The effects of high-quality professional development on teachers and students

A cost-benefit analysis

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Research Area:
Teaching and Leadership: Supply and Quality

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Executive summary

The Education Policy Institute were commissioned by Wellcome to evaluate the costs and benefits of entitling all teachers to 35 hours of high-quality, continuing professional development (CPD) every year. We also conducted analyses to find which factors are likely to be essential for securing the success of the policy.

Teachers in England do less professional development than their international peers

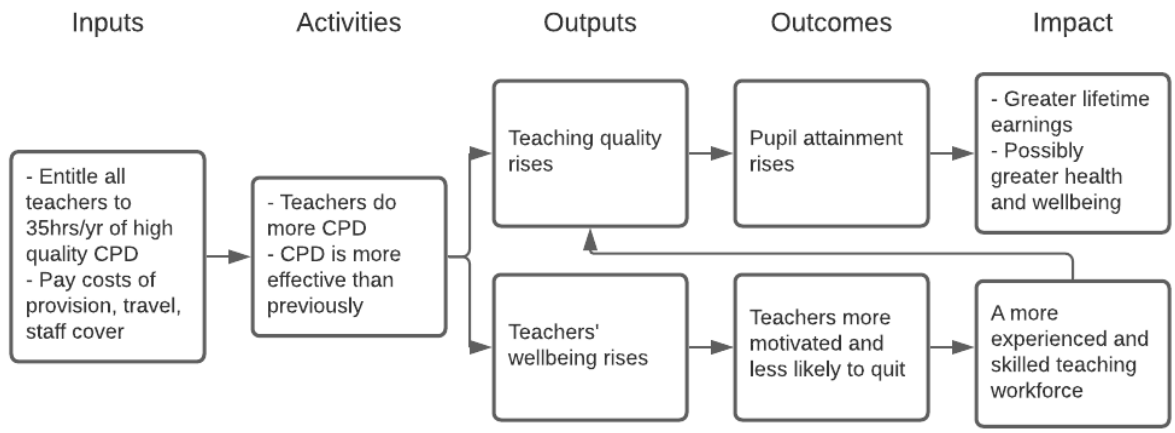
The core problem this policy proposal addresses is that teachers in England do less CPD than their international peers, and what they do does not appear to meet the Department for Education's standards.

- The 2018 TALIS (Teaching and Learning International Survey) data collected by the OECD estimates that England's primary teachers spend, on average, 55 hours a year on professional development, while lower-secondary teachers dedicate only 43 hours a year. That is below the OECD average of 62 hours a year.
- The quantity of CPD that meets the department's criteria for high quality, and is at least 50 per cent subject specific, is much lower. Only ten per cent of teachers taking part in the Wellcome CPD Challenge had undertaken 35 hours of CPD in the past year that met all these criteria.

Increasing the quantity of professional development has a high potential payoff

Our earlier literature review found convincing evidence for the effect of CPD on pupils' attainment, and some evidence for an improvement in teacher retention. The logic chain below sets out the possible chain of causation if the policy were enacted.

Benefits of an entitlement to high-quality professional development



Quantifying those effects, we found:

- Randomised controlled trials find that high-quality CPD for mainstream teachers has an average effect on their pupils' attainment equivalent to one month of extra learning in the year the CPD is undertaken. However, within that average effect, there are also many CPD programmes that have no measurable effect on pupils' attainment.
- The greatest benefit is to the future lifetime earnings of pupils. If a pupil began school in the first year the entitlement was implemented then they would be expected to achieve an additional two-thirds of a GCSE grade over their schooling life, improving their lifetime earnings by over £6,000.
- Among the benefits we were unable to precisely quantify, the CPD entitlement may improve the health and wellbeing of both teachers and pupils, and reduce attrition from the teaching profession. The best available data suggests that around 12,000 more full-time equivalent teachers may remain in the profession each year because of the CPD entitlement.

- Overall, if implemented as effectively as earlier pilots such as the CPD Challenge, a policy entitling all teachers to 35 hours of high-quality CPD every year could increase high-quality CPD by 9 hours per year, at a cost of around £4bn over 10 years, excluding setup costs, and create a net societal benefit of £61bn over those 10 years.
- There is, inevitably, some uncertainty about the precise figures. However, the benefit estimates are an order of magnitude greater than the cost estimates, which means we can be confident that a well-implemented policy would have social benefits. The direct cost of CPD would have to rise from the current average of £40 per pupil per year to an implausible £1000 per pupil per year before the costs outweighed the benefits.

The returns depend on the quality of implementation

- The estimates assume that the entitlement is implemented at a national scale as effectively as existing, smaller-scale CPD programmes, such as the CPD Challenge, were implemented. Any reduction in effectiveness compared to those programmes will dramatically reduce the potential benefits of the policy and, if there was no change in teaching practice, it is possible that the costs could exceed the benefits.
- The crucial element of implementation is the quality of the CPD enjoyed by teachers, rather than the quantity. We found programmes of a short duration that were far more effective than some longer-lasting programmes. Identifying high quality is difficult but it is essential for effective implementation.
- Monitoring the impact of any policy change will require an improvement in the data collected on teachers' CPD. At present, there is a lack of data on both the quantity and quality of CPD undertaken by teachers in England. For instance, it is not possible using the existing data to say whether teachers are doing more or less CPD today than they were five years ago. It is also impossible to know how much of the CPD currently undertaken by teachers in England qualifies as high quality. It is possible that the Department for Education's forthcoming Longitudinal Survey of Teachers will go some way to remedying this gap.

Introduction

The Education Policy Institute (EPI) have been commissioned by Wellcome to evaluate the costs and benefits of a policy entitling all teachers to 35 hours of high-quality continuing professional development (CPD) every year. The aim of the proposed policy is to improve both the quantity and quality of professional development undertaken by teachers in England. There is presently no entitlement to high-quality CPD for teachers in England.

EPI previously undertook a comprehensive literature review to find the impact of high-quality professional development on pupil learning.[1] The review found that high-quality CPD for teachers has an average effect size equivalent to one month of extra learning. This study aims to build on the literature review by valuing the impact of providing more high-quality professional development training for teachers and estimating whether the benefits of introducing this policy exceed the likely costs.

The problem

Teachers in England do comparatively little CPD

There are two parts to the problem this policy seeks to remedy: quantity and quality. The quantity of CPD currently provided in England is low by international standards. The most reliable international comparisons of teachers' CPD are found in the OECD's 2018 Teaching and Learning International Survey (TALIS). [2] This study found that full-time primary teachers in England reported spending, on average, 55 hours a year on professional development, while full-time lower-secondary teachers averaged only 43 hours a year,[3] well below the OECD average for full-time lower-secondary teachers of 62 hours a year.

There is also demand from a significant minority of state-sector teachers for more CPD, as they feel that the amount of time that they currently spend on CPD is inadequate. The TALIS 2018 survey found that 35 per cent of primary, and 45 per cent of lower-secondary teachers, felt that they spent insufficient time on CPD. Teachers' perceived influence over their professional development goals is associated with higher job satisfaction and greater intention of staying within teaching.[4] Not only is more CPD likely to improve their teaching, but it may also improve the wellbeing and retention of teachers.

The CPD they do may not meet the government's quality criteria

Despite teachers in England undertaking less CPD than their international counterparts, they still do more than the proposed 35 hours each year. However, it is likely that the majority of CPD currently being provided in England does not meet all the criteria for high-quality CPD.

To investigate the feasibility of their proposal, Wellcome funded a 'CPD Challenge', which asked participating schools to implement an entitlement to 35-hours of high-quality CPD for their teaching staff. Participating schools received a £7,000 payment and support from staff at the Sheffield Hallam Institute of Education. The programme was independently evaluated by a team at CFE Research.

The evaluators collected information about the CPD conducted at each school both before the programme began and during its delivery.[5] For the purposes of Wellcome's programme of work, key metrics were developed to assess the progress schools were making towards meeting the 35-hour challenge. Evaluating whether CPD is high-quality is difficult so measurable indicators of high-quality CPD were used instead. The most stringent metric

[1] Fletcher-Wood and Zuccollo, 'The Effects of High-Quality Professional Development on Teachers and Students: A Rapid Review and Meta-Analysis'.
[2] Under the assumption that there are approximately 39 weeks in an academic school year, and that teachers are not undertaking professional development in school holidays.
[3] Jerrim and Sims, 'The Teaching and Learning International Survey (TALIS) 2018'.
[4] Van den Brande and Worth, 'Teacher Autonomy'.
[5] Leonardi et al., 'Progress towards the Wellcome CPD Challenge':

developed was undertaking 35 hours of CPD that met all the indicators of high-quality CPD, as specified in the DfE's *Standard for teachers' professional development,* and 50 per cent of which was subject specific. The requirements of the DfE's *Standard for teachers' professional development* are that professional development:[6]

- Should have a focus on improving and evaluating pupil outcomes.
- Should be underpinned by robust evidence and expertise.
- Should include collaboration and expert challenge.
- Should be sustained over time.
- Must be prioritised by school leadership.

The baseline survey conducted before the programme began found that only 11 per cent of respondents' CPD met all criteria. However, 35 per cent of respondents had undertaken 35 hours of CPD, and 23 per cent had undertaken 35 hours with half being subject-specific.

The implication is that much of the CPD presently undertaken in England is unlikely to be meeting all the criteria of high-quality CPD. Not only is lower quality CPD less likely to improve pupils' learning but it becomes a drag on teachers' time, which is already limited due to the considerable number of hours teachers spend on marking, planning and administrative tasks.[7]

As a note of caution, it is important to draw a distinction between meeting these standards and delivering high-quality CPD. Recent work has suggested that, while much effective CPD might meet these criteria, not all CPD that meets the criteria is necessarily effective.[8] Academic researchers are actively looking for ways to better predict how effective CPD will be, and the Education Endowment Foundation has recently funded a project to examine the question. Until better evidence appears, the standards are the most widely used criteria for quality.

This report

Evaluates costs and benefits from a societal perspective

This report evaluates the costs and benefits of Wellcome's policy proposal to estimate the net societal benefit. It encompasses the total benefit to society wherever possible, rather than taking a narrower view and estimating only the benefit to the government.

Unfortunately, in many cases it is infeasible to quantify or value the benefits of the policy. In those cases, we have outlined the theoretical case for the benefits but excluded them from the quantified costs and benefits. That is likely to mean our final figures underestimate the total societal impact of the policy proposal. Lack of quantification does not imply that those benefits are unimportant, only that there is insufficient evidence to quantify them.

Does not evaluate the feasibility of implementation

This report estimates the costs and benefits of the operational policy but does not estimate the costs of implementation or take a view on the machinery that might need to be put in place to implement the policy. The starting point of our analysis is the time at which the policy is fully implemented, without restrictions or caveats, and teachers are beginning to take advantage of their entitlement.

That means we do not account for any costs, benefits, or limitations that may occur during implementation. For example, there may be costs to the DfE to put the entitlement in place, costs to CPD providers of scaling up their offerings, and costs to schools from changing timetables and staffing to be available for the entitlement. We do not include any of those costs in this analysis.

Similarly, we assume that the existing evidence on the impact of CPD is representative of the impact that CPD will have under the policy proposal. If the implementation of the policy resulted in weaker CPD than has previously

[6] Department for Education, 'Standard for Teachers' Professional Development'.
[7] Van den Brande, Worth, and Walker, 'Teacher Workload Survey 2019'.
[8] Sims and Fletcher-Wood, 'Identifying the Characteristics of Effective Teacher Professional Development'.

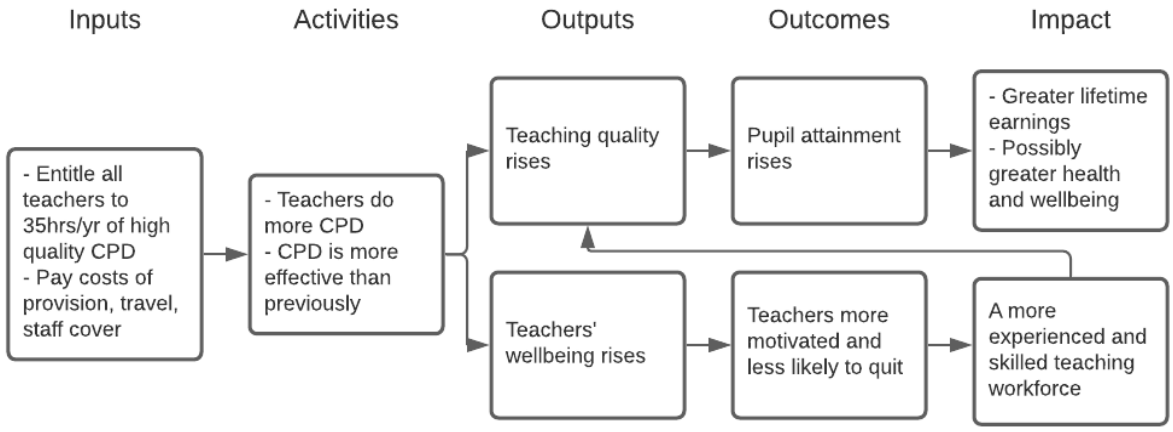
been provided, and evaluated, in the studies we draw upon, then that would cause the benefits to be lower than we estimate here.

That does not mean we naively assume the policy is perfectly implemented: as described in more detail later in this report, we use the best available evidence on compliance and impact to estimate the likely impact. However, scaling smaller studies up to a national level, while maintaining the level of impact and controlling costs, is extremely challenging. Because of that, our results should not be interpreted as a forecast of the impact of the policy, but as an illustration of the potential rewards if the entitlement were implemented as well at a national scale as it has been in the smaller studies we draw upon for our evidence.

Modelling an entitlement to professional development

The costs and benefits of the proposal are described by the logic chain in Figure 1, showing how the entitlement is intended to change the activities that teachers undertake and thus have a positive social impact.

Figure 1: Logic chain of the benefits of an entitlement to high-quality professional development



Moving from left to right, the logic chain describes the causal relationship between the policy intervention and the eventual impact, which is what we seek to estimate. Implementing the entitlement has immediate costs but may cause both the teachers' wellbeing and skill to increase. Greater teaching skill leads to pupils acquiring skills at a greater rate and ending up more skilled and knowledgeable when they leave school. That results in greater pupil attainment, more motivated teachers, and fewer teachers leaving the profession. Eventually, those students who benefitted from better teaching are likely to be slightly happier, healthier, and wealthier than they would otherwise have been.

Of course, these are only hypothesised relationships and, below, we supply more detail on the mechanisms and explain how we will go about establishing and estimating them. For ease of exposition, we group the relationships into:

- **Improved teaching**: this is about the effect of CPD on teachers' practice and wellbeing. It captures the activities and outputs in the logic chain.
- **Improved pupil outcomes**: this is about the effect of improved teaching on pupils' attainment at school and later life. It captures the outcomes and impacts in the logic chain.
- **Costs of providing professional development**: these are the costs of providing more and better CPD, over and above the present costs. They are part of the inputs.

