples from the four nations of the UK where data is available. We envision the recommendations applying in each of the nations.



Improving student outcomes

The UK's education systems are already strong by international standards, with average scores for 15-year-olds in all four UK nations matching or exceeding the OECD averages in mathematics, reading and science.²⁹ Improving the quality of teaching in UK schools would improve outcomes for all students, opening more doors to further and higher education and helping more students to ultimately realise their full potential in high-value, high-skilled employment.

Subjects are the drivers of our education system: subjects matter. For students to acquire excellent knowledge at school, particularly as part of a knowledge-rich curriculum, teachers themselves need to have excellent knowledge of their subject and how to teach it – we refer to this as ‘subject knowledge for teaching’, which comprises substantive, disciplinary and pedagogic content knowledge (PCK). Each of these elements is essential to high-quality teaching and studies have shown that this knowledge is an ‘important predictor of student learning’.³⁰ Good subject knowledge for teaching not only enables teachers to convey knowledge to students effectively; it also allows them to enrich students’ experience of a subject,³¹ increasing the enthusiasm with which students engage with and apply that knowledge during their time at school and beyond, raising their aspirations and giving them a lasting sense of the value of their learning.

Although most teachers will have acquired many aspects of the necessary subject knowledge for teaching before entering ITE, there will still be many gaps in their knowledge and PCK in particular will be completely new. Professional learning of subject knowledge for teaching is needed within ITE and should continue, in a systematic way, through teachers’ early careers and onwards.³²

Developing subject teaching through CPD

The impact of high-quality CPD can be significant, having a greater effect on pupil attainment than interventions such as implementing performance-related pay for teachers or lengthening the school day, and can close the gap between new and more experienced teachers: research from the Education Policy Institute found the improvement in pupil outcomes attributable to CPD to be of the same order as the impact of having a teacher with ten years’ experience over a new graduate.^{33,34,35}

There is a need for more peer-reviewed academic studies regarding the direct impact of subject-specific CPD on student outcomes (as highlighted in a recent review³⁶), which reflects the limited and disjoint nature of existing provision. However, practice-based evaluations have demonstrated the effectiveness of subject-specific CPD in improving student outcomes and teacher retention.³⁷ These evaluations also confirm the positive effect of such programmes on the mechanisms that are likely to further improve outcomes, such as: improving teachers’ subject knowledge for teaching, reported improvements in teachers’ ability to teach a topic well, increased confidence and increased motivation. An expanded and coordinated approach to the provision of subject-specific CPD would enable a more robust evidence base to be built and demonstrate its relative impact and which methods of provision are most effective.



Examples of impact

Stimulating Physics Network

The Stimulating Physics Network (SPN), run by the IOP, aims to improve the number of students progressing to A level physics by supporting teachers in schools where there is a shortage of in-field physics teachers. At any one time, the programme's CPD leaders are working with about 400 schools in England, usually running workshops for the whole science department within the school. An analysis of NPD data showed that, from 2015 to 2018, the number of students progressing to A level physics increased by 24% in SPN partner schools, compared to 4% for all other subjects in those schools, and a 5% national increase in progression to physics. The number of female students taking A level physics increased by 45% and the number of pupil premium students increased by 46%. There was also an increase of 36% in the number of students achieving A*/A grades at A level.

Geography Quality Marks

The Geography Quality Marks (GQM) run by the Geographical Association supports the development of high-quality curriculum provision and teaching in geography, of high standards and expectations, behaviour and relationships, subject leadership, subject status and 'subject thinking'. It does this through robust and supported self-evaluation, collaborative critical reflection and evidence gathering and analysis, focusing clearly on the quality of geography education, including its intent, implementation and impact, and fostering subject community links. Since its inception in 2006, over 1,250 primary and secondary schools have achieved a GQM and at any one time there are over 300 schools who hold an award. The impacts of the process are consistently impressive, with 99% of school co-ordinators each year suggesting that engaging with the GQM has been positive for them and their students.

Subject-specific CPD for the arts

Spaeda, with support from the Arts Council, developed arts CPD for subject leaders built around action learning networks, cultural events, conferences and seminars. An important part of the provision was a collaborative sketchbook project and exhibition called Switchbook, which arts leaders and young ambassadors in schools worked together on. The project, delivered with the National Society for Education in Art and Design, the University of Exeter and the National Sketchbook Circle Project, improved students' cultural capital and wider cultural knowledge, and increased the maturity of student outcomes as a result of working with culturally engaged and more confident teachers. In addition, the Artist Teacher Scheme (ATS) was an accredited programme run in partnership between 12 higher education providers and 12 regional cultural institutions. Evaluation of the ATS found that two thirds of participants increased their subject knowledge, and saw an increase in student attainment.³⁸ Ofsted named the ATS as a particularly valuable form of CPD for arts educators.³⁹

STEM Learning

STEM Learning provides high-quality subject-specific CPD, delivering over 50,000 days of CPD a year for teachers in primary and secondary schools and post-16/further education colleges, improving teaching and tackling shortages by encouraging teachers to stay in teaching. Independent analysis shows that teachers are 160% more likely to remain in the profession after STEM Learning support. Students also benefit: primary schools improve pupil science results 50% faster and secondary schools double the rate of progress in science GCSEs, with an increase of over 10% in the proportion of pupils achieving two good science GCSEs.⁴⁰ In 2018/19, schools that engaged with STEM Learning CPD saw 16,000 additional young people achieving grade 4 or above in at least two science GCSEs. At A level, entries into STEM subjects have increased 8.5% over the last three years, with 80% of these entries from schools benefitting from STEM Learning CPD.

Providing equal access to high-quality teaching

Investment in developing teachers' professional knowledge will help reduce inequalities in access to high-quality teaching. The best-performing education systems internationally are those in which every student, regardless of their background, has access to excellent teaching.⁴¹ In the UK, regional inequalities are evident and, worryingly, appear to be getting worse, with analysis from the Social Market Foundation Commission on Inequality in Education suggesting that the area in which a child lives has become a more powerful predictive factor of performance for those born in 2000 compared to 1970.⁴² Failure to address these inequalities is likely to undermine the UK Government's plans to level up the economy as disparities in educational attainment are known to be the greatest drivers of regional variation in productivity.⁴³

These inequalities are compounded by teacher shortages in our school system. A shortage of high-quality subject teachers means some schools do not have a full complement of those teachers, and those schools tend to be in more deprived areas. Currently, pupils in schools serving areas of higher deprivation are much more likely to have teachers without an academic degree in a relevant subject.⁴⁴ This highlights another fundamental and long-standing problem in our education system. There is a marked gap in attainment and progression between disadvantaged students and their more affluent peers – a problem which is more pronounced in the UK than in many other OECD countries.⁴⁵

Improvements in teaching quality offer significant potential to reduce, and in some cases even eliminate, the attainment gap.⁴⁶ Increasing the number of teachers with excellent subject knowledge could help provide better access to high-quality teaching for every child, irrespective of their household income or where they live, supporting the UK Government's ambition to level up opportunity throughout the UK.

Strengthening the teaching profession

In recent years, the number of qualified teachers in state schools has failed to keep up with the growth in pupil numbers.⁴⁷ The number of graduates entering initial teacher education in 2018/19 fell below the required targets for computing, chemistry, maths, modern foreign languages and physics, as well as the overall targets for secondary and primary teachers in England,⁴⁸ Wales⁴⁹ and Scotland.⁵⁰ Although teacher numbers have increased a little, the wastage rate (the percentage of teachers not identified as teaching in a school in a given year who were in the previous year, divided by the total number of teachers teaching) also increased in every subject between 2011 and 2015.⁵¹

With a rising population, pressures on teacher recruitment and retention are likely to grow in the coming years unless mitigating action is taken.⁵² Several initiatives have been launched in recent years, such as the Department for Education's recruitment and retention strategy and early career framework (ECF), financial incentives in Wales,⁵³ and dedicated professional learning as part of the Teacher Induction Scheme (TIS) in Scotland;⁵⁴ however, these initiatives have tended to overlook subject-specific support, particularly at the implementation stage.

As well as the direct impact on teaching quality, subject-specific CPD can further contribute to improved educational outcomes by keeping experienced teachers in the profession for longer. Participation in subject-specific CPD can positively impact a number of factors which have been shown to influence teacher retention: by improving their confidence, increasing their sense of effectiveness (or self-efficacy), giving them more agency and providing them with autonomy over their professional learning.

Autonomy and agency

Teacher autonomy is strongly associated with teachers' job satisfaction and intention to stay in the profession, and research suggests the average teacher in England has less agency and autonomy compared to similar professionals.⁵⁵ When considering different aspects of teachers' autonomy, their sense of autonomy over their professional development goals was found to be particularly low, while also being the feature most likely to improve their job satisfaction and intention to stay in teaching.