Improved teaching

Teachers do more, and better, CPD

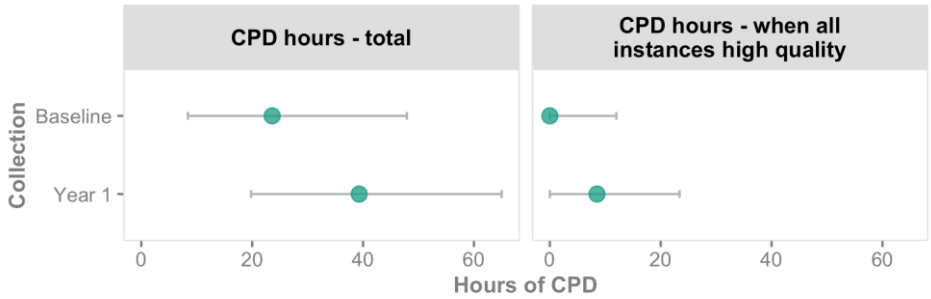
The most important assumption of this exercise is that entitling teachers to 35 hours of high-quality CPD each year will increase the average quantity of high-quality CPD they undertake. If that is not the case then there will be no improvements compared to continuing with business as usual.

There is a lack of data on the quantity and quality of CPD undertaken by teachers in England. The best, nationally representative data is collected in the OECD's TALIS survey, which England took part in for the 2013 and 2018 editions. However, that still surveys only 4,400 teachers at 300 schools every 5 years and does not always ensure that data is comparable across waves. For instance, it is not possible using the existing data to say whether teachers are doing more or less CPD today than they were five years ago. It is also impossible to know from TALIS how much of that CPD qualifies as high quality.

The quantity and quality of CPD of additional CPD are the most important influences on the impact of the entitlement. Unfortunately, the lack of evidence on the current state of CPD forces us to rely on smaller surveys, with an attendant increase in the uncertainty of our estimates.

Our primary source of data is Wellcome's CPD Challenge, which piloted an entitlement identical to the policy proposal in 40 schools in South Yorkshire.[9] That pilot has been evaluated by CFE Research, who gathered information from teacher records across all the schools in the survey about the quantity, quality, and cost of CPD both before the pilot began, and after a year of operation. In the baseline, before the programme began, 1,164 CPD Records were received from staff out of 1,481 (79 per cent), representing 6,660 instances of CPD. While after a year of operation, 1,075 CPD Records were received from staff out of 1,458 (74 per cent), representing 13,160 instances of CPD. Further information will be available for future years of the programme but, because it is being conducted concurrently with this study, it was not available at the time of writing.

Figure 2: Changes in CPD during the CPD Challenge



Source: EPI calculations using data from Leonardi et al. (2020)

Note: Point indicates median hours. Whiskers indicate the interquartile range.

The results so far in Figure 2: Changes in CPD during the CPD Challenge show that little of the CPD undertaken by teachers met all the high-quality indicators, including 50 per cent of the CPD being subject-specific. Notably, while the CPD hours that met all the high-quality indicators have risen, most teachers have not been able to reach 35 hours of it in the first year of the CPD Challenge.

It is possible that will change over the coming years as schools move towards full compliance and emerging data from the second year of the CPD Challenge suggests that is already happening.[10] Even once a new equilibrium is reached, it is likely that the average number of hours of high-quality CPD will be below full compliance. In our model, we use this data to estimate the increase in the number of hours of CPD across the country, rather than optimistically assuming full compliance. However, it is worth emphasising that these estimates are based on the responses of only a handful of schools and are highly uncertain.

An obvious objection to this assumption is that it is far easier to gain compliance with a small, voluntary, supported pilot than with a national policy. However, a national policy is also likely to generate an infrastructure of support for schools among CPD suppliers, which would not occur in a small, regional pilot. Neither compliance, nor general equilibrium effects, can be extrapolated from the CPD Challenge and the number of teaching CPD suppliers is too small to usefully model with standard techniques using input-output tables.

Rather than strive for spurious precision we instead estimate a central scenario and bounds for the overall results by using the increase in median hours as our main estimate and bounding it with increases of 0 and 35 hours. These scenarios are discussed in detail in the next chapter.

Teaching quality rises

Moving on to the outputs described in Figure 1, teachers receiving more high-quality CPD will tend to improve their teaching skill. Importantly for this report, we make no judgment about the aspects of teachers' skills that will

[9] Leonardi et al., 'Progress towards the Wellcome CPD Challenge':, 1.
[10] Leonardi, 'CPD Challenge: Progress before and during the COVID-19 Pandemic'.

be improved by more, and better, CPD. The entitlement leaves schools and teachers to decide what qualifying CPD best meets their needs.

That increase in teaching skill has immediate benefits for their pupils and may also improve teachers' own wellbeing. However, the evidence on this is very mixed: in our literature review we found that "of 53 trials, only seven quantified effects on other outcomes for teachers, and most did not find statistically significant results."[11]

The benefit to pupils is likely to be the most valuable outcome and is discussed in the next section. The benefit to teachers' wellbeing is difficult to value because we have been unable to identify high quality studies which have rigorously evaluated and measured it. Consequently, we do not attempt to model or value it in this report. That does not mean it is not important: simply that estimation based on the existing research would not produce values that are comparable to the other figures in our model.

Figure 1 also shows that teaching quality might improve through the indirect mechanism of improved retention. Teachers are more likely to be retained in the profession if they are receiving continual support and training to improve their pedagogical and subject knowledge. Improvements in teacher wellbeing are clearly associated with higher retention rates in the profession in the national data.[12]

Reducing the number of teachers who quit the profession allows them to gain more experience and further develop their skills. Evidence from US schools shows that teachers continue to develop their skills and measurably improve their teaching performance for at least the first decade of their careers.[13] Therefore, a more experienced workforce will, on average, be a more effective teaching workforce. Unfortunately, measuring and valuing this indirect channel has proven challenging.

Teachers are less likely to leave the profession

Improved teacher retention is one of the two primary outcomes highlighted in Figure 1. In addition to the indirect benefits to pupil attainment, reducing attrition from the profession may also eliminate some of the costs of hiring and training new teachers that are borne by both schools and taxpayers. If fewer teachers need to be trained then some government subsidies for initial teacher training may be avoided. However, that assumes the government has met its targets for recruitment to initial teacher training, which has not been the case for several years.[14] We also do not account for any effects of the covid-19 pandemic, and ensuing recession, on recruitment or retention.

Unfortunately, our literature review found no randomised controlled trials that estimated the effect of CPD on teacher retention, and only one quasi-experimental study that related to a specific CPD programme for science teachers. That evaluation of the National STEM Learning Network (NSLN) provides the only high-quality evidence of the direct, casual impact of CPD on teacher retention and found that "*the odds that an individual teacher stays in the profession the year after participating in an NSLN course are around 160 per cent higher than similar non-participants*".[15] This finding did not vary significantly by either the experience of the teacher that undertook the professional development course or the length of the CPD course.

That study's finding is unequivocal but there is enormous uncertainty in generalising the findings from a single evaluation of a single programme for secondary science teachers to all teachers in the state sector. In addition, because it is the only high-quality study available, we cannot quantify the degree of uncertainty in applying those findings to other groups. Nonetheless, it seems likely that there is some positive effect of CPD on teacher retention. As a compromise, we have included estimates of the number of additional teachers likely to be retained in the profession based solely on this study; however, we have not tried to value that additional retention for

[11] Fletcher-Wood and Zuccollo, 'The Effects of High-Quality Professional Development on Teachers and Students: A Rapid Review and Meta-Analysis', 9.
[12] Bamford and Worth, 'Teacher Retention and Turnover Research, Research Update 3, Is the Grass Greener Beyond Teaching?'
[13] Kraft and Papay, 'Can Professional Environments in Schools Promote Teacher Development?'
[14] At the time of writing, the covid-19 pandemic is providing a boost to ITT recruitment but that is not expected to persist beyond the next few years.
[15] Allen and Sims, 'Improving Science Teacher Retention: Do National STEM Learning Network Professional Development Courses Keep Science Teachers in the Classroom?'

inclusion in our headline benefit-cost ratios. In the language of the logic chain in Figure 1, we measure the outcomes (with great uncertainty) but do not value the impacts.

Because of that uncertainty, we have also chosen not to measure the possible indirect effect of improved retention on pupil attainment.

Improved pupil outcomes

Pupil attainment rises

This is the most important outcome of CPD and the primary reason for undertaking it: pupils learn more and improve their skills more than they otherwise would if their teachers had not attended the CPD.[16] We have termed it 'pupil attainment' because the skills gained at school are typically measured using standardised tests of attainment - an approach we also employ. However, the skills that pupils learn through education are broader than the knowledge that is tested: the personal and socioemotional skills that pupils learn at school are also crucial products of their education.[17]

Importantly, teachers who are good at imparting the knowledge that leads to improvements in test scores are not always the same teachers who are good at improving socioemotional skills.[18] The implication is that, unfortunately, not all improvements in teaching will be captured by standardised test scores. Nonetheless, test scores are the only standardised measure of learning that we have available in England. They are also the measure that is most reported in the studies we reviewed in our earlier literature review. We use the test scores of students to measure improvements in skills but, when interpreting our results, there is the caveat that our estimates are likely to be biased downward by construction.

A further limitation is that the literature review did not reveal systematic differences across groups of pupils, or phases of education, in the effect of CPD on pupil attainment. That is most likely because of the relatively small number of high-quality studies available for the meta-analysis in our literature review. However, it means that we cannot differentiate between the effect of CPD on the learning of, for example, primary and secondary pupils.

Using attainment also means that we undervalue the benefits of CPD for particular groups of pupils. Most troubling is that we are unable to capture the benefits of CPD for pupils who are very unlikely to achieve any 'good' GCSEs.[19] This group of pupils has many with complex and special needs, who require highly skilled teaching staff. Teachers in England report needing far more training in teaching children with special needs so there is likely to be a benefit to those pupils from more, and better, CPD.[20] However, because the benefits will often not be fully reflected in the number of pupils gaining good GCSEs, it is difficult to measure them in a standardised way across all pupils.

A final consideration that this underlines is the unequal treatment of individuals in our modelling. The limitations of our measurement instruments – such as GCSE attainment – mean that we count the value of costs and benefits that are straightforward to monetise in a standardised fashion across much of the relevant population. However, some of the groups excluded from our calculations will be those who are often marginalised, such as those with severe special educational needs. When interpreting the results, it is important to bear in mind that the benefits to some groups may be unmeasured, despite possibly being of greater importance to policy development than the benefits we are able to measure.

The marginal increase in pupil attainment is drawn from our literature review. The CPD literature review supplies the basis for quantifying the improvement in pupil learning from the CPD entitlement. This review found 53

[16] Goe, *The Link between Teacher Quality and Student Outcomes*.
[17] See, for example, this summary of the benefits to both individuals and society: Department for Business, Innovation and Skills, 'The Benefits of Higher Education Participation for Individuals and Society : Key Findings and Reports "The Quadrants"', 6.
[18] Jackson, 'What Do Test Scores Miss?'
[19] A 'good' GCSE is defined as a pupil achieving GCSE/GNVQ qualifications at grades A*-C.
[20] Jerrim and Sims, 'The Teaching and Learning International Survey (TALIS) 2018', 19.

randomised controlled trials of professional development interventions - interventions in which professional development changed teachers' practices and improved student learning.

We measure the impact of an improvement in high-quality CPD provision on pupil attainment at GCSE level first and then extrapolate our results to younger children. We calculate the average per pupil benefit for our GCSE cohort and, using published DfE statistics on pupil numbers by age group, we apply our average per pupil benefit from this cohort to all state-funded mainstream pupils.[21]

Greater earnings and wellbeing

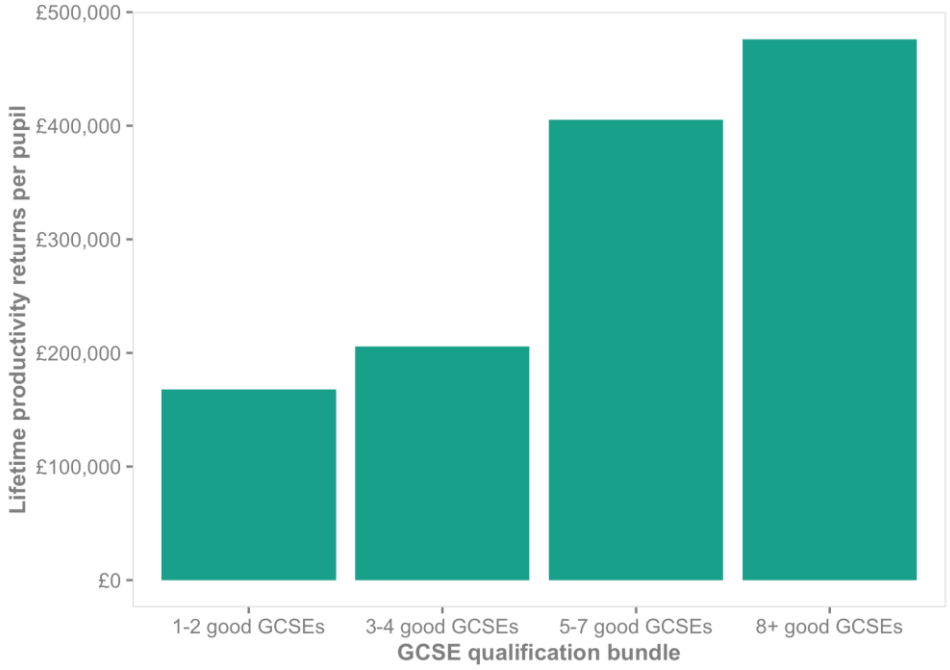
Pupils who gain more skills at school are likely to realise many benefits in adulthood. Associations have been found between education and a host of benefits to both society and individuals, from the propensity to vote and volunteer to reduced crime and increased societal trust, from higher earnings to increased employability.[22] Unfortunately, the causal evidence is not equally strong for all these associations and it is not clear that they are directly caused by more, or better, education.[23] The strongest causal evidence exists for labour market outcomes such as earnings and employability, which is where we focus our modelling efforts.

An improvement in teacher quality leads to young adults with better skills, who are then more productive in the labour market over their working lifetimes. They will receive both higher earnings and will be more likely to be employed in the future.[24]

To estimate the increase in pupils' later earnings, we need to map the improvement in pupils' GCSE grades to an expected increase in earnings throughout the rest of their lives. To do that, we draw on various returns to education estimates (detailed in Appendix A) to value the impact of improved GCSE grades on earnings. Figure 3 shows the added earnings that a pupil achieving a specific number of 'good' GCSEs could expect to receive over their lifetime, compared to a pupil who earned no 'good' GCSEs.[25] We value the impact of improved GCSE grades on earnings when the improvement in human capital is accrued not when it is realised in income (ie in the year that the pupil is exposed to a teacher receiving the high-quality CPD entitlement, rather than when the earnings are realised in the labour market).