Improving teachers' subject knowledge for teaching will improve their agency, i.e. their ability to make effective personal decisions about their teaching and planning, as well as provide them with the ability to determine their own professional learning, further increasing their sense of autonomy and, as a result, helping to reduce attrition rates.

In addition, recording the subject-specific CPD teachers have participated in, through a more systematic approach, would enable headteachers to more easily deploy teachers according to their strengths and reduce the amount of out-of-field teaching that they are required to do. Evidence shows that deploying teachers in their main field helps them become good more quickly and keeps them in the profession for longer by reducing their workload, further increasing their self-efficacy and confidence. Effective deployment also increases the opportunities for students to experience the best quality teaching available in their school.

Improving teachers' job satisfaction in these ways could help to keep more teachers in the profession for longer, increasing the overall experience of the teaching workforce, and reducing wasted investment in teacher

recruitment and initial teacher education. High-quality CPD has been shown to improve teacher retention⁵⁶ and the positive impact of subject-specific CPD in particular is evidenced by the STEM Learning CPD programme: 1 in 12 teachers who did not participate in STEM Learning CPD left teaching the following year, compared with 1 in 30 of those who did.⁵⁷ This demonstrates the potential of subject-specific CPD to provide a good return on investment even when only considering its impact on retention (and this is explored further in the box on the next page).

Increased morale and professionalism among teachers could also improve the perceived attractiveness of teaching as a career choice, in turn increasing both the number and calibre of potential new recruits.

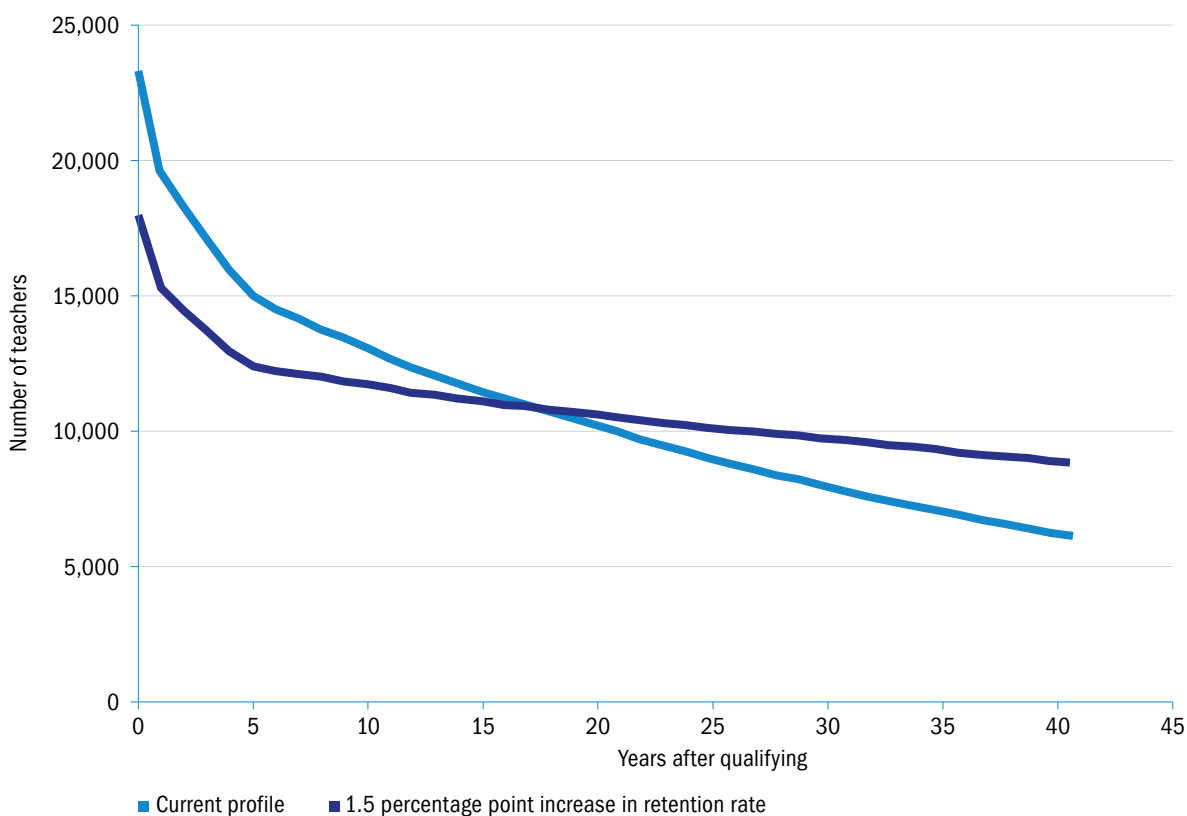


Making teacher recruitment more cost efficient

In addition to the wider economic and societal benefits resulting from high-quality teaching, opportunities exist to make recruitment, development and retention of the teaching workforce more cost efficient. In England, for example, around 23,500 new teachers are recruited every year.⁵⁸ This high level of recruitment is driven, in part, by wastage – around 40% of teachers leave the profession within the first five years⁵⁹ and just 6,000 of the original 23,500 remain in the profession until retirement. Estimating the minimum cost of initial teacher education to be £23,000⁶⁰ per teacher results in a total annual ITE cost of over £540 million.

The impact of a relatively modest improvement in teacher retention on the cost of recruitment is quantified in the models in figure 3.⁶¹ The blue line shows a model for current teacher retention in England, with 23,500 teachers being recruited each year, 6,300 retiring and a total teacher workforce of 453,000. The red line shows a revised model with an increase in the retention rate of 1.5 percentage points for all teachers. The total number of teachers is still 453,000; however, 8,800 teachers now remain in the profession until retirement and the recruitment burden needed to retain 453,000 teachers is reduced to 18,000 a year. Such a reduction in ITE costs would directly save at least £126 million per year from the estimated total cost of £540 million.

Figure 3. Models showing how increasing the teacher retention rate by 1.5 percentage points would reduce recruitment needs by more than 35%



Leading the world in high-quality subject teaching

Improving subject teaching is at the heart of improving educational outcomes. The UK has an opportunity to lead the world in the quality of its education systems, increasing the number of better educated school leavers and reducing disparities in their outcomes, and realizing the benefits in terms of increased economic growth across all its nations and regions.



CPD expenditure varies greatly between schools and local authorities, with the highest expenditure-per-student being nearly ten times greater than the lowest

Opportunities to improve provision

The development of excellent teachers is a career-long process requiring ongoing, high-quality professional learning which starts in initial teacher education, is built upon early in their careers and continues throughout their professional lives.

While some excellent subject-specific CPD programmes exist,⁶² and each nation has shown a commitment to investing in CPD, current provision is piecemeal and in many cases restricted to shortage subjects. In England, the Maths Hubs,⁶³ guided and coordinated by the National Centre for Excellence in the Teaching of Mathematics (NCETM), linking with the Advanced Maths Support Programme,⁶⁴ led by Mathematics in Education and Industry (MEI), go some way towards providing a coherent subject-specific CPD provision for mathematics,⁶⁵ but it is crucial for all subjects. Other challenges exist which prevent the effective development of all teachers' professional knowledge, across all UK schools and education systems.

Learning from existing programmes

At the January 2020 symposium at the IOP, participants discussed the challenges currently facing teachers and schools in accessing high-quality subject-specific CPD, and identified a number of opportunities to improve existing provision. These include:

- A. Addressing all types of professional learning need
- B. Improving links between delivery programmes
- C. Improving links to expertise outside of schools
- D. Creating a culture of CPD for all teachers
- E. Increasing participation and extending access
- F. Improving the quality of provision
- G. Enabling teachers to plan their professional learning
- H. Sustaining access to programmes
- I. Collecting more evidence about what works.

A. Addressing all types of professional learning need

Teachers take different pathways into teaching and will have different amounts of subject knowledge when they enter the profession. Consequently, their professional learning requirements vary widely. An effective CPD system must cater for this diversity of needs. A simplified model is shown in figure 4, illustrating the three main routes to becoming a teacher in a subject, alongside details of the professional learning support currently associated with each.



“

58% of teachers surveyed did not feel they received enough subject-specific CPD in a typical year⁶⁶

Pathways of professional support

In-field professional support: In-field teachers (route 1 in figure 4) typically have a degree in a subject related to the subject they are teaching and their initial teacher education will have focused on this subject. Ongoing professional learning enables these teachers to continue to improve at teaching their subject.