[21] Department for Education, 'Schools, Pupils and Their Characteristics'.
[22] Public Health England, 'The Link between Pupil Health and Wellbeing and Attainment'; Department for Business, Innovation and Skills, 'The Benefits of Higher Education Participation for Individuals and Society : Key Findings and Reports "The Quadrants"'.
[23] Cattan and Crawford, 'Assessing the Economic Benefits of Education: Reconciling Microeconomic and Macroeconomic Approaches', 8–10.
[24] Chetty, Friedman, and Rockoff, 'Measuring the Impacts of Teachers II'; Hanushek, 'The Economic Value of Higher Teacher Quality'.
[25] Earnings are referred to for ease of exposition, but the calculation includes a 30% uprating over wages to account for non-wage labour costs. Once again, a 'good' GCSE here means a grade of A*-C in the grading system that existed in 2013/14. See Appendix A for an explanation of why this cohort was chosen.

Figure 3: The lifetime productivity return to each GCSE bundle



Source: EPI calculations using economic returns to education data from Hayward et al. (2014), Department for Business, Innovation & Skills (2015) and Britton et al. (2020)

It is notable that there is a big jump in lifetime productivity returns around achieving below or above 5 good GCSEs. This is largely because pupils who achieve at least five good GCSEs are far more likely to progress to A levels, and then more likely to go on to higher education. For example, looking just at those who achieve 5-7 good GCSEs, around 70 per cent of this group then achieve an A level, or equivalent qualification, and over a third progress to higher education.

As teachers become more skilled, pupils are likely to achieve more good GCSEs, and thus more likely to receive an earnings benefit from the teachers' CPD. Using our estimates of the effect of CPD on pupil attainment, we can estimate the probability of a pupil moving between GCSE qualification bundles, and thus calculate the expected increase in productivity that follows from the teacher's CPD.

Costs of providing professional development

Providing more high-quality CPD is an added cost to schools which needs to be factored into our modelling. There are several categories of costs associated with the policy proposal:

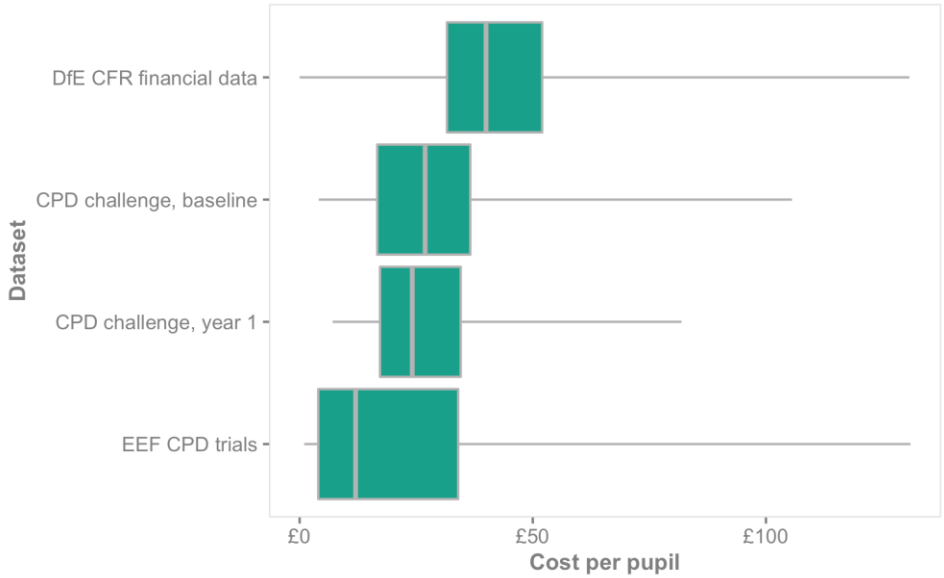
- Costs for providing the CPD.
- Costs for travel and subsistence if the CPD is externally provided.
- Costs for staff cover as teachers will not be able to teach lessons when they are undertaking their CPD.
- Opportunity cost of time for all the teaching staff involved.

There are several possible sources of data available to estimate these costs:

- **School expenditure data published by the DfE** through its consistent financial reporting framework contains a field for development and training expenditure. It is collected for all maintained schools and there are over 14,000 schools in the 2018/19 dataset. This DfE data represents schools' spending on current CPD, not the additional cost of any increase in high-quality CPD hours. We augment the data on development and training by using wage data to estimate the additional staff costs for 9 hours of training.
- The **CPD Challenge's baseline and year 1 data** was provided to us by the programme's evaluators, CFE Research. It contains data on schools' self-reported CPD costs, collected both before the programme began and then again after the first year of the programme. There are 21 schools in the baseline data and 13 in the year 1 data, so the sample size is small.

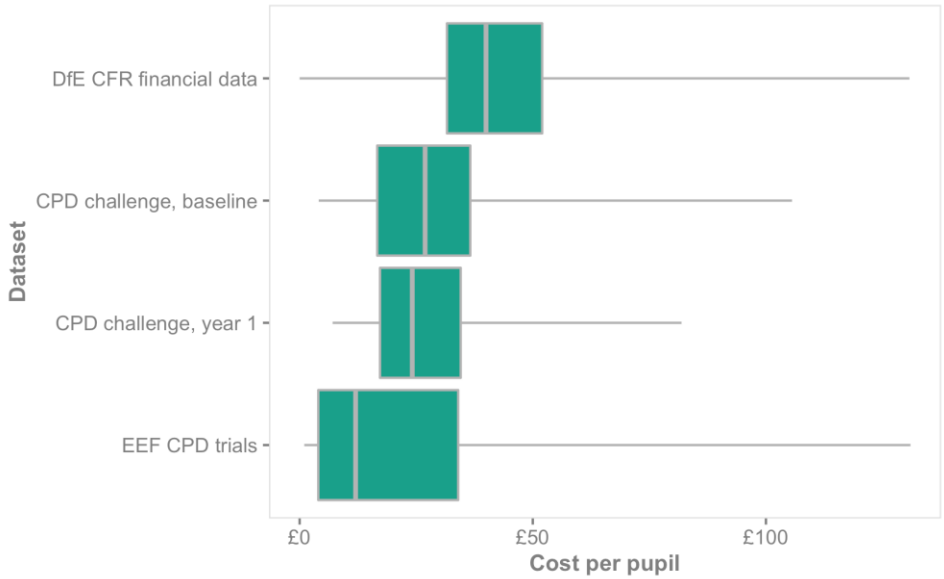
- The cost of **interventions evaluated by the EEF** and assessed in our literature review. There are 21 studies in this group. The costs from these randomised-controlled trials are the additional costs resulting from the various policy interventions. The literature review identified the Dialogic Teaching study as one which evaluates a professional development intervention that fits well with the CPD entitlement policy, both in terms of its transmission through improvements in teacher quality and its effect size.[26]

For each of these datasets, we calculated the cost per pupil affected by the CPD and the distributions are summarised in the boxplots of Figure 4: Comparing the cost of providing CPD across different datasets



Note: Boxes show the interquartile range, bands show the median, whiskers indicate the minimum and maximum (truncated at £130)

Figure 4: Comparing the cost of providing CPD across different datasets


DfE CFR financial data
CPD challenge, baseline
CPD challenge, year 1
EEF CPD trials
Dataset
£0
£50
£100
Cost per pupil
Note: Boxes show the interquartile range, bands show the median, whiskers indicate the minimum and maximum (truncated at £130)

The figure shows the highest cost per pupil is from the consistent financial reporting (CFR) data supplied by the DfE.[27] The data provides nationally representative, annual spending figures on staff development and training. However, it is important to note that it does not specifically measure the cost of any additional, high-quality CPD. The CFR data also does not include the cost of staff cover while the CPD is taking place but, to account for this, we

[26] Fletcher-Wood and Zuccollo, 'The Effects of High-Quality Professional Development on Teachers and Students: A Rapid Review and Meta-Analysis', 9.
[27] Education and Skills Funding Agency, 'Consistent Financial Reporting Framework'.

estimate the additional cost of staff cover using teachers contracted hours, and DfE salary data, and uplift the CFR figures accordingly.

The second notable feature of the chart is that, according to the CPD Challenge data, the cost per pupil of the high quality CPD entitlement did not increase for schools after introducing the policy, despite more, and better, CPD being undertaken. It is possible that schools did not increase the amount they spent on CPD to accommodate more high-quality CPD but, rather, spent their existing budgets more effectively. However, most schools reported spending the £7,000 payment on CPD, which conflicts with reported cost figures.

There are other reasons to be cautious about the CPD Challenge's reported costs. It has an extremely small sample size and the schools who reported in the baseline are not necessarily the same schools who reported in year 1. It also does not include the full cost of the CPD provision and the opportunity cost of the CPD undertaken. Consequently, due to many of the costs associated with the CPD intervention not being included in the CPD Challenge's data, we are reluctant to conclude from it that more CPD, and better CPD, is no more expensive than the status quo (ie the minimal difference in costs per pupil between baseline and year 1 does not serve as the full additional cost of any increase in high-quality CPD hours).

Finally, the costs reported in the EEF trials are markedly lower than those reported in the three other datasets. That is not surprising because the EEF trial data relates to a single intervention, while the other datasets cover all training and development at a school.

However, the literature review did identify the Dialogic Teaching study as one which is representative of the EEF professional development interventions that had positive effect sizes. The intervention aimed to improve pupil engagement and attainment through changing teachers' practice, which is similar in nature to the transmission mechanism through improving teacher quality in our model. Likewise, the impact of the study on primary outcomes (an effect size of 0.09 – 0.15 depending on the subject) is the same as the impact of high-quality CPD found in the literature review. Furthermore, the £54 cost per pupil is at the upper quartile of the CFR estimates (£52), which feels appropriate because delivering higher quality CPD is likely to cost more than the current cost of CPD. Lastly, the study required each teacher to attend three days of CPD training which is similar to the amount of extra professional development hours Wellcome's CPD entitlement would provide teachers with. For these reasons, this study is deemed as the most appropriate study for our modelling purposes.

None of these datasets can entirely account for the opportunity cost of staff time, though the costs of cover account for part of it where cover is required.

There is no ideal data to use to reflect all the costs of undertaking additional, high-quality CPD so we deal with the uncertainty in two ways: first, we use the costs per pupil from Education Endowment Foundation's Dialogic Teaching intervention for our central scenario. Secondly, we conduct a break-even analysis to ask how great the cost of the policy would need to be for the costs to exceed the benefits. Because the cost of high-quality CPD is so uncertain, we can use this estimate to assess how plausible it is that the costs could be greater than the benefits.

Lastly, it is important to note we do not estimate any implementation costs of the proposal, so all costs are variable in the model, rather than having a fixed component. That means, if teachers do not increase the quantity of CPD they undertake, we estimate no additional cost of the policy.

Table summarises the categories of costs associated with the policy proposal that each data source covers.

Table 1: Summary of which costs the data sources include

Source	Costs of CPD provision?	Costs of travel?	Costs of staff cover?	Opportunity cost of staff time?
School expenditure data published by the DfE	Partially	Yes	No (However, we augmented them to estimate this	No

			using DfE wage data)	
CPD Challenge's baseline and year 1 data	Partially (the bursary given to schools to provide the CPD is not fully accounted for)	Yes	Yes	No
Interventions evaluated by the EEF (eg Dialogic Teaching)	Yes	Yes	No	No

Summary of what is included in the model

Table 2 summarises the various costs and benefits identified above and how we will deal with them in our modelling. We aim to be transparent about what outcomes we can measure and, of these outcomes, which ones we are able to value and therefore quantify in our cost-benefit analysis.

Many elements of the model we are simply unable to value due to a lack of robust, causal evidence. This is typical for cost-benefit analyses in education, which tend to focus on monetizable labour market returns because that is where the strongest evidence lies.[28] However, it is essential to interpret that quantification in the context of the other likely costs and benefits, even when they are less quantifiable with existing data.

In the preceding section we have focussed in some places on the limitations of the available data. It is important to recognise those limitations, but it is also important not to be pessimistic about what is known. Most of the benefits in an education CBA are usually the wage returns and those are well-estimated in our model. That gives us confidence that any positive net benefits in our quantification can be interpreted as a true positive effect.

Table 2: Summary of model elements

Element	Outcome measured?	Impact valued?	Why was it measured that way?
Improved teaching			
▪ Greater teacher retention	Yes	No	Highly uncertain estimates based on a single paper.
▪ Greater teacher wellbeing	No	No	Limited causal evidence.
▪ More experienced teachers	No	No	
▪ Lower recruitment costs	Yes	Yes, but not in central scenario	Highly uncertain estimates based on a single paper.
Improved pupil outcomes			
▪ Greater pupil skill	Partially	Yes	Only as far as it is reflected in GCSE attainment.
▪ Greater pupil wellbeing	No	No	Limited causal evidence.
▪ Wider benefits to individual (eg health)	No	No	Limited causal evidence.

[28] For example, Allen et al., 'The Longer-Term Costs and Benefits of Different Initial Teacher Training Routes'; Walker et al., 'The Costs and Benefits of Different Initial Teacher Training Routes'.

▪ Wider benefits to society (eg societal trust)	No	No	Limited causal evidence.
Costs of providing professional development			
▪ Costs of CPD provision	Yes	Yes	From DfE national spending data
▪ Costs of travel	Yes	Yes	
▪ Costs of staff cover	No	No	
▪ Opportunity cost of staff time	No	No	

Scenarios

The previous section outlined our conceptual approach to defining and modelling the costs and benefits of the policy proposal. In this section we describe the essential elements of our approach to calculating and valuing the costs and benefits outlined above.

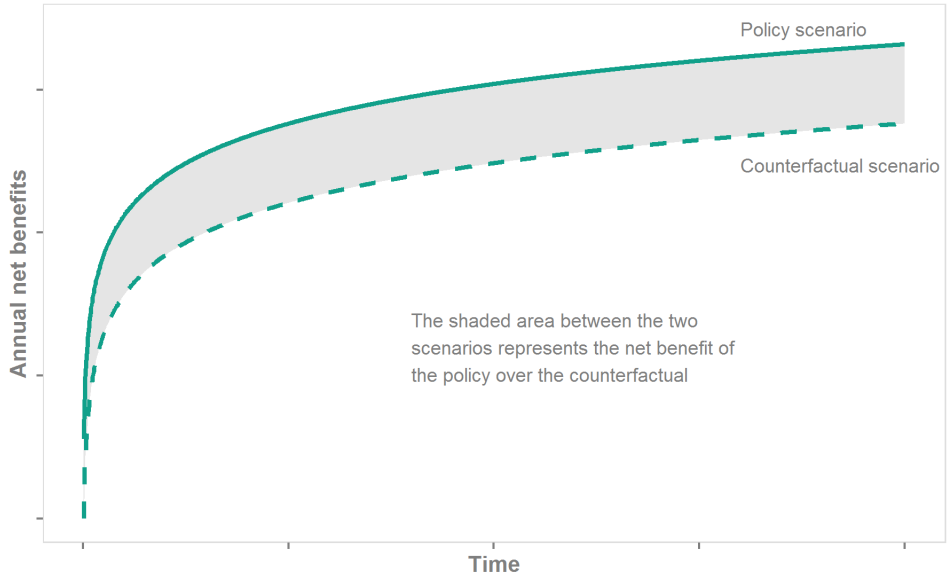
Where we have made judgements based on limited evidence, we have also developed alternative scenarios that quantify the sensitivity of the results to our judgements.

Further details of the calculations are contained in the appendices to this report, which provide a more complete description of our modelling approach.

Core assumptions

Cost-benefit analysis (CBA) models compare the policy intervention to some alternative scenario, often referred to as a counterfactual. The counterfactual describes what would happen if the policy intervention did not happen. The benefits and costs of the proposal and the counterfactual are summed over their lifetimes and compared.

Figure 5: Policy proposal and counterfactual



Thus far we have outlined all the relevant costs and benefits which may arise from the policy intervention. The appraisal involves calculating the net present value (NPV) – the present value of benefits less costs – and benefit-cost ratio (BCR) – the ratio of benefits to costs.

That means we must:

- Specify the counterfactual scenario we are using.
- Specify the time horizon over which we measure the differences between the policy scenario and the counterfactual.
- Decide how to value benefits that accrue in the future relative to benefits that accrue today (the discount rate).

The counterfactual is business-as-usual

The most significant costs and benefits to quantify are those likely to be decisive in determining the difference between the policy and the alternative 'business as usual' (BAU) case. The BAU case assumes the proposed policy was not implemented (ie the continuation of the status quo) and provides the counterfactual with which to compare the policy proposal.

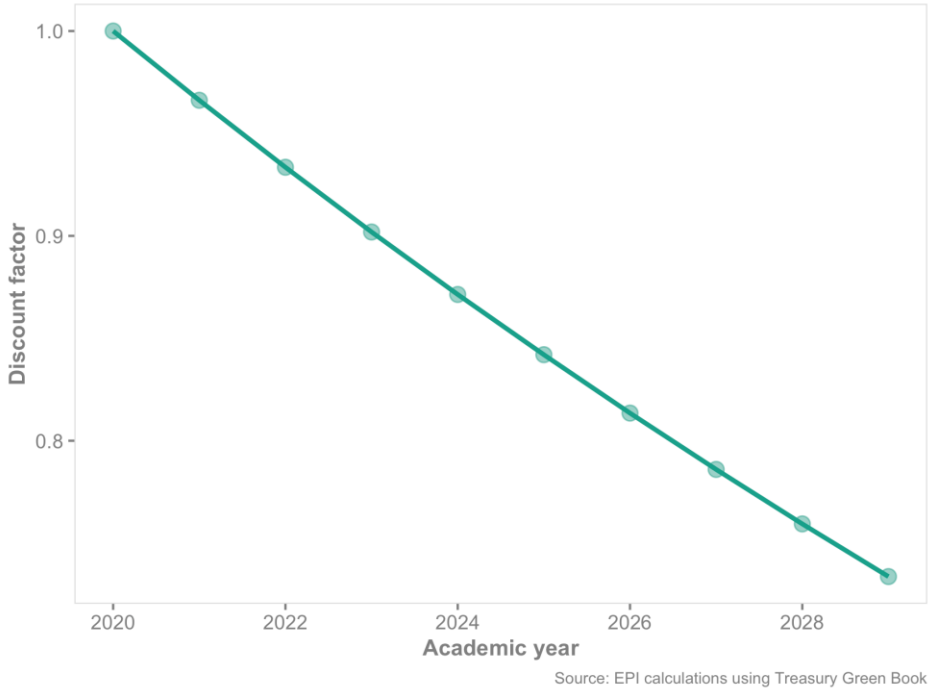
The central question for the counterfactual is how much CPD will teachers do, and what will the quality be, if the CPD entitlement is not implemented? There are no obvious mechanisms present in the education system that are likely to cause the number of high-quality CPD hours to grow dramatically in the next few years, so we have assumed that there is no growth in the number of high-quality CPD hours in the counterfactual scenario. In other words, we assume that the quantity, quality, and cost of CPD remains as it is today for the next ten years.

A ten-year horizon on benefits

A CBA requires a fixed period over which the differences between the policy and the counterfactual are evaluated. The Treasury's Green Book guidance states that '*costs and benefits should be calculated over the lifetime of an intervention*'.[29] For the policy we are evaluating, the question is how long until the quantity and quality of CPD in the counterfactual catch up to the quantity and quality in the policy scenario? That is impossible to know so we use the Green Book's default recommendation of a 10-year time horizon, concluding in the academic year 2029/2030.

Discounting at Green Book standard rates

The discount rate determines the value of costs and benefits that accrue in future, relative to those that accrue today. We use a constant discount rate of 3.5 per cent, as recommended in the Green Book, which values future costs and benefits as shown in Figure 6: The value of future costs and benefits

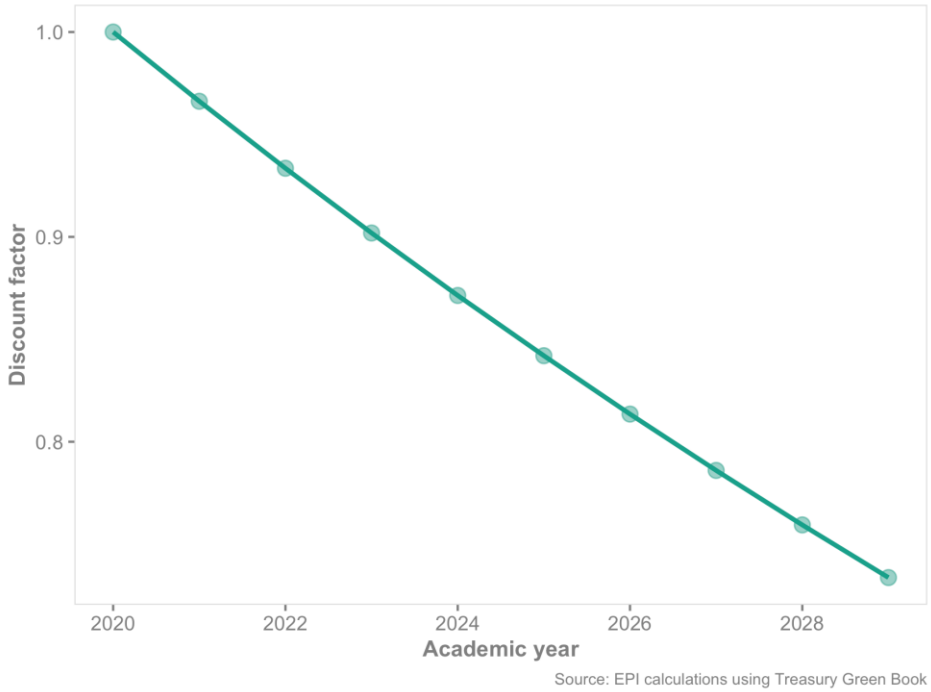


Source: EPI calculations using Treasury Green Book

below. The chart shows that the net benefits in the academic year 2029/30 will be valued at only 70% of the net benefits in 2020/21 when they are summed.

[29] HM Treasury and Government Finance Function, 'The Green Book', para. 5.14.

Figure 6: The value of future costs and benefits



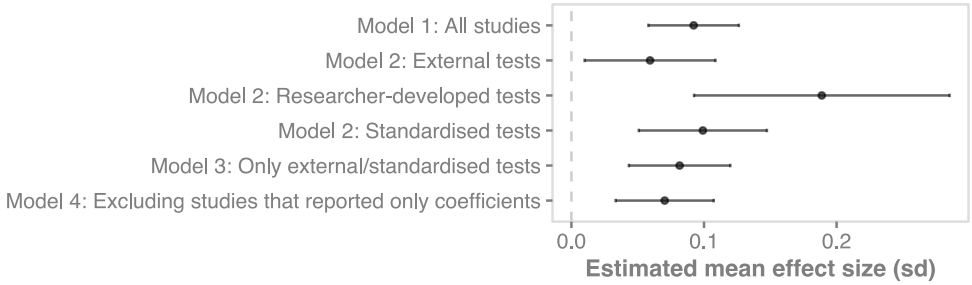
Source: EPI calculations using Treasury Green Book

Improved teaching

The effect of CPD

Our central scenario uses the average effect size from external tests only from the literature review to quantify the improvement in pupil outcomes resulting from the CPD entitlement. The literature review analysed 52 randomised controlled trials from 42 studies to identify an average effect size of professional development on student learning equivalent to an extra month of learning. This average effect size, however, includes evaluations of all types of interventions. Some are interventions in the US, others are UK-based. Some are evaluated using specific examinations for the programme being tested, others are evaluated using external, national examinations.

Figure 7: Impact of CPD on pupil attainment



Source: Fletcher-Wood et al. (2020)

We instead will utilise the effect size from external tests only (model 2 in Figure 7), which is equivalent to an extra GCSE grade on average, as these professional development interventions are mainly based in the UK and were all evaluated with an examination which is comparable to GCSE points scores. This excludes researcher-developed tests, which may have incomparably high effect sizes as an artefact of their design. Therefore, the effect size on pupil achievement from external tests only will be used to determine the shift in the distribution of GCSE point scores from an increase in teacher's professional development time.

However, as with all estimates, there is a degree of uncertainty in the estimation which needs to be reflected in the CBA model. The confidence interval for this estimate provides a plausible range for the effect of high-quality CPD interventions on pupil learning. Table 3 shows the effect size from external tests only from the literature

review, along with the corresponding standard error and confidence interval, all drawn directly from the literature review.

Table 3: Estimated effect size from the CPD literature review

	Effect size	Standard error	95% confidence interval
External tests only	0.06	0.03	(0.01, 0.11)

Note: All figures rounded to 1sf

To assess the sensitivity of the effect of CPD on our BCR estimates, we will vary the effect size using the lower and upper limit of the confidence interval.

The quantity of CPD

A key assumption here is that reducing the number of hours of CPD will reduce the effectiveness of the CPD. Our literature review did not find a clear relationship between the number of hours of CPD and the outcomes for pupils. We concluded that the appropriate number of hours probably depends on the design and intent of the CPD, and that 35 hours would most likely be sufficient to achieve the average effect size from the literature review. However, it is also certain that zero hours of high-quality CPD, the median number of high-quality CPD hours in the baseline of the CPD Challenge, is insufficient.

We cannot unravel the complex relationship between intensity, impact, and design in this CBA. Instead, we construct three scenarios:

- A **central scenario** in which the impact scales with the number of hours. In the CPD Challenge, participants did approximately 9 hours more high-quality CPD, which is around a quarter of the target 35-hours. Consequently, we scale the effect size to be a quarter of the effect size from external tests only.
- A **lower bound** where participants do no more hours of high-quality CPD. A few teachers in the schools in the CPD Challenge did not do any high-quality hours of CPD, so this is a plausible lower bound. In this case, the effect of CPD on pupil attainment is zero.
- An **upper bound** where schools do an additional 35 hours of CPD. It is very unlikely that the average national level of high-quality CPD would exceed the policy target, or even reach it. However, this can also be interpreted as a scenario in which our preferred effect size (external tests only) is not scaled down at all because the quantity and design of the CPD is sufficiently well matched in all cases to realise the full effect we find in the literature review.

These bounds of 0 and 35 hours of additional, high-quality CPD are extremely wide and that reflects the lack of available evidence on both the current level of high-quality CPD, and the likely change in response to the proposed entitlement.

We scale costs according to the quantity of additional high-quality CPD undertaken by teachers in England. There are no costs for the lower bound of this alternative scenario but when schools do an additional 35 hours of CPD, in the upper bound, costs per pupil of the policy are quadrupled.

Costs and benefits are immediately realised

The literature review uncovered conflicting evidence about how long it takes to improve teaching. It appears likely that sustained CPD produces greater benefits, but several meta-analyses have found no connection between the length of time and impact.[30] Ours, too, found numerous programmes that took a year or less to produce an impact. Consequently, we assume that teachers immediately begin doing more CPD when the policy is enacted and that their teaching is improved within that first year.

It is possible that many schools would be unable to increase the amount of high-quality CPD that is provided to their teachers so rapidly. A recent review of subject-specific professional development highlighted several barriers

[30] Fletcher-Wood and Zuccollo, 'The Effects of High-Quality Professional Development on Teachers and Students: A Rapid Review and Meta-Analysis', 16.

to the development of high-quality, subject-specific professional development, including budgets, workload, competing priorities and a lack of high-quality provision.[31] However, the CPD Challenge suggests that many schools can increase the amount of high-quality CPD by redirecting resources.

In case that central scenario is too optimistic, we also include an alternative scenario in which the benefits lag the costs by a year.

Benefits are the same across the attainment distribution

There is no difference in the benefit to different pupils in the CBA model. We have implicitly assumed that the increase in pupil learning is the same across the GCSE attainment distribution. All pupils go on to achieve higher grades and hence gain a higher probability of achieving the various GCSE qualification bundles and consequently higher lifetime productivity returns.

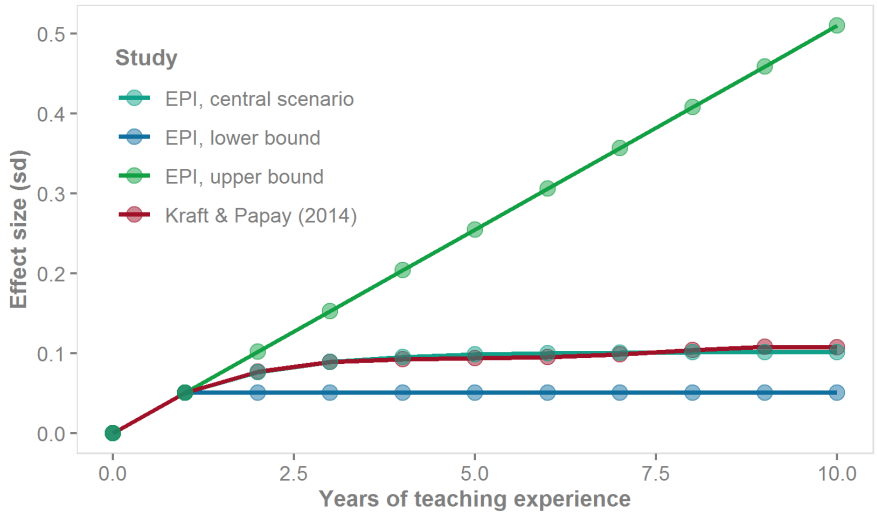
Improved pupil outcomes

There are diminishing returns to more years of better teaching

The evidence we gathered in the literature review has little to say about the impact of sustained participation in CPD for many years. It seems obvious that a teacher who has undertaken high-quality CPD for five years will have learned more than after one year; however, they probably will not have learned five times as much. This assumption of diminishing marginal returns is common in CBA modelling because it is unlikely that teaching skill can indefinitely improve at a constant rate when exposed to the same amount of CPD each year.

One study that does examine the accumulation of skill over a decade of teaching is Kraft & Papay (2014).[32] The authors document the returns to teaching experience and estimate the effect size of being taught by a more experienced teacher. As Figure 8: The diminishing returns to additional experience shows, they find diminishing marginal returns to further experience.

Figure 8: The diminishing returns to additional experience



Source: Kraft & Papay (2014), Figure 4; Author's calculations

Note: The year 1 effect size has been rescaled to be identical. Subsequent years are not rescaled.