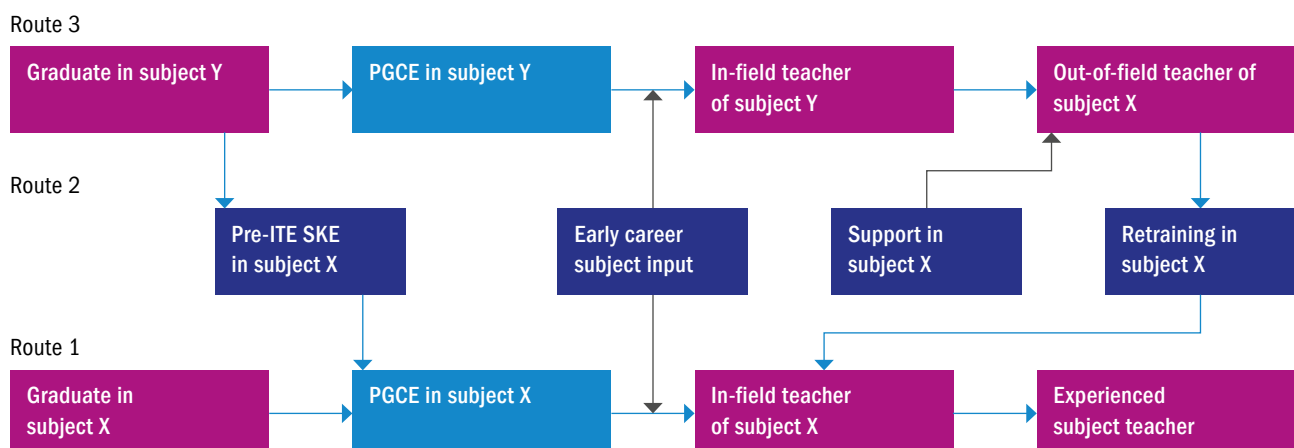
Pre-service retraining: Some teachers retrain before their initial teacher education through a subject knowledge enhancement course (route 2 in figure 4). Some of these courses are excellent; however, there is little standardisation, and the link between these courses and in-service training is weak, partly because no record is kept of the course or topics within.

In-service retraining: Some out-of-field teachers retrain and gain an extra specialism once they are in service. While such programmes have existed,⁶⁷ it is not clear how they link with general support and other subject-specific programmes, and they are not necessarily driven by the particular needs of a school or teacher.

Support outside field of expertise: Out-of-field teachers (route 3 in figure 4) can benefit from support (rather than full-scale retraining) aimed at improving their knowledge of topics or subjects that they are asked to teach but may not have studied since they were themselves at school. These programmes provide essential support given the significant numbers of teachers who have to teach outside their field.⁶⁸ However, currently, these are often stand-alone programmes or even stand-alone events with no obvious links to retraining programmes or to the ongoing needs of a teacher.

Early career professional learning: While many in-field teachers have completed undergraduate or postgraduate degrees in their subject, subject-specific support and development is required in their first few years' practice to assist them in becoming proficient in teaching their subject. This need has been acknowledged in the early career framework (ECF) in England and Teacher Induction Scheme (TIS) in Scotland. Whether as part of the ECF, TIS or more generally, the required subject support is intensive and often relies on a head of department with subject expertise. However, not every new teacher will have a head of department with that expertise so external support will also be required.⁶⁹ Early career teachers make up a large portion of the teaching population⁷⁰ and accelerating their learning would consequently have a large effect on overall teaching quality; this could be particularly impactful in the next few years in retaining the likely bulge in teachers entering the profession during and after the Covid-19 pandemic.

Figure 4. The three main routes to becoming a subject teacher in subject X



Generic and subject-specific CPD

Teachers' individual professional learning needs vary according to a range of factors, including their ITE pathway, career stage, school setting and year group. Not all of their professional learning needs will relate to their subject knowledge for teaching; however, even seemingly generic teaching skills and behaviours can vary when teaching different content, and benefit from development within the context of their subject.⁷¹

Teachers say that they find subject-specific CPD more beneficial to their teaching than generic CPD, and evidence suggests it is more effective in terms of impact on pupil outcomes.⁷² Despite this, most CPD accessed by teachers in the UK is generic, and schools that are seen to be struggling in terms of pupil outcomes and/or inspection results appear less likely to prioritise subject-specific CPD over more general provision.

An effective approach to CPD should account for teachers' individual needs, and recognise the importance of subjects in both shaping and fulfilling these needs.

B. Improving links between delivery programmes

Large CPD programmes tend to operate in isolation from each other leading to a lack of connection between their offers, inconsistencies in approaches and content, and duplication which hinders economies of scale. This makes it difficult for teachers to understand how each individual programme matches their development needs and career stage. Linking the aims, approaches and content of CPD programmes in a coherent way would promote more effective learning and more efficient use of teachers' time.

C. Improving links to expertise outside of schools

A review of international evidence found that the skills and knowledge required by CPD leaders are particularly important for the effectiveness of CPD, and that 'external input is a common factor in successful outcomes, sometimes in tandem with internal specialists'.⁷³ A lot of subject-specific CPD is provided by teachers in schools or multi-academy trusts (MATs), or by freelance CPD leaders who are not connected to any network and are not specifically trained to lead CPD activities. This can lead to isolation and reinforcement of a narrow, personal view from the CPD leader of what constitutes good teaching in the subject rather than a view based on evidence and best practice. It is important that CPD leaders are connected to external networks and do not learn, develop or practice their CPD leadership role in isolation.

D. Creating a culture of CPD for all teachers

Expanding provision of subject-specific CPD is not, on its own, sufficient to increase participation and effect wholesale improvements to teaching quality. A culture must be fostered in which all schools prioritise subject-specific professional learning and senior leaders recognise their role in enabling teachers to realise their entitlement to and responsibility for improving their subject knowledge for teaching.⁷⁴ (In England, the most recent Ofsted education inspection framework evaluates leaders' effectiveness according to, among other aspects, the extent to which they focus on improving staff's subject, pedagogical and pedagogical content knowledge, and to which the subject knowledge of staff are built up and improve over time.⁷⁵)

In addition, many large CPD programmes in recent years have concentrated on teachers teaching out of their field. These programmes are essential in a landscape in which there are still shortages in some subjects; however, an unintended consequence has been the perception among some of subject-specific CPD as being solely of benefit to the out-of-field teacher. Subject-specific CPD should not be solely to put right deficits, it should be viewed as a valuable and essential part of all teachers' development that enables them to continually improve at the core part of their job – teaching their subject in a classroom.



58% of teachers surveyed took part in one day or less of subject-specific CPD in a typical year

E. Increasing participation and extending access

Teachers' ability to access CPD is strongly dependent on the available resources and individual approach of their school. Many schools impose tight restrictions on how much external CPD teachers are able to access during a year and are particularly reluctant to fund intensive or sustained subject-specific CPD, despite evidence that CPD is most effective if sustained over time.⁷⁶ Centrally managed CPD budgets are widely seen as a restriction rather than an enabler for the uptake of subject-specific CPD⁷⁷ and the role of the school's CPD leader is often to challenge any perceived need and to save money. This perception can be changed, as shown by the Wellcome Trust's CPD Challenge pilot,⁷⁸ and externally funded provision can help drive demand.

F. Improving the quality of provision

There are currently no common standards or methods of assuring the quality of subject-specific CPD programmes or providers. In addition, those leading CPD are not currently trained in a coordinated way, and there is no form of certification to show that they have either the necessary subject knowledge or the coaching skills to lead high-quality CPD in that subject, despite evidence that these are particularly important for the effectiveness of CPD.⁷⁹ This means that quality is both variable and unknown, making it difficult for teachers to plan and choose CPD and potentially leading to ineffective use of schools' CPD budgets. The perception that externally run CPD can be poor quality⁸⁰ leads schools to rely more heavily on internal expertise, perpetuating disparities in the quality of teaching across the UK's schools.

G. Enabling teachers to plan their professional learning

Evidence suggests that most schools provide little direction or planning for an individual's subject needs. There is also no curriculum for learning to teach a subject and teach it better. Such a curriculum would specify the subject knowledge for teaching a subject and enable teachers to reflect on their own practice, identify opportunities to strengthen their knowledge and direct their own professional learning as part of a sustained developmental plan. Teachers instead tend to participate in one-off CPD events, based on what is available at the time, which is both less effective in improving teaching quality and less cost-effective than a planned developmental approach in which ideas are revisited through sustained or repeated access to a CPD programme.

H. Sustaining access to programmes

One aspect of enabling teachers to plan is providing them with sustained access to programmes and therefore ensuring that they are implemented and supported over a long period. Currently, many government-funded programmes are funded for a few years at a time; this repeated funding cycle hinders long-term planning for both the CPD provider and for teachers.

I. Collecting more evidence about what works

Although some important evaluations have been carried out for large-scale CPD programmes, there is little evaluation of the impact of smaller programmes, nor any systematic research into which approaches, types of CPD and frequency of CPD result in the most cost-efficient improvements in teacher subject knowledge for teaching and pupil outcomes.

The need for a systematic approach

Considering all the above, we recognise an opportunity to systematically strengthen and expand the provision of subject-specific CPD, to improve quality, trust and participation, and help achieve better outcomes for students and the UK's education systems.