We calibrate our central scenario to the rate of diminishing marginal returns that they find in their study, which means that each additional year of CPD is worth half as much as the previous year in additional pupil attainment. This implies that in our central scenario, if a pupil began school in the first year the CPD entitlement was

[31] Cordingley et al., 'Developing Great Subject Teaching: Rapid Evidence Review of Subject-Specific Continuing Professional Development in the UK'.

[32] Kraft and Papay, 'Can Professional Environments in Schools Promote Teacher Development?'

implemented then they would be expected to achieve an additional two-thirds of a GCSE grade over their schooling life.

Figure 8: The diminishing returns to additional experience shows the growth in effectiveness that implies and that it is a good fit to the relationship estimated by Kraft & Papay. Note that Figure 8: The diminishing returns to additional experience scales our level of growth to the effect sizes in their study for ease of comparison.

To test the sensitivity of this decision we will vary this assumption with:

- A **lower bound** where the impact is only present in the first year of the policy intervention and there are no further improvements in teaching skill thereafter.
- An **upper bound** where the impact remains constant for the entire duration of the policy (ie the full gain to pupil learning in the first year is experienced every year over the ten-year timeframe).

The lower bound is a very conservative one, because it dictates that the effect of the high-quality CPD entitlement completely dissipates after the first year of the policy. The upper bound of this assumption provides a feasible scenario for the dynamics of the model as the literature review analysed randomised-controlled trials which tended to be evaluated over a one to two-year period. Therefore, it is possible that if the CPD entitlement is providing teachers with the specific CPD training to match their needs every year then the policy is just as beneficial year-on-year. For example, a teacher's pupils may gain 0.1sd from their teacher's improved assessment one year, then another 0.1sd in another year from their improved classroom management.

Within-firm productivity spillovers are included

Our estimates of the increased earnings from greater pupil attainment follow Hayward et al (2014) and uprate the earnings of individuals by 30 per cent to account for the additional non-wage costs of employing people, such as national insurance and pensions.[33] That implicitly accounts for the productivity of individuals to the extent that the benefits are captured by their employer, though not if the benefits accrue to others outside the firm. The underlying assumption is that the firm would not hire a person if they did not generate at least as much value for the firm as the cost of employing them.

Costs of providing professional development

The central scenario uses an Education Endowment Foundation (EEF) study on Dialogic Teaching, which aimed to improve pupil engagement and attainment through changing teachers' practice.[34] It cost £52 per pupil. We uplift this cost to current prices which gives an approximate cost of £54 per pupil.

We assume the per-pupil cost of the high-quality CPD entitlement remains the same in real-terms each year. Accumulating the costs over the duration of the policy proposal and discounting according to HMT's Green Book guidance gives the overall cost for the policy proposal.

To provide a sensitivity test, we will use the median cost per pupil from the DfE's national spending data to give a £40 cost per pupil for the policy. We will also estimate the costs that would be required to drive the BCR of the proposal below 1, where costs exceed benefits.

Summary of scenarios

Table 4: Summary of scenarios

Assumption	Central scenario	Alternative scenario
Improved teaching		

[33] Hayward, Hunt, and Lord, 'The Economic Value of Key Intermediate Qualifications: Estimating the Returns and Lifetime Productivity Gains to GCSEs, A Levels and Apprenticeships', 19.
[34] Jay et al., 'Dialogic Teaching'.

▪ The effect of CPD on pupil attainment	External tests only: an average effect equivalent to an extra GCSE grade (0.06)	Use the confidence interval from CPD literature review to vary the impact of the CPD entitlement on pupil attainment: (0.01, 0.11)
▪ Improvements in teacher quality	Benefits are realised from year 1	Lag benefits one year behind costs
▪ The quantity of CPD	Teachers do nine additional hours of CPD per year and pupil attainment improvements are scaled down accordingly.	Estimate bounds for compliance at 0 and 35 hours per year, with pupil attainment improvements scaled accordingly.
Improved pupil outcomes		
▪ The marginal value of additional CPD	The additional impact of more CPD on pupil attainment halves each year.	An upper bound with a constant additional impact. A lower bound with a one-off increase in skill.
Costs of providing professional development	£54 per pupil	An alternative scenario of £40 per pupil. A breakeven analysis.

Results

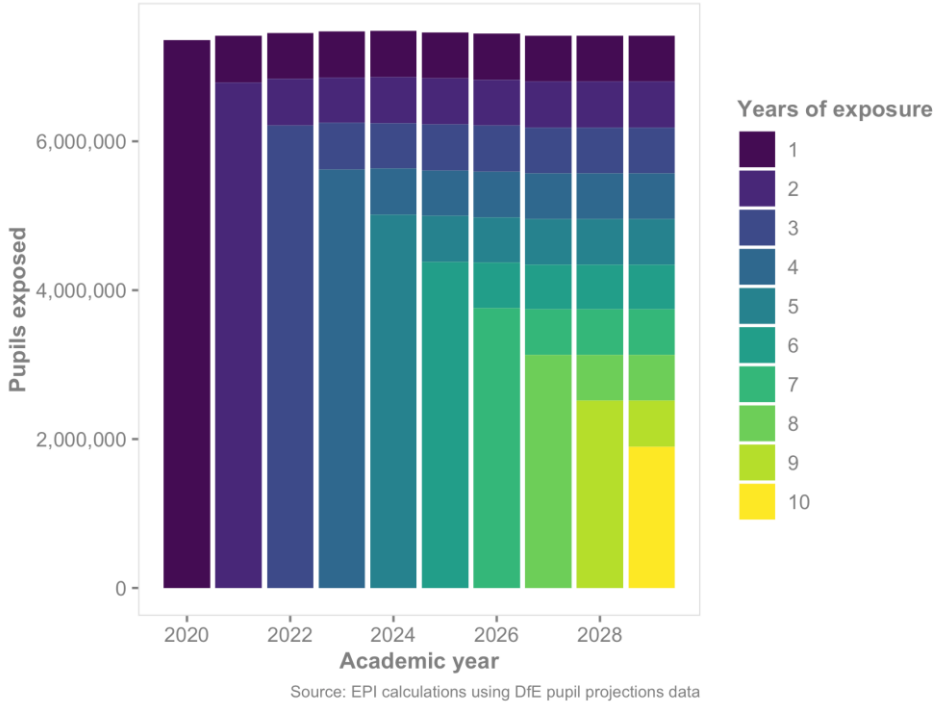
We report all the results from our central scenario below and only those results from our alternative scenarios where we vary assumptions in the later subsections. This section follows the steps in the logic chain described previously (Figure 1).

Central scenario

Number of teachers and pupils affected

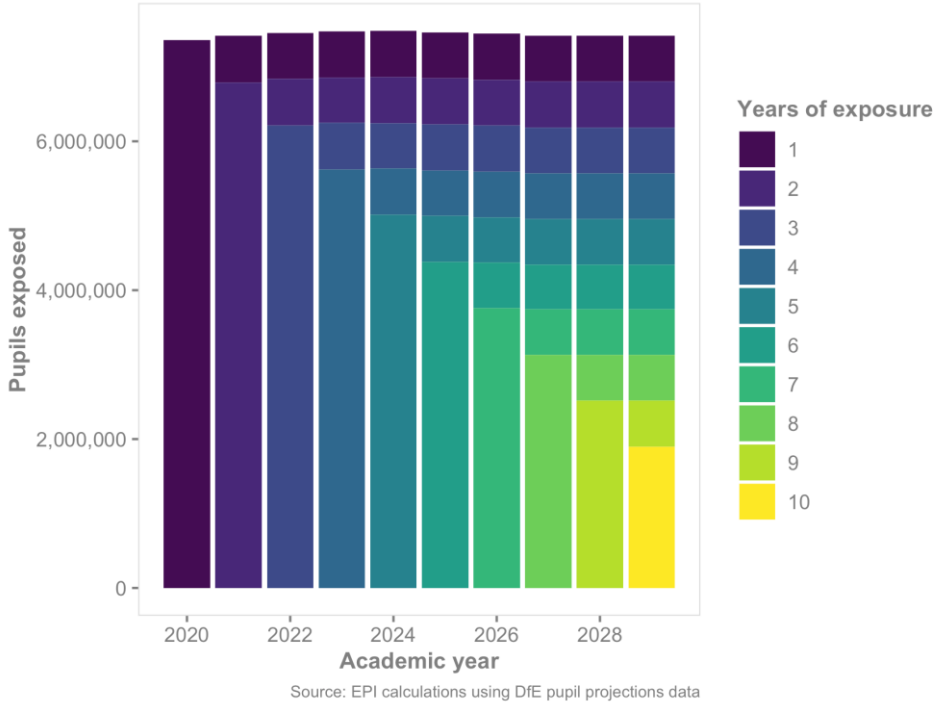
This policy will affect all teachers in mainstream schools, and they are assumed to benefit uniformly from the entitlement. This equates to approximately 425,000 full-time equivalent (FTE) teachers annually who will be doing more high-quality professional development and realising improvements in teacher quality as a result.

Approximately 13 million pupils are affected over the ten-year timeframe, approximately 7 million pupils are impacted in the first year and are continually exposed to the policy proposal for their school life and approximately 615,000 pupils enter the mainstream education system each year and will undertake more, and better, CPD. The degree to which their attainment is affected is dependent on their exposure to the policy: a pupil joining the education system in the academic year 2020/21 will observe a much greater impact than a pupil who starts school in the academic year 2029/30. This is because the benefit to pupil outcomes accumulates the longer a pupil is in the education system, as shown in Figure 9: The number of years pupils have been exposed to the policy



Source: EPI calculations using DfE pupil projections data

Figure 9: The number of years pupils have been exposed to the policy



Source: EPI calculations using DfE pupil projections data

Teacher retention

We have emphasised the difficulty of assessing the impact on teacher retention because of the lack of evidence. However, if one were to use the estimates from the single high-quality study available, they would imply that the proposal would reduce attrition from the profession by around 12,000 FTE annually. To put that in perspective, about 40,000 teachers leave the profession each year and the recruitment shortfall relative to the DfE's targets in recent years has been about 3,000 teachers.

Improved pupil outcomes

In our central scenario, pupils each gain a benefit to lifetime productivity returns of approximately £3,000 from their teacher's additional CPD. To benchmark those returns, we compared it against figures from two prominent estimates of the returns to improved teaching in the US. To compare on the closest like-for-like basis, we adjusted for differences between effect sizes, currencies, discount rates, the base year of the estimate, and productivity spillovers.

Adjusting our estimate for productivity spillovers to transform our lifetime productivity returns into lifetime earnings returns gives a central estimate of approximately £2,300. Reassuringly, Figure 10: Comparison of lifetime earnings benefit per pupil from CBA model to other estimates

shows that our estimates are comparable to these other estimates.

Figure 10: Comparison of lifetime earnings benefit per pupil from CBA model to other estimates

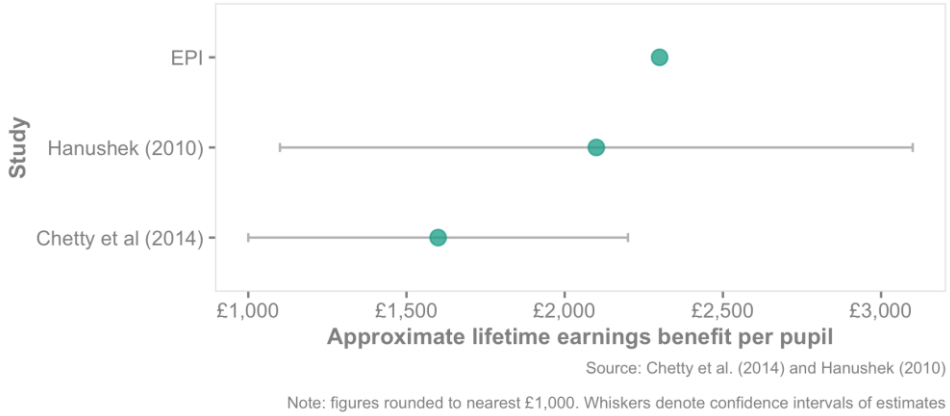
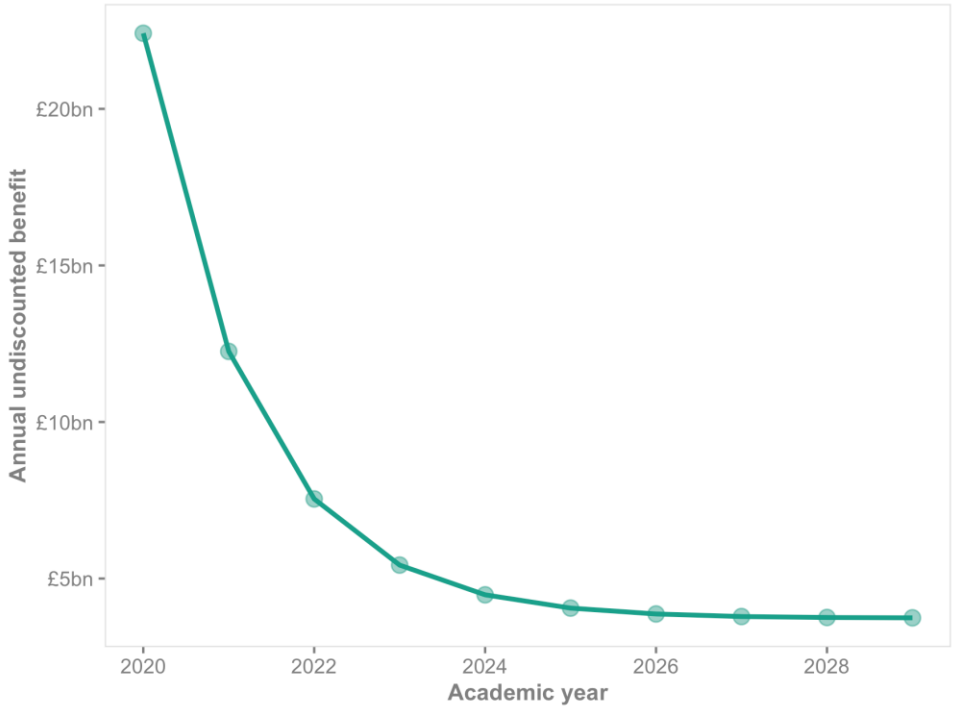


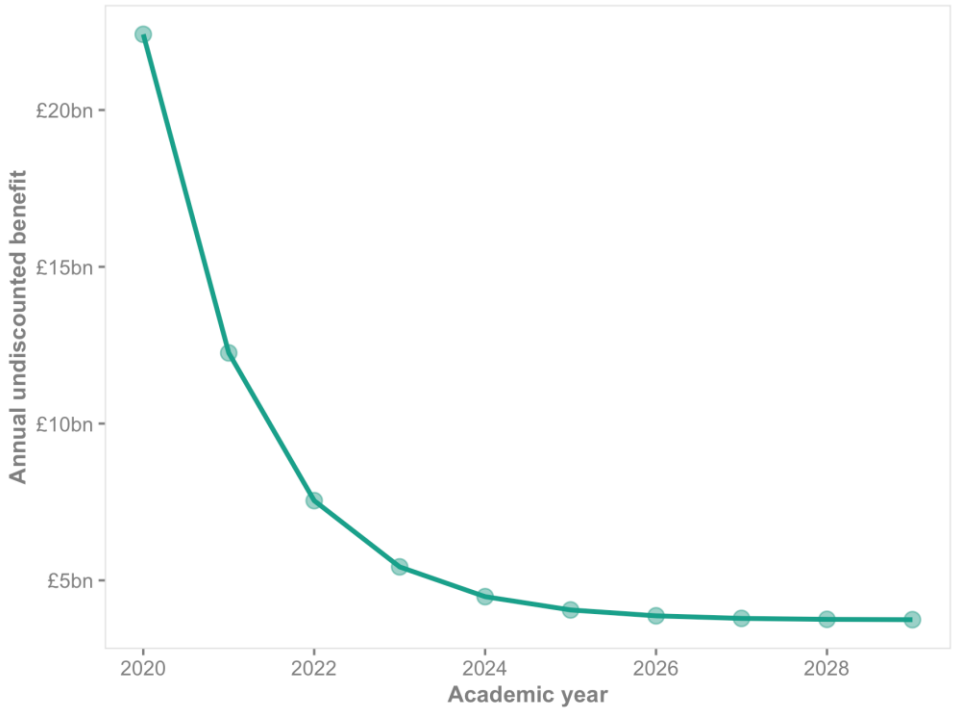
Figure 11: Annual undiscounted benefit of CPD entitlement over time for the central estimate



shows the stream of total benefits to pupil outcomes once they are summed across all pupils in the state-funded mainstream school system. The annual benefit is the largest in the early years of the policy implementation and decreases marginally each year that the policy is in effect. That is because of the interaction of two assumptions: first, the marginal

benefit to additional CPD is declining, as discussed previously. Secondly, we count the expected earnings benefit when the pupil gains the skills rather than when they begin earning. That approach is consistent with the ONS' approach to measuring human capital and analogous to accrual accounting.

Figure 11: Annual undiscounted benefit of CPD entitlement over time for the central estimate

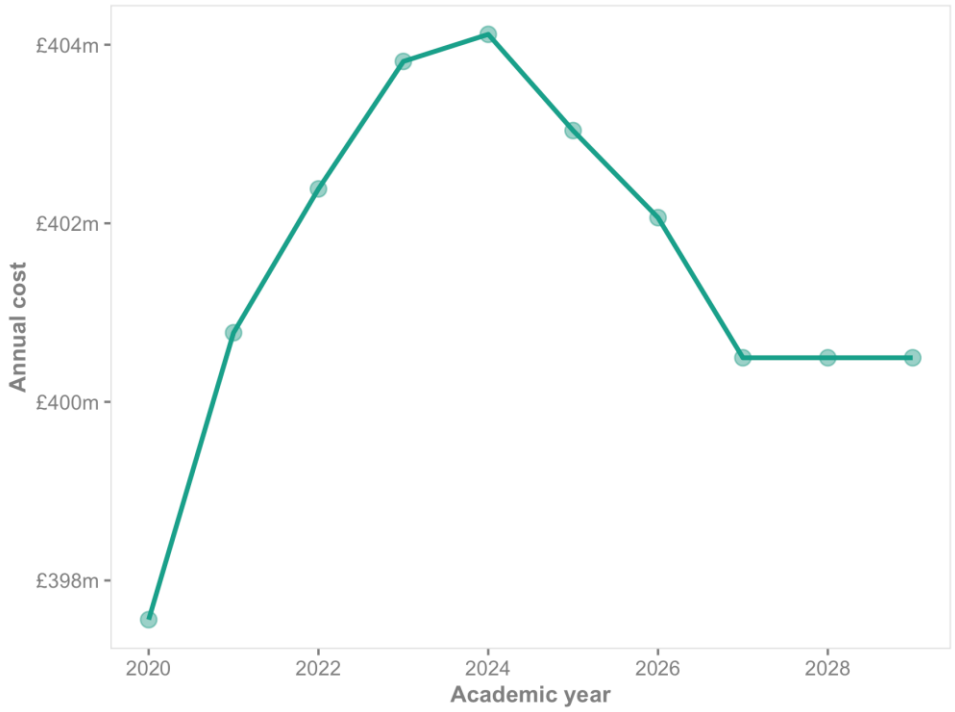


Costs

Using the Dialogic Teaching report as our source for costs, the cost of the policy would be approximately £54 per pupil per year. This equates to less than one per cent of schools' budgets. Applying this cost figure to pupil numbers gives an annual cost of approximately £398 million in the first year of the policy. The total cost of the policy is £4bn over the 10-year period the CPD entitlement is in place for. As shown in Figure 12, the annual cost follows fluctuations in pupil numbers over time. Therefore, as pupils' numbers are projected to rise for the next few years and fall thereafter, our costs rise.

Costs remain constant from 2027/28 onwards because DfE does not publish pupil projections beyond that point and we assume that pupil numbers subsequently remain constant. We investigated the possibility of using ONS population projections to change this assumption, but it made a negligible difference to the results.

Figure 12: Annual undiscounted cost of high quality CPD over time



Benefit-cost ratio

Collating aggregate costs and benefits gives a net present value for the central scenario of the CPD entitlement policy in our central scenario of approximately £61bn. That means the implementation of the policy for a decade delivers benefits that are equivalent to a one-off £61bn increase in lifetime incomes.

That gives a benefit-cost ratio of 18.9 in our central scenario, which implies that the benefits of this policy proposal are around 19 times the costs. These numbers are extremely large, which reflects both the importance of the quality of teaching for pupils, and the importance of education for pupils' later earnings.

Alternative scenarios

Here we vary the assumptions, as described in Table , and report the changes from the central results.

The quantity of CPD

At the lower bound, when teachers do not increase their hours of high-quality CPD, neither costs nor benefits change from BAU and the BCR is zero.

At the upper bound, when teachers do 35 additional hours of CPD and realise the full effect on pupil attainment of an extra GCSE grade, the gain in lifetime productivity per pupil rises to approximately £8,800. However, we scale costs according to the increase in the quantity of CPD so the BCR decreases to 14.1 as the increase in costs in this scenario is greater than the increase in the benefit. This is because the costs increase by the same percentage as the quantity of the CPD but, because costs remain constant over time and benefits have diminishing marginal returns, the cost increase eclipses the benefits increase.

The effect of CPD

Here we vary the effect of high-quality professional development on pupil learning using the confidence intervals from the literature review. At the upper limit of the confidence interval, with an effect size equivalent to almost two GCSE grades (still scaled to the 9 hours per year to account for schools being below full compliance), the gain in lifetime productivity per pupil rises to approximately £5,700 while costs remain the same. The BCR rises to 35.2.

At the lower limit of the confidence interval, the gain in lifetime productivity per pupil falls to approximately £500 while costs remain the same. The BCR falls to 3.2.

Delaying the improvements in teacher quality

Delaying benefits by a year relative to costs results in a BCR of 16.5. The costs and benefits do not change; they are simply offset slightly relative to the central scenario.

The marginal value of additional CPD

In the lower bound of this scenario, teachers improve their teaching skill only in the first year that they undertake more, and better, CPD, the gains to pupil attainment accrue in only the first year the CPD entitlement is in place and dissipate completely thereafter. The upper bound applies the gain in lifetime productivity per pupil of approximately £3,000 every year for the 10-year timeframe.

At the end of the 10 years, the BCR of a policy entitling all teachers to 35 hours of high-quality professional development per year ranges between 10.6 and 56.4 from varying this assumption.

Costs of providing professional development

Using the CFR national data for school expenditure on staff development and training, a cost of £40 per pupil would increase the BCR to 25.5.

The costs would have to exceed £975 per pupil for the costs to be greater than the benefits. Only tutoring and coaching programmes that are extremely labour intensive tend to reach these levels. In our literature review we considered some of these programmes available in the UK for context:

> CatchUp Literacy achieved an effect size of 0.01 at a cost of £53 per pupil per year (EEF, 2019b), Switch-on reading achieved an effect size of 0.00 at a cost of £546 per pupil per year (EEF, 2019c), while a small-scale trial of graduate coaching achieved an effect size of 0.36 at a cost of £1,400 per pupil per year (Lord et al., 2015).[35]

Summary of results

Table 5 collates the BCR estimates calculated above for the various scenarios.

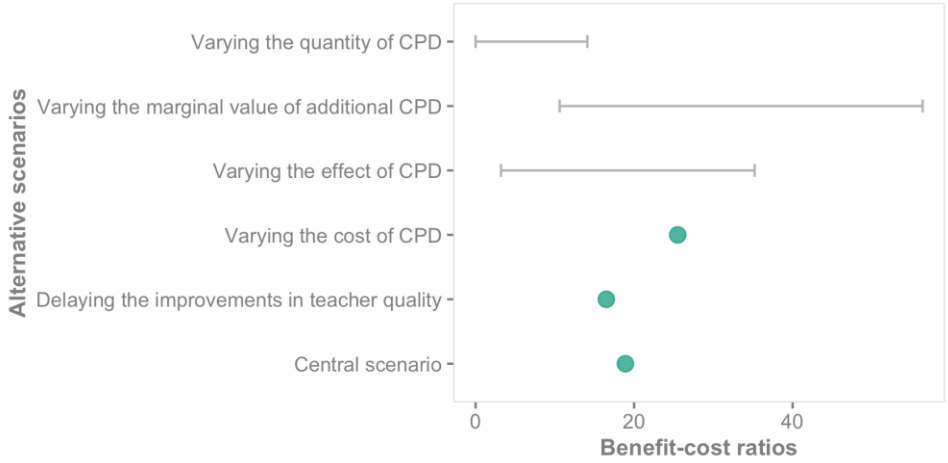
Table 5: Summary of benefit-cost ratios for each scenario

Scenario	Benefit-cost ratio (parentheses denote upper and lower bounds/scenarios)
Central scenario	18.9
Improved teaching	
▪ Varying the effect of CPD	(3.2, 35.2)
▪ Delaying the improvements in teacher quality	16.5
▪ Varying the quantity of CPD	(0.0, 14.1)
Improved pupil outcomes	
▪ Varying the marginal value of additional CPD	(10.6, 56.4)
Costs of providing professional development	25.5

[35] Fletcher-Wood and Zuccollo, 'The Effects of High-Quality Professional Development on Teachers and Students: A Rapid Review and Meta-Analysis', 9.

Charting those BCRs clearly illustrates what matters most to the success of the policy proposal: the quality of CPD that is undertaken by teachers. The only other parameter that matters as much is the marginal return to additional CPD, which may prove difficult for policymakers to influence.

Figure 13: Benefit-cost ratios under the various alternative scenarios



Among the parameters we varied, quantity and quality are the two most amenable to policy intervention and quality is the most important. That means an excellent implementation of the entitlement could reap enormous gains for the nation. However, it also means that poor implementation may lead to little or no gain at all.

When interpreting these results, it is important to recall that we have taken no position here on the ease or cost of implementation. While we have used the most reliable estimate available for the possible effect of the policy, those effects are conditional on the implementation across the entire country being as good as that of the studies from which we drew our estimates. If it falls short of that standard then, depending on the administrative cost of implementation, the policy may still return a negative BCR.

However, these results show that, if implementation is done effectively, then even quite large costs are unlikely to drive the BCR below 1.

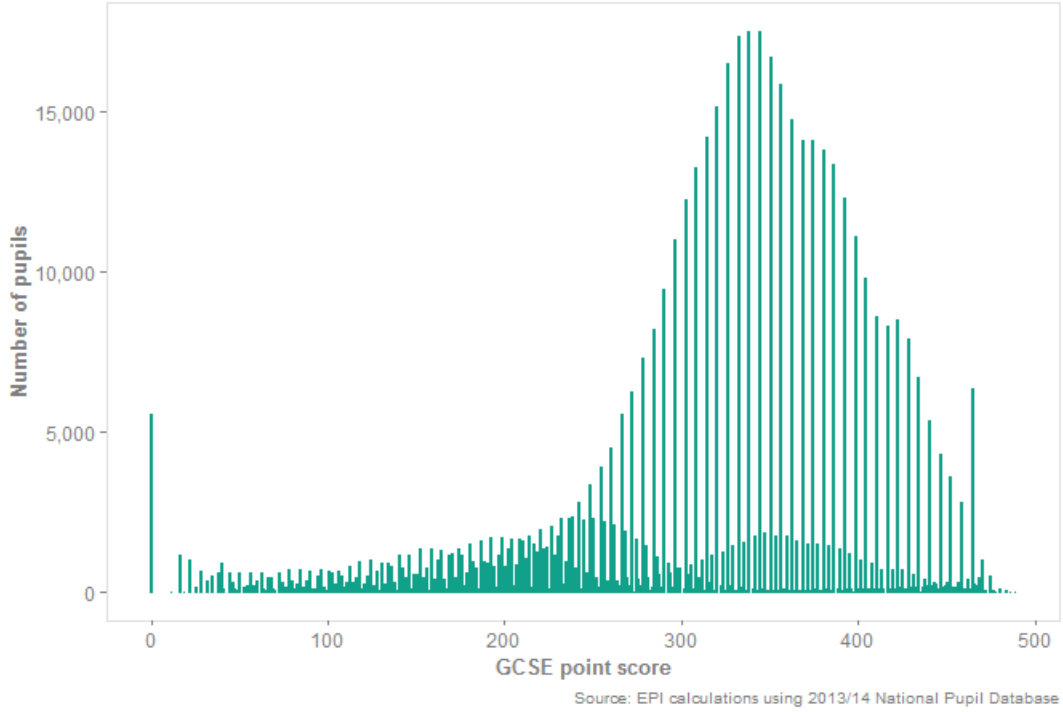
Appendix A: Improved pupil outcomes

This appendix describes how we valued the improvements in pupil attainment resulting from the CPD entitlement policy.

We utilise the National Pupil Database to analyse all pupils in state-funded mainstream schools who finished Key Stage 4 (KS4) in the academic year 2013/14, this equates to just over 550,000 pupils across England. We measure GCSE point scores through capped GCSE and equivalents point scores, hence we are also considering pupils who do not sit their GCSEs but undertake equivalent qualifications. The 2013/14 KS4 cohort was selected for this analysis because:

- using an earlier cohort for whom we have data in later years allows us to track a single, consistent cohort over time through various education stages (KS4, KS5 and post-KS5).
- the old-style GCSE points system in place in 2013/14 (which changed soon after) is more granular, which is better suited for capturing marginal improvements in GCSE pupil attainment.
- the old-style GCSE points system also aligns with the most up-to-date published economic returns estimates.
- this cohort's GCSEs relate to post-Wolf reforms and post reforms to early GCSE entry rules, which is consistent with the current educational context.
- although the most recent KS4 cohort (2018/19) best represents today's educational context, the new-style GCSEs and A levels were only fully introduced in 2018 so reforms will not have been fully embedded yet and as the model merely shifts the underlying distribution of attainment, this should not change drastically between academic years for a given effect size.