A systematic approach

To build a more confident and engaged teaching workforce, equipped with the necessary subject knowledge for teaching quickly and efficiently, the UK needs a world-class system of high-quality subject-specific CPD for teachers in each subject, guided by subject experts.

Such a system would build upon and strengthen existing programmes to improve the quality of teaching in our schools, contributing to better student outcomes, reduced disparities in our education system and improvements in the knowledge and skills that young people carry into the workforce. By ensuring every student can realise their full potential, we can accelerate progress towards the UK Government's vision of increased productivity and economic growth in all parts of the UK.

Teachers can develop their subject knowledge for teaching in a number of ways: learning from colleagues, reading books and journals, accessing articles and videos online and taking part in organised CPD sessions with external input. The first three of these are valuable and essential parts of a teacher's professional learning. However, it is the last that we are focusing on here: organised programmes of subject-specific CPD, the most successful of which use external subject expertise.⁸¹

Characteristics of a world-class system

A world-class system of subject-specific CPD is one that:

- A. **is accessible and available to all teachers of all subjects**, so as to increase participation and improve teaching quality across the UK. By having ready access to CPD that is both high quality and meets their needs, teachers will view it as a more valuable and ongoing feature of their professional life
- B. **is of universally high quality**, providing teachers with access to CPD of a consistent standard no matter where they teach or how they access it, and improving outcomes across all schools

- C. **preserves choice for schools**, enabling them to address their specific needs through a variety of CPD programmes, while having assurance of quality
- D. **caters for the diverse needs of teachers** at different points in their careers or with different backgrounds,⁸² enabling teachers to target their specific professional learning needs and ultimately derive the greatest impact on teaching quality
- E. **tracks and records the outcomes of professional learning** so that teachers can identify opportunities to improve their practice and grow as professionals, and can demonstrate their subject knowledge for teaching at a topic level. This would enable schools to deploy teachers according to their demonstrable strengths and more easily identify and address any skills gaps, improving quality of teaching for students
- F. **improves continuously** based on regular and rigorous evaluation and evidence of impacts on teachers and student outcomes.

Teachers should have an entitlement to subject-specific CPD and a responsibility to continually develop their expertise, as is the case in other professions. There would be an expectation that subject-specific CPD would make up at least half of the organised CPD that teachers take part in and, in a given year, a school should allocate an average of at least 2.5 days per teacher to subject-specific CPD (based on the recommendation from the Wellcome CPD Challenge that teachers participate in at least 35 hours of CPD each year).

Subject-specific support in all contexts

While much of the evidence in this report relates to secondary schools, as this is where most existing provision is targeted, subject-specific CPD should be an essential part of the development of teachers in all schools and colleges, and we envision the proposed system applying to all teachers. Clearly the implementation in primary schools and early years settings would be very different from that in secondary schools; teachers in these settings typically teach a wide range of subjects and will benefit from support in all of the subjects that they teach. However, the principles – including the need for CPD champions, subject frameworks, external expertise and access to a variety of quality-assured programmes – remain valid and essential.

Building blocks of a world-class system

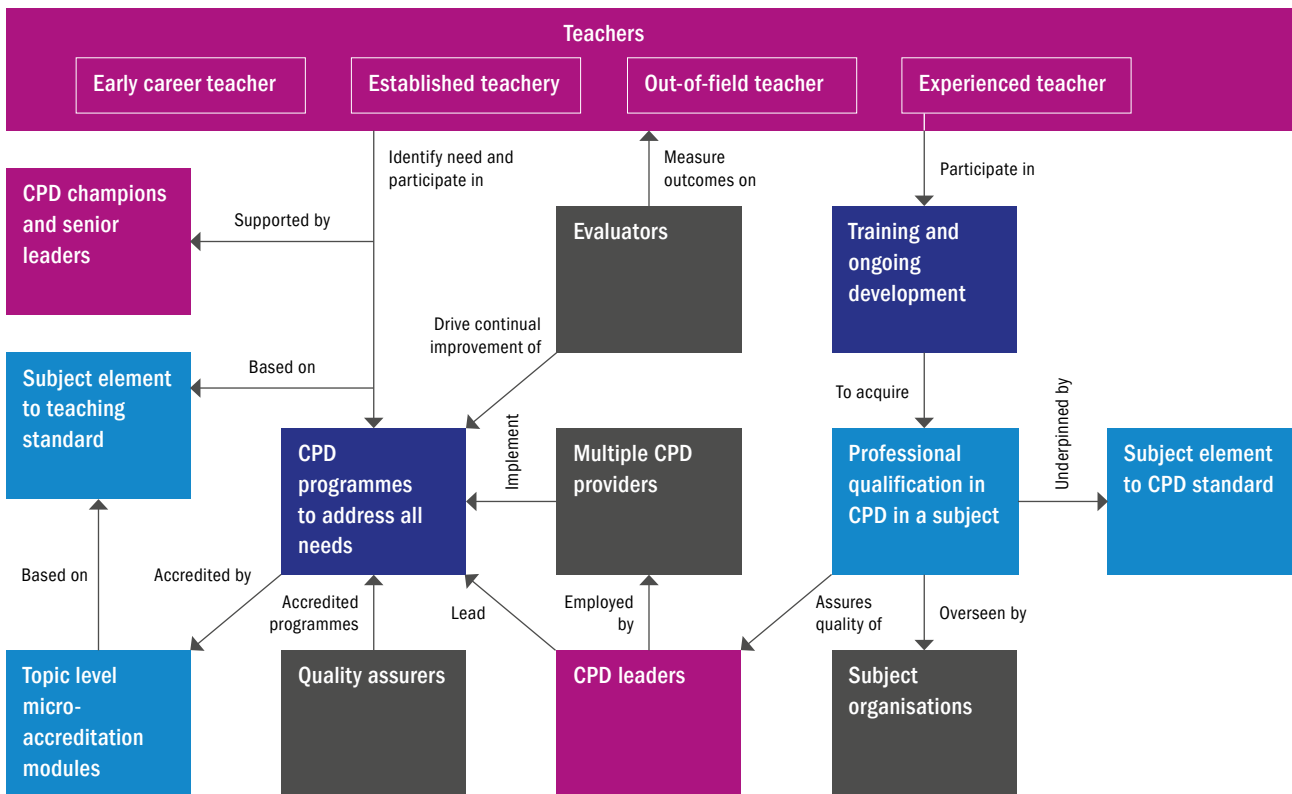
A system of subject-specific CPD which possesses all the above characteristics is likely to comprise a number of different, interconnected elements, including:

- a. **In-school CPD champions** who work with teachers and senior leaders to identify and meet the needs of teachers and their schools
- b. **A subject component to the national standard for teaching** that specifies the subject knowledge required for teaching in each subject, helping teachers to identify their needs, and record and take ownership of their professional learning
- c. **Micro-accreditation** to enable teachers and schools to track and record the outcomes of professional development and make deployment more effective
- d. **Multiple providers** to ensure teachers and schools have access to a variety of quality-assured programmes that address their differing needs
- e. **A national standard for subject-specific CPD**, outlining the required knowledge for CPD leaders within a subject, to provide assurance of quality through a professional qualification, which could be administered by subject organisations
- f. **Evaluation**, designed into programmes, to drive continuous improvement.

Figure 5 shows how these elements could work together in a world-class system of subject-specific CPD.



Figure 5. An illustration of the elements which could be combined to build a world-class system of CPD



Building on and strengthening existing initiatives

Strong foundations already exist in each of the UK nations and many of the elements above are in place in some form. These include the teaching and professional learning standards, recent innovations in England in the early career framework (ECF) and national professional qualifications (NPQs), and the Teacher Induction Scheme (TIS) and Professional Learning and Leadership programmes⁸³ in Scotland. However, although subjects are frequently referenced, the standards contain no details of the subject requirements (in each subject) and initiatives such as the ECF have minimal subject support.

Teaching and CPD standards

Each nation has a national standard for teaching.⁸⁴ While all of these standards refer to the need for teachers to be able to demonstrate good subject knowledge and pedagogic content knowledge, none of them specify what that knowledge should be within each subject.

We recommend that governments, with the support of subject associations, develop appendices to the teachers' standards that specify the subject knowledge for teaching in each subject; these would be, in effect, a curriculum for becoming a good teacher in a given

subject. These appendices would outline the aspects of subject knowledge for teaching that a teacher should have studied, thought about and learned in their ITE and early years in teaching. This would allow teachers to develop their substantive knowledge, disciplinary knowledge and pedagogic content knowledge in a consistent and cumulative way through this period and throughout their career.

Each nation also has a standard for teachers' professional learning; however, these make only a general reference to the need for a teacher to have good subject knowledge. We recommend that these standards be expanded to include a section on the specific expectations, in each subject, of people who are providing subject-specific CPD. This should include, for each subject, the required subject knowledge for teaching and the required knowledge about educating teachers. This subject-level specification would help ensure that subject-specific CPD is of universally high quality and could support the recruitment, training and certification of CPD leaders as part of a professional qualification, such as those mentioned below.

Early career support

Continuing teachers' education into their early career is known to be an effective way of helping them to become good quickly. It is essential that such continued learning explicitly includes the development of subject knowledge for teaching within a teacher's subject. Teachers acquire new knowledge about their subject at the fastest rate in their first three years of teaching⁸⁵ and need specific, targeted support during this time.

This need has been recognised in the Department for Education's recent teacher recruitment and retention strategy for England, in particular through the launch of the ECF, which is designed to provide high-quality, structured support and professional development to teachers in the first years of their careers similar to that provided in the legal and medical professions.⁸⁶

However, the absence of subject-specific support in the emerging delivery programmes for the ECF is concerning, particularly as many schools will not have the necessary internal expertise in every subject. A structured and systematic approach to providing external subject support for early-career professional learning is needed in each subject.

Professional qualifications

The NPQs in England and the requirement for headteachers in Scotland to hold a master's qualification for headship have been successful in incentivising and developing teachers to become senior leaders in schools, and recent reforms include the introduction of qualifications for leading teaching (including in a subject) and leading teacher development.

For subject teaching, it would be possible to use qualifications such as the new NPQ for Leading Teaching (along with the addition to the teachers' standards above) to drive and recognise improvements in teachers' subject knowledge for teaching by adding a subject element for each subject.

The NPQ for Leading Teacher Development will result in better training, development and certification of CPD leaders (within their subject) and provide assurance to programme managers and teachers that a given programme draws on high-quality CPD leaders. This will improve and professionalise the practice of leading CPD, establish a cadre of professional CPD leaders (in each subject), connect CPD leaders (particularly those who might otherwise be isolated within their own school or multi-academy trust) with evidence and practice beyond their own experience of teaching, ensure that CPD draws on external expertise and, in general, drive up the quality of provision of subject-specific CPD.

CPD champions

The Wellcome Trust and Sheffield Hallam University ran the successful and informative CPD Challenge programme with 40 schools in Yorkshire.⁸⁷ The evaluation found 'a positive impact on teaching as a result of participating in more high-quality CPD, through improvements to teachers' subject and pedagogical knowledge' and that there is a 'critical role played by CPD Champions in driving change by implementing or improving school CPD systems and helping to identify and meet teachers' professional learning needs.' This resulted in more teachers feeling that they had ownership of their CPD and were able to identify high-quality CPD, and in teachers finding the CPD more worthwhile.

Estimated costs

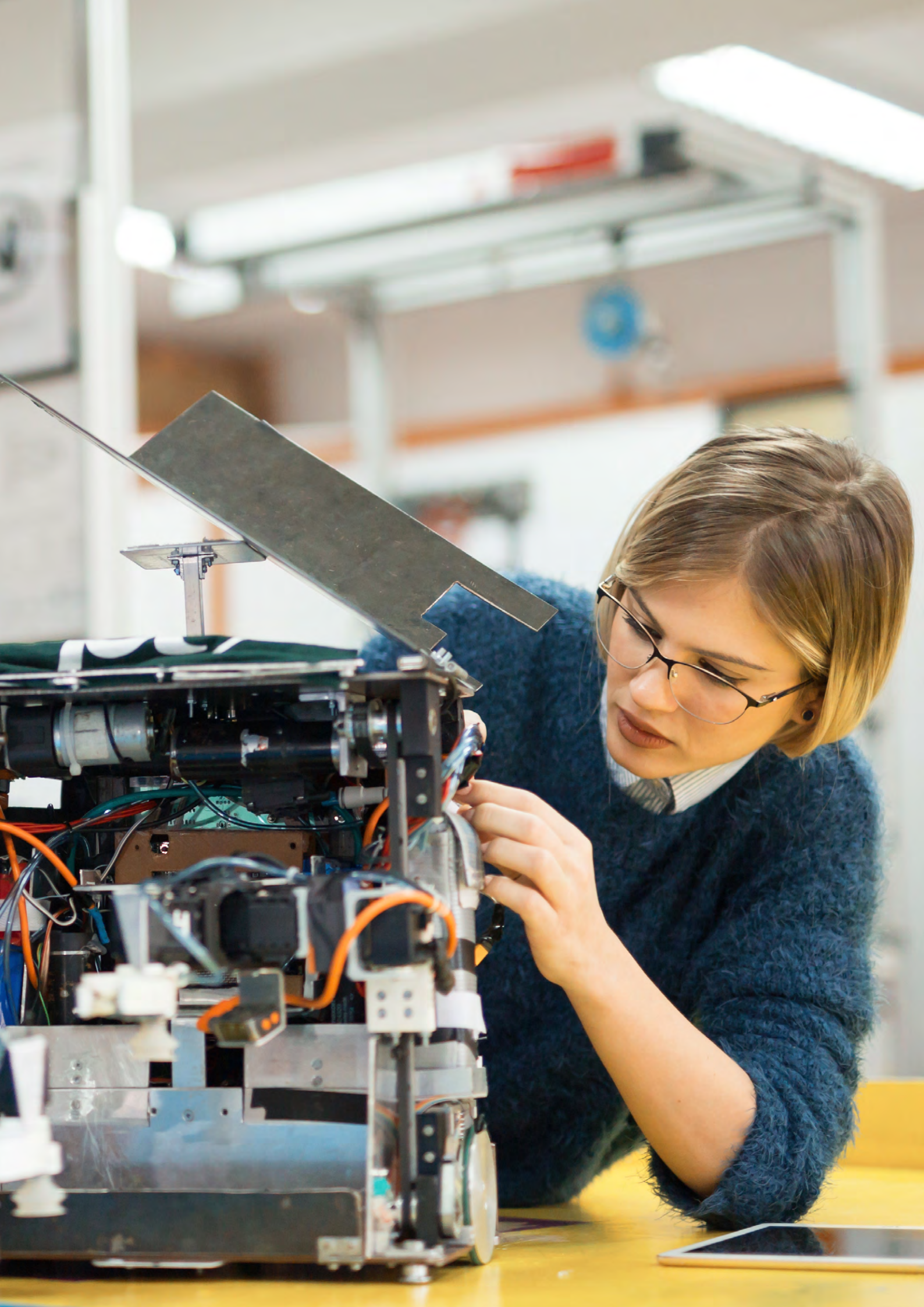
The cost of a world-class system of subject-specific CPD will depend on the exact design of the system. However, as a very broad estimate, we suggest that a viable systematic approach could provide an average of 2.5 days per year of high-quality subject-specific CPD to all UK teachers at an annual cost of about £400 million or £800 per teacher. This is equivalent to approximately 0.4% of the current education budget and 2% of the salary bill for teachers, and of a similar order of magnitude as the cost of ITE.

A significant proportion of this investment already exists within our education systems; for example, state schools in England spent £261 million on staff development in 2019.⁸⁸ In addition, some of the cost could be offset by future improvements in retention (which could be as much as £126 million per year in England alone – see figure 3).

We have estimated the cost by considering existing national programmes. Many national programmes operate using hub schools, which support around ten local schools by allocating one day a week of an experienced teacher's time to lead CPD. Typically, a hub school can provide around 4 days of CPD for 25 teachers across the year. The programme cost per hub school is around £30,000 and this includes all costs associated with the programme. This equates to £300 per teacher day of CPD (which also aligns with the typical cost of a one day course) or approximately £800 for 2.5 days.

We can also estimate the cost by considering the cost of scaling up an existing national subject-specific CPD programme to reach all schools. Based on existing programmes and on the addition of the underpinning elements, we estimate that it would cost up to £10 million for each secondary school subject and £20 million each for maths and English. This would result in a total cost for secondary schools of around £140 million, and we would expect the cost for primary schools to be similar. There would be an additional cost of around £120 million to support the provision of CPD champions in schools. Once again, this gives an estimated total cost of £400 million.

These estimates do not factor in the cost of providing cover for teachers, as this will vary significantly depending on how teachers access the system and the extent to which this is done outside of teaching hours (for example, on allocated training days).



Conclusion

We are recommending that governments build on existing strong foundations to establish a world-leading, national system of subject-specific CPD in each school subject for all primary and secondary teachers.

A modest additional investment could result in significant improvements in the quality, efficiency and impact of teachers' professional learning. Many of the proposed changes simply require the addition of subject elements to official frameworks to exemplify and make explicit the support or knowledge that is needed in each subject, alongside the provision of high-quality subject-specific CPD programmes and support to increase participation so that all teachers can benefit.