Figure A1: The distribution of pupils GCSE points scores in the academic year 2013/14



The first step is to round GCSE point scores to the nearest integer to avoid cases of small numbers of pupils with a given point score. The probability of an individual obtaining various GCSE qualification 'bundles' based on their capped GCSE and equivalents points score is then calculated. We simply map GCSE point scores onto the likelihood of attaining different 'bundles' of GCSEs and estimates how a marginal change in points scores affects the number of pupils achieving each of these GCSE bundles. Our bundles are categorised as pupils attaining a certain number

of GCSE/GNVQ qualifications at grades A*-C, which we refer to as 'good' GCSEs. The bundles are categorised as follows:

- 0 good GCSEs
- 1-2 good GCSEs
- 3-4 good GCSEs
- 5-7 good GCSEs
- 8+ good GCSEs

The probabilities of being in each GCSE bundle are calculated by constructing an ordinal logistic regression model (also known as a proportional odds logistic regression model):

$$logit[P(Y \leq j)] = \alpha_j - \beta\, KS4pointscore_i, j = 1, \ldots, J-1$$

where P is the probability of being in a certain GCSE bundle, j is the ordered category with J levels (in this case our GCSE qualification bundles) and the dependent variable is a logit, which is the natural log of odds:

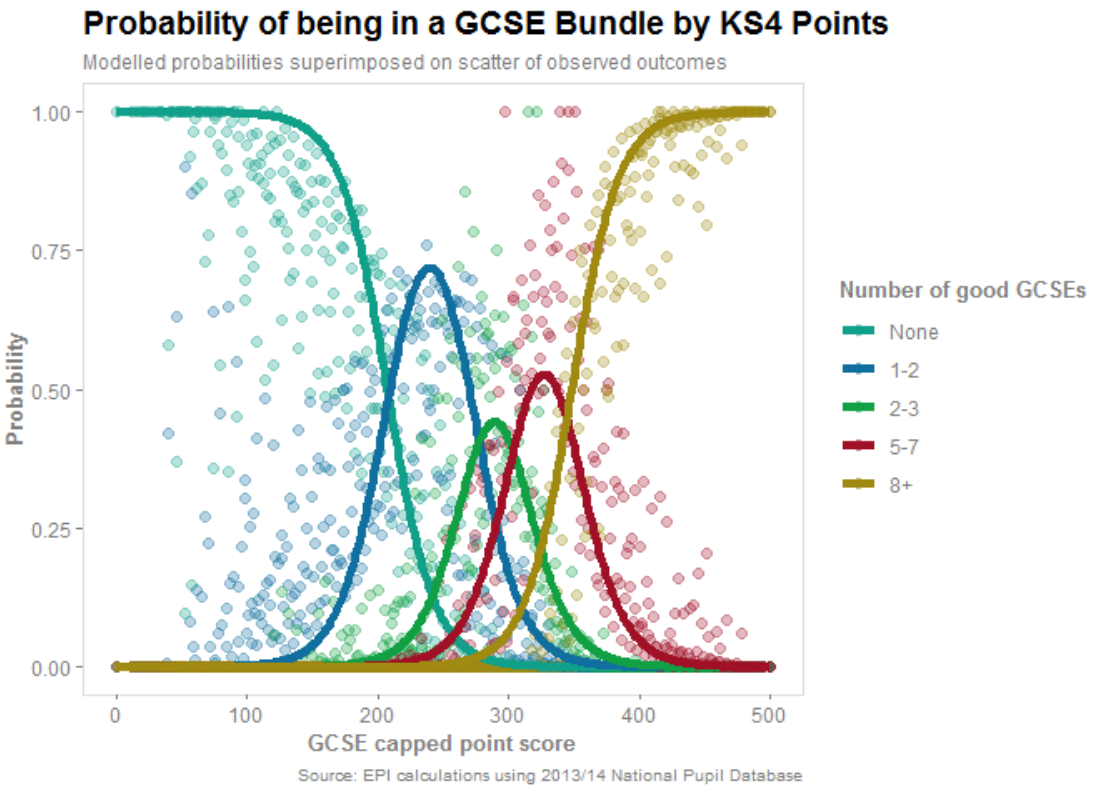
$$ln\left(\frac{P}{1-P}\right)$$

Effectively the dependent variable takes the following form for these GCSE bundles (where 0 good GCSEs, 1-2 good GCSEs, 3-4 good GCSEs, 5-7 good GCSEs, 8 + good GCSES are denoted as $P0$, $P1$, $P2$, $P3$ and $P4$ respectively):

- 0 good GCSEs, $ln\left(\frac{P0}{P1+P2+P3+P4}\right)$
- 1-2 good GCSEs, $ln\left(\frac{P0+P1}{P2+P3+P4}\right)$
- 3-4 good GCSEs, $ln\left(\frac{P0+P1+P2}{P3+P4}\right)$
- 5-7 good GCSEs, $ln\left(\frac{P0+P1+P2+P3}{P4}\right)$

The model generates the probabilities of being in each GCSE qualification bundle for a given point score. The cumulative probabilities are calculated by taking the inverse logit of the above equation, plugging in the values from the model output and the relevant point score. The probability of being in each bundle is then calculated through simple subtraction. This type of regression model smooths the data between points in the attainment distribution to convert GCSE point scores into the likelihood of attaining the various GCSE 'bundles', as shown in Figure A2.

Figure A2: Probability distribution and how that distribution is modelled by our ordinal logistic regression model for each GCSE 'bundle' by point scores



Hence this method ensures that all GCSE point scores have probabilities of being in each bundle regardless of the number of pupils achieving each point score. Moreover, this also helps to smooth 'kinks' in the data that could otherwise result in counter-intuitive results, such as higher points translating into a lower likelihood of qualification attainment at specific points in the distribution. We keep pupils attaining a GCSE point score of zero, though it is very unlikely that there will be a policy impact for this group as the published returns estimates only allow us to value attainment improvements if a pupil attains at least one good GCSE. This would therefore require a pupil (who would otherwise attain no GCSEs) to experience a step-change in their attainment worth 5 grades (or 40 points), which is very unlikely given the modest average effect size from the CPD intervention.

The pupil attainment model has mapped GCSE point scores onto the likelihood of attaining different 'bundles' of GCSEs and estimates how a marginal change in points scored affects the number of pupils achieving each of these GCSE bundles. This has effectively shifted the GCSE points distribution because of the CPD intervention and calculated how many more pupils would attain better GCSE qualifications from the policy intervention (ie the change in the number of learners achieving different qualifications). The second stage of constructing the pupil attainment model is to value the lifetime productivity improvements from increased pupil attainment using economic returns to education estimates. To show the direct impact of an improvement in high-quality CPD provision on pupil attainment, we aim to capture the economic benefits of improved GCSE attainment in the form of higher lifetime productivity earnings. Not only will we value the immediate gains from improved GCSE achievement measured but also the benefits of this improved attainment in facilitating progression to higher qualifications beyond their GCSEs. This is significant as many students do not complete their education at age 16 and the returns to higher level qualifications are often sizeable. These figures are derived by combining returns to GCSE qualifications with estimates of the likelihood of pupils achieving higher-level qualifications based on their GCSE prior attainment and adjusted lifetime productivity returns of achieving those qualifications. This gives us the lifetime productivity gains due to improved pupil achievement from all teachers receiving 35 hours of CPD.

The economic returns to our GCSE qualification bundles are derived from a DfE analysis of the Labour Force Survey estimating the lifetime productivity returns broken down by gender.[36] Each of the returns to the GCSE qualification bundles are relative to the level below (ie the returns to 1-2 good GCSEs are relative to individuals with no good GCSE qualifications, the returns to 3-4 good GCSEs are relative to individuals with 1-2 good GCSE qualifications and so forth).

Table A1: The unadjusted lifetime productivity estimates for Key Stage 4 qualifications split by gender

Qualification	Comparator	Lifetime productivity return - Males	Lifetime productivity return - Females
1-2 good GCSEs	0 good GCSEs	£170,984	£110,395
3-4 good GCSEs	1-2 good GCSEs	£39,047	£28,432
5-7 good GCSEs	3-4 good GCSEs	£60,611	£59,019
8+ good GCSEs	5-7 good GCSEs	£91,686	£36,147

These GCSE productivity returns estimates are:

- for those achieving that GCSE qualification bundle (as opposed to pupils undertaking that number of GCSEs).
- discounted to first quarter 2013 prices (which is when the analysis was undertaken) HMT Greenbook guidance, which applies a discount rate on the lifetime productivity returns of 3.5 per cent for the first 30 years and 3 per cent thereafter.
- gross lifetime productivity returns (ie present values), so the returns do not take account of the cost of the qualification.
- accounting for productivity increases over wage returns of 30 per cent, which covers non-wage labour costs according to the Department for Business, Innovation and Skills.
- assuming 0 per cent ability bias, therefore the returns estimates are assuming that there is no difference in wages due to inherent productivity differences between people but rather these differences are as a direct result of their education.
- assuming real earnings growth of 0 per cent for both the qualification holder and the control group who do not hold the qualification (ie that people's real wages do not rise over time).
- 'average' returns, which captures the benefit across everyone who holds the qualification. This is as opposed to 'marginal' returns, which incorporates only the subset of learners for whom the qualification bundle is their highest qualification.

To adjust these estimates to match our value of improved teaching model probabilities and ensure they are in current prices, we take a simple average across men and women, as our model does not account for gender, and use the latest set of GDP deflators to uplift the 2013 estimates to 2019 prices (which is the latest available year). As these returns are 'average' returns, the number of pupils holding a given bundle of GCSEs (before and after the intervention) relates to everyone who holds that qualification bundle – regardless of whether they progress.

Table A2: The adjusted lifetime productivity returns for each GCSE bundle

Qualification	Comparator	Lifetime productivity return
1-2 good GCSEs	0 good GCSEs	£156,012
3-4 good GCSEs	0 good GCSEs	£193,426

[36] Hayward, Hunt, and Lord, 'The Economic Value of Key Intermediate Qualifications: Estimating the Returns and Lifetime Productivity Gains to GCSEs, A Levels and Apprenticeships'.

5-7 good GCSEs	0 good GCSEs	£259,756
8+ good GCSEs	0 good GCSEs	£330,634

These adjusted figures form the basis of our economic returns to education model. However, we also want to capture the benefits of students progressing on to further studies beyond their GCSEs or equivalent qualifications. This is essentially the likelihood of pupils achieving higher qualifications (for each given level of GCSE prior attainment) multiplied by the returns to those qualifications.

To model progression beyond GCSEs we use published DfE post-KS4 destinations data to identify what routes students are participating in during the year after sitting their GCSE qualifications. Destination data is split by prior attainment at KS4 for consistency with the GCSE returns bundles (pupils holding 1-2, 3-4, 5-7 or 8+ good GCSEs). We assume that the route that young people participate in during the year after completing their KS4 qualifications is based on whether, or not, they achieve A*-C in their English and Mathematics GCSE qualifications. Specifically, the pupils attaining 5+ good GCSEs (ie those who attain 5-7 or 8+ good GCSEs) achieve this and those attaining less than 5 good GCSEs do not (ie those who attain 1-2 or 3-4 good GCSEs).

We then identify the likelihood of students following various post-KS4 routes given they are in one of these four prior attainment GCSE bundles. We combine published DfE data that provides the likelihood that young people progress via a certain educational route and whether they have achieved Level 2 or Level 3 qualifications for each of these routes by age 19. Furthermore, we assume that young people who have not achieved 5+ good GCSEs by age 16, by definition, cannot achieve Level 3 by age 19 and if they have already achieved 5+ good GCSEs by age 16 are not 'banking' further gains by age 19 if they subsequently achieve any Level 2 qualifications. The relative likelihood of young people achieving L2 or L3 qualifications for different routes is based on the entire cohort (as no data is available to break this down by prior attainment at KS4). Therefore, we must indirectly estimate these probabilities by prior attainment at KS4 by combining various published DfE statistics. The results of which are shown in Table A3 and A4. Using the likelihood of a pupil with 1-2 GCSEs achieving a Level 2 qualification from further education as an example, our approach is the following:

- If you have 1-2 GCSEs, there is a 57 per cent likelihood you will participate in further education in the year after completing KS4.
- Across the entire cohort, there is a 12 per cent likelihood that you will achieve Level 2 between ages 16-19 whilst being in further education.
- Overall, 38 per cent of the entire cohort are in further education in the year after completing KS4.
- The relative chance of achieving Level 2 given that you are in further education is therefore 31 per cent (calculated as 12 per cent divided by 38 per cent).
- As 57 per cent of those with 1-2 GCSEs enter further education, the likelihood of this group with 1-2 GCSEs achieving a Level 2 qualification via further education is therefore 18 per cent (calculated as 57 per cent multiplied by 31 per cent).

Table A3: Probabilities of pupils with 1-2/3-4 good GCSEs achieving various post-KS4 qualifications broken down by different educational routes

	Further education	School sixth form	Sixth form college	Other education	Apprenticeship	Destination not sustained	Not captured
Probability of entering route[1]	0.57	0.16	0.07	0.03	0.09	0.1	0.01
Likelihood of entire cohort achieving Level 2 qualification (during 16-19)[2]	0.12	0.00	0.01	0.01	0.03	0.00	0.00

Likelihood of entire cohort achieving Level 3 qualification (during 16-19)[2]	0.15	0.33	0.10	0.01	0.02	0.00	0.00
Likelihood of entire cohort being in route[1]	0.38	0.38	0.13	0.02	0.06	0.05	0.01
Likelihood of those in route achieving Level 2 qualification (during 16-19)	0.31	0.00	0.11	0.28	0.50	0.00	0.00
Likelihood of those in route achieving Level 3 qualification (during 16-19)	0.39	0.87	0.76	0.40	0.35	0.00	0.00
Likelihood of those in route AND with given prior attainment achieving Level 2 qualification (during 16-19)	0.18	0.00	0.01	0.01	0.04	0.00	0.00
Likelihood of those in route AND with given prior attainment achieving Level 3 qualification (during 16-19)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Students who have not achieved Level 2 by the end of KS4 are assumed not to achieve Level 3 by age 19
Sources: 1. https://www.gov.uk/government/statistics/destinations-of-ks4-and-ks5-pupils-2016, Key stage 4 - national tables: SFR56/2017 2. https://www.gov.uk/government/statistics/level-2-and-3-attainment-by-young-people-aged-19-in-2018

Table A4: Probabilities of pupils with 5-7/8+ good GCSEs achieving various post-KS4 qualifications broken down by different educational routes

	Further education	**School sixth form**	**Sixth form college**	**Other education**	**Apprenticeship**	**Destination not sustained**	**Not captured**
Probability of entering route[1]	0.24	0.53	0.17	0.01	0.05	0.02	0.01
Likelihood of entire cohort achieving L2 qualification (during 16-19)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Likelihood of entire cohort achieving L3 qualification (during 16-19)[2]	0.15	0.33	0.10	0.01	0.02	0.00	0.00
Likelihood of entire cohort being in route[1]	0.38	0.38	0.13	0.02	0.06	0.05	0.01
Likelihood of those in route achieving L2 qualification (during 16-19)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Likelihood of those in route achieving L3 qualification (during 16-19)	0.39	0.87	0.76	0.40	0.35	0.00	0.00
Likelihood of those in route AND with given prior attainment achieving L2 qualification (during 16-19)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Likelihood of those in route AND with given prior attainment achieving L3 qualification (during 16-19)	0.09	0.46	0.13	0.00	0.02	0.00	0.00

Note: By definition, those with 5+ good GCSEs by the end of KS4 have already achieved Level 2 by age 19. Therefore, there are no further attainment gains at Level 2 for pupils with 5-7 or 8+ good GCSEs. Sources: 1. https://www.gov.uk/government/statistics/destinations-of-ks4-and-ks5-pupils-2016, Key stage 4 - national tables: SFR56/2017 2. https://www.gov.uk/government/statistics/level-2-and-3-attainment-by-young-people-aged-19-in-2018

These probabilities are then attached to economic returns estimates for the various post-KS4 qualifications. We split the Level 2 and Level 3 qualifications into more disaggregated qualification types so that we can assign appropriate returns to education estimates to them.