By continually improving all teachers' subject knowledge for teaching, we can build a more confident, engaged teaching profession. The proposed system will increase

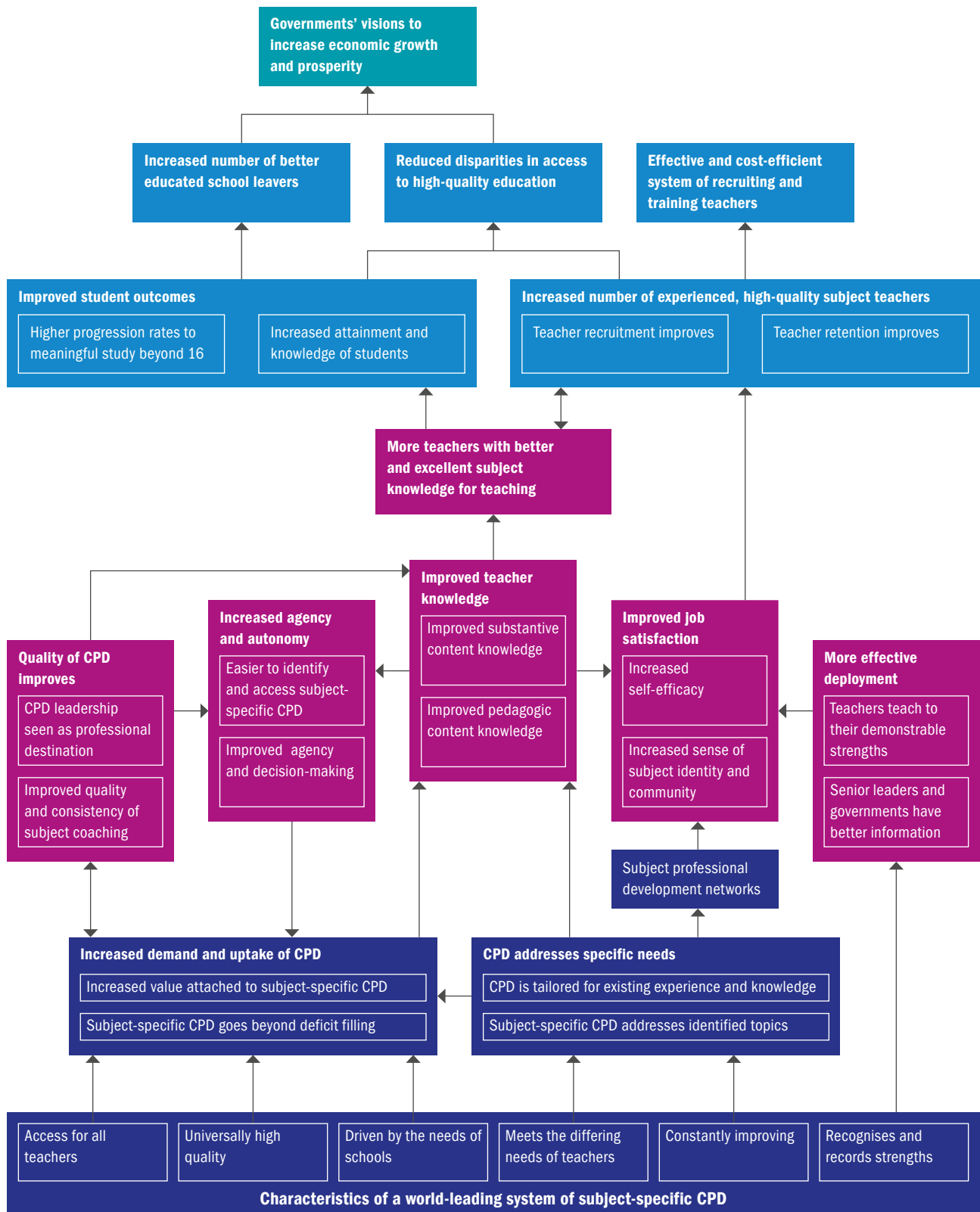
the overall quality of teaching in our schools by increasing the number of knowledgeable, experienced and high-quality subject teachers in the education system, making teaching a more rewarding and satisfying career and improving the standing of the teaching profession.

Providing more students with access to excellent subject teachers will help to improve outcomes, reduce disparities in access to high-quality education, and increase the number of well-educated, school leavers entering further and higher education and the workforce, to the benefit of society and the economy.



Appendix A: Fuller logic model

Figure 6. A full logic model showing how the characteristics of a world-leading system of subject-specific CPD contribute to better subject teaching, reduced teacher attrition, improved educational outcomes and increased economic growth



Appendix B: Acknowledgements

On 22 January 2020, the IOP hosted a symposium on developing a high-quality system of subject-specific CPD. The symposium was instrumental in the development of this report.

The IOP would like to thank Professor Sir John Holman, who chaired the symposium, and Professor Rob Coe, whose paper and presentation underpinned the discussions.

We would also like to acknowledge the following organisations for their contributions during the symposium:

AQA

Association for Language Learning
Association for Science Education
Centre for Teacher Education, University of Warwick
Chartered College of Teaching
Ed Walsh Consulting Ltd
Education Development Trust
Gatsby Charitable Foundation
Geographical Association
Historical Association
Institute of Physics
Mathematics in Education and Industry (MEI)
National Centre for Excellence in the Teaching of Mathematics (NCETM)
National Society for Education in Art and Design (NSEAD)
National Teacher Accreditation
Northumbria University
Physics Partners
Royal Geographical Society
Royal Society
Royal Society of Biology
Royal Society of Chemistry
Sheffield Institute of Education, Sheffield Hallam University
STEM Learning
Teach First
Teacher Development Trust
University of Oxford
University of Southampton
University of York
Wellcome Trust

The symposium was observed by representatives from the Department for Education and Welsh Government.

We are also grateful to the following individuals for their contribution to the development of this report (note, those listed were not asked to endorse the report's conclusions or recommendations):

Alan Kinder, Geographical Association
Amanda Dickins, STEM Learning
Bethan Hindley, Teacher Development Trust
Carol Wild, Centre for Teacher Education, University of Warwick and NSEAD
Cat Scutt, Chartered College of Teaching
Charlie Stripp, MEI
David Montagu, Royal Society
David Weston, Teacher Development Trust
Professor Emily Perry, Sheffield Institute of Education, Sheffield Hallam University
Dr Eva Duran Eppler, Centre for Research in English Language and Linguistics (CRELL), University of Roehampton
Gill Collinson, STEM Learning
Hannah Russell, Association for Science Education
Professor Sir John Holman, University of York
Laura Molway, University of Oxford
Lauren McLeod, Royal Society of Biology
Maria Cunningham, Teacher Development Trust
Marianne Cutler, Association for Science Education
Martin Shevill, National Teacher Accreditation
Dr Mary Stevenson, NCTEM
Melanie Jones, Historical Association
Nan Davies, Wellcome Trust
Peter Finegold, Royal Society
Dr Rebecca Fisher, English Association
Rebecca Sullivan, Historical Association
Professor Rob Coe, Evidence Based Education
Sarah Robertson, Royal Society of Chemistry