Table A5: Assumed lifetime productivity returns based on the post-KS4 institutions that young people are studying in

Educational route by age 19	Assumed lifetime productivity return – Level 2	Assumed lifetime productivity return – Level 3
Apprenticeship	Level 2 apprenticeship	Level 3 apprenticeship
Further education	Level 2 further education	Level 3 further education
School sixth form	5+ GCSEs	2+ A levels

Sixth form college	Average across 5+ GCSEs & Level 2 vocational qualifications	Average across 2+ A levels & Level 3 vocational qualifications
Other education	-	-

Note: There are no productivity returns attached to the route 'other education' as no returns to education estimates were relevant to this educational route.

The returns to A level qualifications are derived from the same paper as the GCSE qualification returns, while a Department for Business Innovation and skills analysis derives the Net Present Value for all further education qualifications.[37] The return for each higher-level qualification is relative to the level below (for instance, the returns for pupils who hold a Level 2 apprenticeship are relative to young people that hold a Level 1 apprenticeship). This is consistent with our earlier returns estimates at GCSE because the gains from a student's lower-level qualifications at KS4 have already been banked, as they have been applied to all young people who hold the qualification (the 'average' return) – not just those for whom it is their highest qualification (the 'marginal' return).

Table A6: The lifetime productivity estimates for Key Stage 5 qualifications

Qualification	Comparator	Lifetime productivity return
Level 2 apprenticeship	Level 1 apprenticeship	£35,000
Level 3 apprenticeship	Level 2 apprenticeship	£49,000
Level 2 further Education	Level 1 further Education	£43,000
Level 3 further Education	Level 2 further Education	£47,000
2+ A levels	5-7 good GCSEs	£57,973 (Male) / £42,982 (Female)

As the A level productivity returns have the same assumptions underpinning them as the GCSE productivity estimates, they are adjusted in the same way. The further education productivity returns estimates are:

- not estimated separately by gender, unlike the GCSE returns estimates, so no aggregation is necessary for these returns.
- net of costs of further education (ie these return estimates are NPVs)
- relevant to learners who start their courses in 2013/14, as opposed to completers/achievers of the qualification (ie they already have pupils who drop-out of the qualification incorporated into them).
- assuming an annual real earnings growth of 2 per cent per annum.
- are for those who hold them as their highest qualification ('marginal' returns) rather than to all young people that hold the qualification ('average' returns).
- assuming a discount rate of 3.5% for the first 30 years and 3% thereafter (this is consistent with the HMT Green Book guidance)
- accounting for productivity increases over wage returns of 25 per cent, which covers non-wage labour costs according to the IER / Cambridge Econometrics (ie a 25 per cent productivity spill over)

Table A7: The adjusted lifetime productivity returns for each post-KS4 qualification

Qualification	Comparator	Lifetime productivity return
Level 2 apprenticeship	Level 1 apprenticeship	£38,812
Level 3 apprenticeship	Level 2 apprenticeship	£54,337

[37] 'Further Education'.

Level 2 further education	Level 1 further education	£47,683
Level 3 further education	Level 2 further education	£52,119
2+ A levels	5-7 good GCSEs	£55,975

The final stage of the economic returns to education model is to add progression beyond age 19. We use the DfE post-KS5 destinations data which shows the likelihood that individuals participate in different routes, based on the KS5 route they are participating in during the previous year. By construction, this only covers students who have completed KS5, so we are unable to model progression for those who have not completed KS5.

Table A8: Probabilities of pupils with 5-7/8+ good GCSEs achieving various post-KS5 qualifications broken down by different educational routes

	Further education	**School sixth form**	**Sixth form college**	**Other education**	**Apprenticeship**	**Destination not sustained**	**Not captured**
Further education (level 3 and below)	0.15	0.04	0.04	0.00	0.00	0.00	0.00
Higher education (level 4 and above)	0.34	0.59	0.55	0.00	0.00	0.00	0.00
Other education destinations	0.00	0.04	0.05	0.00	0.00	0.00	0.00
Intermediate apprenticeships (level 2)	0.03	0.03	0.03	0.00	0.00	0.00	0.00
Advanced apprenticeships (level 3)	0.04	0.03	0.03	0.00	0.00	0.00	0.00
Higher and degree apprenticeships (level 4 and above)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sustained employment destination	0.28	0.18	0.20	0.00	0.00	0.00	0.00
Destination not sustained	0.10	0.06	0.07	0.00	0.00	0.00	0.00
Activity not captured in the data	0.04	0.03	0.03	0.00	0.00	0.00	0.00

Note: By assumption, pupils achieving less than 5 good GCSEs do not progress onto post-KS5 as they do not achieve more than a level 2 qualification. Therefore, this table is only representative of pupils who have achieved 5-7 or 8+

good GCSEs. Source: https://www.gov.uk/government/statistics/destinations-of-ks4-and-ks5-pupils-2016, Key stage 5 - national tables: SFR56/2017

Table A9: Assumed lifetime productivity gains based on the post-KS5 institutions that young people are studying in

Post-Key Stage 5 route	Assumed lifetime productivity return
Intermediate apprenticeship	Level 2 apprenticeship
Advanced apprenticeship	Level 3 apprenticeship
Higher & degree apprenticeship	Degree
Further education (Level 3 & below)	Average across further education
Higher education (Level 4 +, including Higher National Diploma and Higher National Certificate)	Degree
Other education	-
Sustained employment	-

Note: there are no attainment gains for young people whose destination is unsustained or not captured. There are also no productivity returns attached to the route 'other education' or 'sustained employment' as no returns to education estimates were relevant to this educational route.

The basis for the returns to higher education are taken from an Institute for Fiscal studies paper which estimated the impact of university degrees on young people's lifetime earnings.[38]

Table A10: The unadjusted lifetime earnings returns of higher education split by gender

Qualification	Type of return	Lifetime earnings return - Males	Lifetime earnings return - Females
Degree	Private	£130,000	£100,000
Degree	Exchequer	£110,000	£30,000
Degree	Total	£240,000	£130,000

These higher education earnings return estimates are:

- for those enrolling in an undergraduate degree.
- relative to pupils who hold 2 or more A levels but no undergraduate degree.
- net of the costs of higher education, such as tuition fees and additional subsistence.
- are for all young people that hold the qualification ('average' returns) rather than for those who hold them as their highest qualification (‘marginal' returns).

To adjust these post-KS5 figures we calculate an average across men and women, given that our economic returns to education model does not split returns by gender. We also want the productivity return to higher education to capture the full economic benefit (ie the societal gain, as well as the gain to the individual, from obtaining the qualification). Therefore, we adjust the figures in two stages to derive this. First, we sum across the returns accruing to the individual (the 'private' return) and those accruing to the Exchequer. This derives the gross earnings return that is shared between the two groups. We then account for wider spill-over benefits beyond the earnings

[38] Britton et al., ‘The Impact of Undergraduate Degrees on Lifetime Earnings’.

accruing to the individual and the Exchequer by uplifting the figures by 30 per cent. This transforms the wage returns into productivity returns. This cautious assumption is based on Office for National Statistics data on non-wage labour costs and aligns closely to the spill over effects in the KS4 and post-KS4 estimates (which are 30 and 25 per cent respectively). These calculations result in adjusted lifetime productivity returns for a degree qualification of approximately £240,000.

Finally, for each GCSE qualification bundle, the probabilities of students achieving each qualification by following each educational route are multiplied to the corresponding lifetime productivity returns. This results in the progression returns shown in table A11 and A12.

Table A11: Progression returns for pupils holding 1-2 or 3-4 good GCSEs

Route	Level 2 by age 19	Level 3 by age 19
Further education	£8,443	£0
School sixth form	£1,038	£0
Sixth form college	£460	£0
Other education	£395	£0
Apprenticeship	£1,746	£0
Destination not sustained	£0	£0
Not captured	£0	£0

Table A12: Progression returns for pupils holding 5-7 / 8+ good GCSEs

Route	Level 2 by age 19	Level 3 by age 19	Further education (level 3 and below)	Higher education (level 4 and above)	Other education destinations	Advanced apprenticeships (level 3)
Further education	£0	£4,900	£735	£7,687	£0	£204
School sixth form	£0	£25,827	£962	£65,472	£962	£752
Sixth form college	£0	£7,077	£268	£17,017	£335	£210
Other education	£0	£210	£0	£0	£0	£0
Apprenticeship	£0	£962	£0	£0	£0	£0
Destination not sustained	£0	£0	£0	£0	£0	£0
Not captured	£0	£0	£0	£0	£0	£0

Note: Higher and degree apprenticeships (level 4 and above), sustained employment destination, destination not sustained and pupils who have no activity captured in the data have zero returns for all possible routes so are not reported in the table for brevity. Intermediate apprenticeships (level 2) also have null returns, however as stated previously this is an assumption made in the model.

Within GCSE qualification bundles, these progression returns are then added to the adjusted lifetime productivity returns for each GCSE qualification bundle. This derives the economic benefit for each GCSE bundle while incorporating any higher levels of learning.

To then build the model, we first calculate the differences in pupil numbers at each GCSE point score and multiply these to the probabilities of being in each GCSE 'bundle'. As an example, before the intervention there may have been approximately 100 pupils who scored 300 points and will achieve 3-4 good GCSEs but after the impact of CPD on the GCSE point score distribution, there are now approximately 150 – a difference of 50 pupils. The pupil attainment model multiplies this difference in the number of pupils achieving each of the four GCSE bundles (1-2, 3-4, 5-7 and 8+ good GCSEs) by the relevant lifetime productivity return. These returns are then summed across the whole GCSE points distribution to give the gain for the 2013/14 GCSE cohort from an increase in pupil learning because of increased CPD for teachers.

To find the monetary impact for all pupils in England, not just for the cohort taking their GCSE examinations, we extrapolate our results to all year groups. We first calculate the average per pupil benefit by dividing the gain from our analysis by the number of pupils in our 2013/14 GCSE cohort. Then, using published DfE statistics on pupil numbers by age group, we multiply our average per pupil benefit by the total number of state-funded mainstream pupils aged 4 to 15 in the academic year 2020/21. We are assuming that the distribution of GCSE point scores is stable year-on-year and does not differ in a drastic way that would affect our results in any meaningful way. Hence the marginal shift that we apply to the 2013/14 GCSE cohort is equivalent to a marginal shift applied to the 2020/21 GCSE cohort. We then determine the number of pupils aged four in the state-funded school system for a particular year by interpolating the number of pupils aged five from the following year. Although this is unlikely to be the precise number, it is the most reliable predictor that is available and will be within a small margin of error of the true value. The extrapolation from the GCSE cohort to all year groups gives the static monetary gain from an increase in pupil learning because of all teachers in England receiving 35 hours of CPD. We are assuming implicitly from this derivation that an increase in high quality CPD for teachers has a consistent effect on pupil learning for different age groups (ie the impact of a Year 11 mathematics teacher receiving 35 hours of high quality CPD on pupil learning is equivalent to a Year 1 primary teacher or a Year 7 history teacher receiving the same treatment).

The initial, one-year impact of CPD on pupil attainment is informative however we are predominantly interested in a systematic policy change to teachers' CPD in England and hence are concerned with the medium and long-term impact of a high-quality CPD policy intervention. Extending the model to account for multiple years of exposure, we use pupil projections from published DfE statistics to extend our model forward in time. For each academic year from 2020/21, we categorise all state-funded mainstream pupils into the number of years that they have been exposed to the CPD policy intervention. For instance, in the first year of this policy, pupils in all year groups will be exposed to a teacher with 35 hours of high-quality CPD. However, the following year, all pupils aged 5 to 16 will now be exposed to two years of a teacher with 35 hours of high quality CPD, while pupils aged 4 who are just entering the school system will have only been exposed to one year of the CPD intervention. Therefore, categorising pupils as such allows different effect sizes to be applied to the groups so that we can account for the additional gains for pupil learning from multiple years of exposure to a teacher with 35 hours of high-quality CPD.

The latest published DfE statistics on pupil projections only allow the model to be extended to 2027/28. Therefore, to expand the model to later years we assume that the number of pupils in each year group is constant from 2027/28 onwards. Although these pupil numbers are likely to be slightly imprecise, we determined that holding DfE pupil projections flat is a more reliable method than making arbitrary assumptions about the birth rate or changes to immigration post-Brexit. Our CBA model is also only evaluating the high-quality CPD entitlement until 2029/30. Thus, this assumption affects only a small number of years of the model, which gives reassurance that it should not impact our BCR figures in any meaningful way.

Appendix B: Improved teacher retention

This appendix describes how we valued the improvements in teacher retention resulting from the CPD entitlement policy.

Using DfE statistics, we calculate the non-retirement leavers rate before and after the policy intervention. This is defined as the full-time equivalent (FTE) number of non-retirement leavers as a proportion of the total FTE number of teachers in service at the end of the year. We take an average of the last 7 years, as the non-retirement leavers rate varies annually and has been gradually increasing during this time, so an average takes account of this variation to a certain extent. This equates to a leavers rate of 7.1 per cent. The regression modelling in the CPD science retention paper, which aims to find a causal relationship between the NSLN CPD course and teachers leaving the profession, implies that two years after first participating in the CPD course there is a four percentage point reduction in wastage (which is statistically significant at the 99 per cent level). Therefore, applying this directly to the leavers rate of 7.1 per cent, gives a post-CPD intervention leavers rate of 4.3 per cent.

Therefore, the difference between the number of state sector FTE teachers leaving the profession before and after the high-quality CPD intervention is approximately 12,000. We assume that if a teacher permanently leaves the profession, the cost of training a newly qualified teacher is approximately £19,000 based on the cheapest training route in 2013/14 figures that was identified in the literature review (this cost does not include costs to schools or depressed achievement in classrooms with less experienced teachers). Uplifting this cost to the 2019 price year gives a cost of training a newly qualified teacher of approximately £21,000. Therefore, the cost saved from not having to replace teachers who have left the profession with new teachers is approximately £260 million a year in nominal terms. This benefit over 10 years, assuming the cost remains the same in real terms and discounted using HMT Greenbook guidance results in a NPV of approximately £2.2 billion.

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