Endnotes

- 1 Ozturk (2008). The role of education in economic development: a theoretical perspective. *Journal of Rural Development and Administration*, 33, 39-47 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1137541
- 2 Heckman & Klenow (1997). Human capital policy. University of Chicago <http://www.klenow.com/HumanCapital.pdf>
- 3 Sianesi (2003). Returns to education: a non-technical summary of CEE work and policy discussion. Institute for Fiscal Studies and Centre for the Economics of Education https://www.ifs.org.uk/docs/cee_summ.pdf
- 4 Hanushek & Woessmann (2008). The role of cognitive skills in economic development. *Journal of Economic Literature*, 46(3), 607-668 <https://doi.org/10.1257/jel.46.3.607>
- 5 OECD (2012). How does education affect the economy? https://www.oecd-ilibrary.org/docserver/eag_highlights-2012-15-en.pdf?expires=1586541761&id=id&accname=guest&checksum=16A333DC1DCCAF438AF4A864839F3322
- 6 Crespo Cuaresma, Lutz & Sanderson (2012). Age structure, education and economic growth. International Institute for Applied Systems Analysis Interim Report <http://pure.iiasa.ac.at/10263/>
- 7 Patrinos & Psacharopoulos (2013). Education: The income and equity loss of not having a faster rate of human capital accumulation. How much have global problems cost the world? A scorecard from 1900 to 2050. Cambridge University Press <https://www.cambridge.org/core/books/how-much-have-global-problems-cost-the-world/education-the-income-and-equity-loss-of-not-having-a-faster-rate-of-human-capital-accumulation/7BD907149D89356F1CD5E0475698DB51> The data analysed by the researchers also demonstrated that for every additional year of education, there was a 1.4% reduction in inequality (Gini coefficient model) between highest and lowest achievers.
- 8 Bhutoria (2016). Economic returns to education in the United Kingdom. Government Office for Science https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/593895/Economic_Returns_To_Education_-_final.pdf
- 9 Institute for Fiscal Studies (2019). 2019 annual report on education spending in England <https://www.ifs.org.uk/publications/14369>
- 10 See, for example: Financial Times (2020). Levelling up: how wide are the UK's regional inequalities? <https://www.ft.com/content/c9db4c66-5971-11ea-a528-dd0f971feb9c>; University of Sheffield (2019). UK has higher level of regional inequality than any other large wealthy country <https://www.sheffield.ac.uk/news/nr/uk-higher-regional-inequality-large-wealthy-country-1.862262>
- 11 See, for example: Open University (2018). The Open University Business Barometer 2018 <http://www.open.ac.uk/business/apprenticeships/blog/business-barometer>; Vandeplas and Thum-Thysen (2019). Skills mismatch & productivity in the EU. European Commission Discussion Paper 100 https://ec.europa.eu/info/sites/info/files/economy-finance/dp100_en.pdf
- 12 CBI (2017). Unlocking regional growth <https://www.cbi.org.uk/media/1170/cbi-unlocking-regional-growth.pdf>
- 13 OECD (2019). Education at a glance 2019 https://www.oecd-ilibrary.org/education/education-at-a-glance-2019_f8d7880d-en
- 14 Scottish Government (2017). STEM education and training strategy <https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2017/10/science-technology-engineering-mathematics-education-training-strategy-scotland/documents/00526536-pdf/00526536-pdf/govscot%3Adocument/00526536.pdf>
- 15 Department for Education (2018). Schools Minister announces boost to computer science teaching <https://www.gov.uk/government/news/schools-minister-announces-boost-to-computer-science-teaching>
- 16 Prime Minister's Office, 10 Downing Street (2019). Queen's speech December 2019: background briefing notes <https://www.gov.uk/government/publications/queens-speech-december-2019-background-briefing-notes>
- 17 RAND (2019). Teachers matter: understanding teachers' impact on student achievement https://www.rand.org/pubs/research_reports/RR4312.html
- 18 Hanushek (2011). The economic value of higher teacher quality <https://www.nber.org/papers/w16606>
- 19 Darling-Hammond (2000). Teacher quality and student achievement. *Education policy analysis archives*, 8, 1 <https://doi.org/10.14507/epaa.v8n1.2000>
- 20 Besley et al (2013). Investing for prosperity. LSE Growth Commission <http://cep.lse.ac.uk/pubs/download/special/cepssp28.pdf>
- 21 See, for example: Barber & Mourshed (2007). How the world's best-performing schools systems come out on top. McKinsey & Company <https://www.mckinsey.com/industries/social-sector/our-insights/how-the-worlds-best-performing-school-systems-come-out-on-top>; Schleicher (2018). How to build a 21st-century school system. OECD https://www.oecd-ilibrary.org/education/world-class_9789264300002-en;jsessionid=dmkhnT9bWAPoBSEQbSK4BG3Q.ip-10-240-5-24
- 22 Schleicher (2018). How to build a 21st-century school system. OECD https://www.oecd-ilibrary.org/education/world-class_9789264300002-en;jsessionid=dmkhnT9bWAPoBSEQbSK4BG3Q.ip-10-240-5-24
- 23 European Commission (2005). The returns to various types of investment in education and training <https://londonconomics.co.uk/wp-content/uploads/2011/09/82-Study-on-the-returns-to-various-types-of-investment-in-education-and-training.pdf>
- 24 OECD (2014). Education at a glance, table D.7.1c: requirements for teachers' professional development, lower secondary education https://www.oecd-ilibrary.org/education/education-at-a-glance-2014_eag-2014-en
- 25 IOP analysis of Department for Education statistics: local authority and school finance <https://www.gov.uk/government/collections/statistics-local-authority-school-finance-data>
- 26 2019 Department for Education data via SchoolDash <https://www.schooldash.com>
- 27 Department for Education (2019). The Teaching and Learning International Survey (TALIS) 2018 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/809738/TALIS_2018_research_brief.pdf
- 28 Cordingley et al (2015). Developing great teaching: lessons from the international reviews into effective professional development. Teacher Development Trust <https://tdtrust.org/wp-content/uploads/2015/10/DGT-Full-report.pdf>
- 29 Department for Education (2019). Achievement of 15-year-olds in England: PISA 2018 Results https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/849727/PISA_2018_England_Exec_summary.pdf
- 30 Sadler & Sonnert (2016). Understanding misconceptions: teaching and learning in middle school physical science. *American Educator*, 40(1), 26-32 https://www.aft.org/sites/default/files/ae_spring2016sadler-and-sonnert.pdf

- 31 See, for example, the impact of teachers supported to work as 'arts brokers' in the University of Nottingham, Royal Shakespeare Company and Tate's Tracking Arts Learning and Engagement project <https://researchtale.files.wordpress.com/2019/07/time-to-listen-tale-project-final-report.pdf>
- 32 Advisory Committee on Mathematics Education (2002). Continuing professional development for teachers of mathematics http://www.cimm.ucr.ac.cr/formaciondeeducadores/Teaching_training/Advisory%20Committee%20on%20Mathematics%20Education.%20Continuing%20Professional%20Development%20for%20teachers%20of%20mathematics.%20Dic%202002.pdf
- 33 Berliner (2004). Describing the behavior and documenting the accomplishments of expert teachers. *Bulletin of Science, Technology & Society*, 24(3), 200–212 <https://journals.sagepub.com/doi/abs/10.1177/0270467604265535?journalCode=bstas>
- 34 Fletcher-Wood & Zuccolo (2020). The effects of high-quality professional development on teachers and students. Education Policy Institute <https://epi.org.uk/publications-and-research/effects-high-quality-professional-development/>
- 35 Kraft & Papay (2014). Can professional environments in schools promote teacher development? Explaining heterogeneity in returns to teaching experience. *Education Evaluation and Policy Analysis*, 36(4), 476–500 <https://journals.sagepub.com/doi/abs/10.3102/0162373713519496>
- 36 Sims & Fletcher-Wood (2020). Identifying the characteristics of effective teacher professional development: a critical review. *School Effectiveness and School Improvement*, 1–17 <https://www.tandfonline.com/doi/abs/10.1080/09243453.2020.1772841>
- 37 See, for example, evaluations of the IOP's Stimulating Physics Network programme (available on request) and the STEM Learning CPD programme https://www.stem.org.uk/sites/default/files/pages/downloads/teacher_engagement_SL_science_GCSEs_1p_040520.pdf; https://www.stem.org.uk/sites/default/files/pages/downloads/attainment_in_primary_science_1p_040520_0.pdf; <https://wellcome.ac.uk/sites/default/files/science-teacher-retention.pdf>
- 38 Galloway, Stanley & Strand (2006). Artist Teacher Scheme evaluation 2005–2006 <https://www.nsead.org/files/a162324a5f2b5087cf1ca6b93ca65c20.pdf>
- 39 Ofsted (2009). Drawing together: art, craft and design in schools, 2005/08 <https://dera.ioe.ac.uk/10624/1/Drawing%20together.pdf>
- 40 Rate of progress is measured as the year-on-year increase in the proportion of students achieving a certain standard; for primary, this is the expected standard in KS2, and for secondary, achievement of grade 4 or above in at least two science GCSEs.
- 41 Barber & Mourshed (2007). How the world's best-performing schools systems come out on top. McKinsey & Company <https://www.mckinsey.com/industries/social-sector/our-insights/how-the-worlds-best-performing-school-systems-come-out-on-top>
- 42 Clegg et al (2017). Commission on inequality in education. Social Market Foundation <http://www.smf.co.uk/wp-content/uploads/2017/07/Education-Commission-final-web-report.pdf>
- 43 CBI (2017). Unlocking regional growth <https://www.cbi.org.uk/media/1170/cbi-unlocking-regional-growth.pdf>
- 44 Clegg et al (2017). Commission on inequality in education. Social Market Foundation <http://www.smf.co.uk/wp-content/uploads/2017/07/Education-Commission-final-web-report.pdf>
- 45 Education Policy Institute (2018). Education in England: annual report 2018 <https://epi.org.uk/wp-content/uploads/2018/07/EPI-Annual-Report-2018-Executive-Summary.pdf>
- 46 Education Endowment Foundation (2017). The attainment gap https://educationendowmentfoundation.org.uk/public/files/Annual_Reports/EEF_Attainment_Gap_Report_2018.pdf
- 47 Department for Education (2019). School workforce census 2018 <https://www.gov.uk/government/statistics/school-workforce-in-england-november-2018>
- 48 Department for Education (2019). Initial teacher training (ITT) census for 2019 to 2020, England https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/848851/ITT_Census_201920_Main_Text_final.pdf
- 49 Welsh Government (2019). Welsh Government's evidence to the Independent Welsh Pay Review Body: the 2019 teacher's pay award <https://gov.wales/sites/default/files/publications/2019-08/evidence-to-the-independent-welsh-pay-review-body.pdf>
- 50 Scottish Government. Teacher Workforce Planning Advisory Group <https://www.gov.scot/groups/teacher-workforce-planning-advisory-group/>
- 51 Department for Education (2017). Analysis of teacher supply, retention and mobility https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/615729/SFR33_2017_Text.pdf
- 52 Department for Education (2018). National pupil projections: July 2018 <https://www.gov.uk/government/statistics/national-pupil-projections-july-2018>
- 53 Welsh Government (2019). School teachers' pay and conditions (Wales) document 2019 and guidance on school teachers' pay and conditions <https://gov.wales/sites/default/files/publications/2019-10/school-teachers-pay-and-conditions-wales-document-2019-and-guidance-on-school-teachers-pay-and-conditions.pdf>
- 54 General Teaching Council for Scotland. What is the teacher induction scheme? <http://www.in2teaching.org.uk/teacher-induction-scheme/what-is-the-teacher-induction-scheme.aspx>
- 55 Worth & Van den Brande (2020). Teacher autonomy: how does it relate to job satisfaction and retention? National Foundation for Education Research https://www.nfer.ac.uk/media/3874/teacher_autonomy_how_does_it_relate_to_job_satisfaction_and_retention.pdf
- 56 Fletcher-Wood & Zuccolo (2020). The effects of high-quality professional development on teachers and students. Education Policy Institute <https://epi.org.uk/publications-and-research/effects-high-quality-professional-development/>
- 57 Allen & Sims (2017). Improving science teacher retention: do National STEM Learning Network professional development courses keep science teachers in the classroom? Wellcome Trust/Education Datalab <https://wellcome.ac.uk/sites/default/files/science-teacher-retention.pdf>
- 58 Department for Education. School workforce in England: reporting year 2019 <https://explore-education-statistics.service.gov.uk/find-statistics/school-workforce-in-england>
- 59 House of Commons Library (2019). Teacher recruitment and retention in England <https://commonslibrary.parliament.uk/research-briefings/cbp-7222/>
- 60 Institute for Fiscal Studies (2016). The longer-term costs and benefits of different initial teacher training routes <https://www.ifs.org.uk/publications/8368>
- 61 Based on IOP analysis – full details available on request.
- 62 See, for example: Lowden et al (2019). Evaluation of the SSERC primary cluster programme in science and technology: final report <https://www.sserc.org.uk/wp-content/uploads/2019/06/SSERC-PCP-Final-Report-30-March-Definitive-version-2019.pdf>; Lowden et al (2019). Raising Aspirations in Science Education (RAiSE) pilot: final evaluation report <https://education.gov.scot/improvement/Documents/nih027-RAiSE-evaluation-report.pdf>; Clarke & Thom (2012). Evaluation of the Science Learning Centre Network. Department for Education and Wellcome Trust <https://dera.ioe.ac.uk/16128/1/DFE-RR257.pdf>; Geographical Association and Royal Geographical Society (2011). The Action Plan for Geography 2006–2011: final report and evaluation https://www.geography.org.uk/write/MediaUploads/download/GA_APGFinalReportGARGSIBG.pdf; Soon to be published evaluation of the Stimulating Physics Network
- 63 The Maths Hubs <https://www.ncetm.org.uk/maths-hubs/>
- 64 The Advanced Mathematics Support Programme <https://amsp.org.uk/>

- 65 Stripp (2020). Professional development: the key to making teaching a career worth having <https://www.ncetm.org.uk/features/professional-development-the-key-to-making-teaching-a-career-worth-having/>
- 66 Based on a 2020 survey of 518 UK teachers commissioned by the IOP.
- 67 For example, teacher subject specialism training (TSST) in England <https://www.gov.uk/guidance/teacher-subject-specialism-training-courses>
- 68 Of state-funded secondary school teachers in England in 2018, 64% of teachers of computing, 49% of Spanish, 37% of physics and 34% of geography did not hold a relevant post-A level qualification in their subject. This problem is not confined to a small set of subjects – for the majority of subjects taught in secondary schools, at least a quarter of teachers do not hold a relevant post-A level qualification in their subject. <https://www.gov.uk/government/statistics/school-workforce-in-england-november-2018> In addition, the proportion of teaching carried out by non-specialist teachers can vary significantly across year groups. For example, in 2018, 60% of non-selective state-funded schools reported that at least some of year 7 history was taught by non-specialists. <https://www.history.org.uk/secondary/categories/rg-survey-results>
- 69 Department for Education (2020), Early career framework reforms: overview <https://www.gov.uk/government/publications/early-career-framework-reforms-overview/early-career-framework-reforms-overview#:~:text=The%20early%20career%20framework%20is,behaviour%20management>
- 70 Ingersoll, Merrill & Stuckey (2014). Seven trends: the transformation of the teaching force (updated April 2014). CPRE Report, #RR-80. Consortium for Policy Research in Education <https://eric.ed.gov/?id=ED566879>
- 71 Coe (2020). The case for subject-specific CPD. Available on request.
- 72 Cordingley et al (2018). Developing great subject teaching: rapid evidence review of subject-specific continuing professional development in the UK. Wellcome Trust <https://wellcome.ac.uk/sites/default/files/developing-great-subject-teaching.pdf>
- 73 Cordingley et al (2015). Developing great teaching: lessons from the international reviews into effective professional development. Teacher Development Trust <https://tdtrust.org/wp-content/uploads/2015/10/DGT-Full-report.pdf>
- 74 Advisory Committee on Mathematics Education (2016). Professional learning for all teachers of mathematics <https://royalsociety.org/~media/policy/Publications/2016/professional-learning-for-all-teachers-of-mathematics-final-12-2016.pdf>
- 75 Ofsted (2019). The education inspection framework https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801429/Education_inspection_framework.pdf
- 76 Department for Education (2016). Standard for teachers' professional development <https://www.gov.uk/government/publications/standard-for-teachers-professional-development>
- 77 Cordingley et al (2018). Developing great subject teaching: rapid evidence review of subject-specific continuing professional development in the UK. Wellcome Trust <https://wellcome.ac.uk/sites/default/files/developing-great-subject-teaching.pdf>
- 78 The Wellcome CPD Challenge <https://www.shu.ac.uk/about-us/academic-departments/institute-of-education/research/projects/the-wellcome-cpd-challenge>
- 79 Cordingley et al (2015). Developing great teaching: lessons from the international reviews into effective professional development. Teacher Development Trust <https://tdtrust.org/wp-content/uploads/2015/10/DGT-Full-report.pdf>
- 80 Cordingley et al (2018). Developing great subject teaching: rapid evidence review of subject-specific continuing professional development in the UK. Wellcome Trust <https://wellcome.ac.uk/sites/default/files/developing-great-subject-teaching.pdf>
- 81 Cordingley et al (2015). Developing great teaching: lessons from the international reviews into effective professional development. Teacher Development Trust <https://tdtrust.org/wp-content/uploads/2015/10/DGT-Full-report.pdf>
- 82 This is acknowledged in the CPD standards in England: "Ensure that school, subject, phase and individual development plans are coherent and supported." https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/537031/160712_-_PD_Expert_Group_Guidance.pdf
- 83 Education Scotland Professional Learning and Leadership programmes <https://professionallearning.education.gov.scot/learn/programmes/>
- 84 Department for Education, Teachers' standards <https://www.gov.uk/government/publications/teachers-standards>; General Teaching Council for Northern Ireland, Teaching: The Reflective Profession <https://gtcni.org.uk/professional-space/professional-competence/teaching-the-reflective-profession>; General Teaching Council for Scotland, Standards for Registration <http://www.gtcs.org.uk/web/FILES/the-standards/standards-for-registration-1212.pdf>; Welsh Government, Professional Standards <https://hwb.gov.wales/professional-development/professional-standards>
- 85 Kraft & Papay (2014). Can professional environments in schools promote teacher development? Explaining heterogeneity in returns to teaching experience. Education Evaluation and Policy Analysis, 36(4), 476–500 <https://journals.sagepub.com/doi/abs/10.3102/0162373713519496>
- 86 Department for Education (2019). Teacher recruitment and retention strategy https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786856/DFE_Teacher_Retention_Strategy_Report.pdf
- 87 Leonardi et al (2020). Progress towards the Wellcome CPD Challenge: first interim evaluation report. Wellcome Trust and CFE Research <https://wellcome.ac.uk/sites/default/files/progress-towards-wellcome-cpd-challenge-first-interim-evaluation-report.pdf>
- 88 SchoolDash (2020). Personnel development <https://www.schooldash.com/blog-2011.html#20201118>

