



The physics teacher shortage and addressing it through the 3Rs:

Retention, Recruitment and Retraining
(England)

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Foreword

The government has committed to offering high quality opportunities to all students and put a priority on investment in infrastructure. These two ambitions go hand in hand through education. Education underpins both opportunity and future growth. An equitable education system will improve life chances for all students and drive up national productivity for many decades.

Physics is a high-value sector with an enormous potential for growth in new physics-powered industries such as quantum and photonics which require physics skills. In 2019, physics-based industries contributed £190bn to the economy in England¹ employing 2.23m roles across the nation, 1.3m of which are physics related². However, those businesses are finding it difficult to recruit. This shortage of appropriate skills is holding back new investment and growth of these businesses.

Without urgent national investment now, the scale, pace and sustainability of innovation-based growth will all be greatly reduced. The Parliamentary Office of Science and Technology recently found³ that skills shortages across STEM cost the UK economy £1.5bn a year.

The primary route to addressing this dearth of skills is to improve the chances for an additional third of a million students per year to succeed in physics at GCSE level. Currently, many of them are denied that opportunity due to a shortage of high-quality, specialist teachers. At least 600 secondary schools have no in-field physics teacher and, across England, over half of physics lessons at GCSE are taught by out-of-field teachers. As a result, there are about 300 schools that have no students progressing to A-level physics and this is much more prevalent in schools in deprived areas. Despite some recent increases in the numbers taking physics A level, it is clear that far too many young people are still being denied access to a specialist physics teacher, and to the opportunities that helps unlock for their attainment and progression.”

With 44% of physics teachers no longer teaching in state schools five years after qualifying⁴, and the government’s recruitment target being woefully missed year on year (hitting a low of 17% in 2023), we need urgent, far-reaching and well-planned action.

In this report, we recommend the introduction of a ten-year plan to correct, once and for all, the shortage of physics teachers in England. Doing so will ensure our nation’s future wealth, wellbeing and economic security, and contribute to four of the five missions of the current government, relating to growth, clean energy, improving opportunities and rebuilding the NHS.

About 58% of physics lessons at GCSE are taught by an out-of-field teacher.



This plan, like all forms of infrastructure development, will require investment, some of which will come through savings and some by repurposing existing spending. Whatever its source, such investment will be returned many tens of times over through increased economic activity and future earnings of those who benefit from the improvements. Investment of tens of millions now will return increased economic activity in the £billions per year. This might be the single most profitable investment that a government could make.



Judith Hillier

Institute of Physics Vice-President for Learning and Skills
September 2025

Executive summary and recommendations

We recommend that the Government, with cross-party support, puts in place a properly-funded ten-year plan to address the shortage of school physics teachers in Englandⁱ. In this report, we make nine recommendations with 25 detailed proposals under the three pillars of Retention, Recruitment and Retraining – the 3Rs. In addition, we make some cross-cutting underpinning recommendations and proposals which are collected together under the heading of ‘Foundations’. We give a summary of the recommendations and proposals on pages 12 and 13 and they are discussed in detail in section 2.

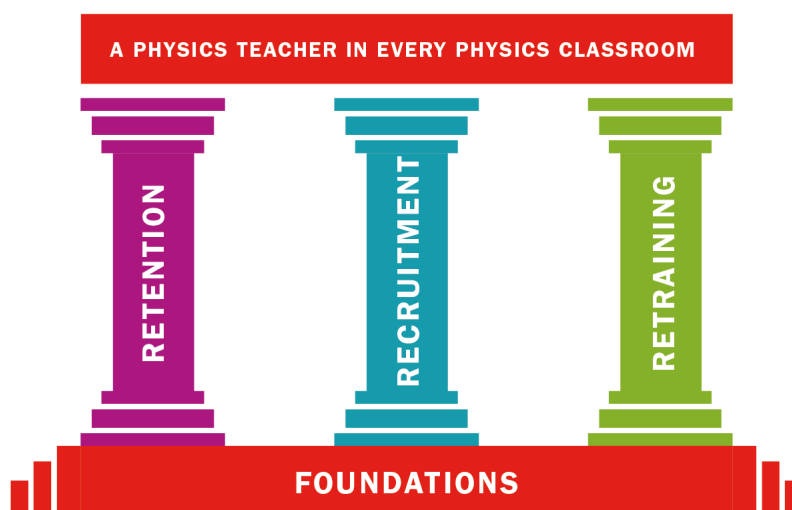


Figure 1. Structuring the ten year plan around the three pillars and foundations.

The ongoing insufficiency of specialism and lack of experience in physics classrooms is costly both to individuals and to the nation because it depresses progression rates and exam performance. The shortage of teachers, and resultant loss of opportunity for students, is greater in schools in more deprived areas.

We recommend that the government addresses urgently both the deficiency and inequitable access with a coordinated and phased set of interventions. These will require a relatively modest amount of central funding, of the order of £12m per year for ten yearsⁱⁱ. We will show that even the short-term benefits and savings make this investment worthwhile, paying for itself within nine years of the end of the plan. Moreover, when the long-term returns – which are of the order of £1.1bn per year for physics – are taken into account, alongside the spill-over into improving teacher supply in other shortage subjects, the case for that investment becomes even more compelling.

Ten-year holistic plan

With reduced attrition and an important contribution from retraining teachers, it will be possible to recruit new physics teachers at a sufficiently high rate to put right the shortage over ten years. After that period, it will then be possible to maintain the level with a very feasible annual recruitment target of about 440.

However, achieving this steady state will require all the issues raised in this report to be addressed in a holistic and planned way – as recommended by the Parliamentary Accounts Committee⁵. That is not to say they will be addressed solely through our recommendations; however, these are a good place to start. Nor are we expecting all the proposals to be implemented at once; they will need to be phased and scaffolded through the plan with the aim of achieving its ambitions by the end of the implementation period.

ⁱIt is our intention to follow this report with similar reports in other UK nations and Ireland; and a report focused on FE. ⁱⁱWe are using the figure of £12m to indicate a range to potential investment in physics teachers of between £10m and £14m per year.

“

The Department should develop a whole-system strategy to help frame how it will recruit and retain school and college teachers.

”

Parliamentary Accounts Committee, 2025^v.

Physics teacher shortage and its effects

There is a chronic and critical shortage of specialist physics teachers in England. This is the result of over 30 years of low recruitment and high attrition. We estimate that the state system falls short of the 10,000 physics teachers it needs by about 3,500 (appendix 1), meaning that over a half of physics classes at Key Stage 4 are taught by a teacher who does not have a post-18 qualification in physicsⁱⁱⁱ (appendix 2).

Students in schools with no in-field teachers are half as likely to progress to A-level physics as those in schools with a sufficiency (appendix 4). NFER recently showed that at least 600 schools^{iv} do not have a single physics teacher with a physics-based post-18 qualification^v. This results in a loss of opportunity and future income for students in those schools, as well as a loss of talent for the nation; and that talent is urgently needed to address the government’s aim of growing an economy based on innovation.

The shortage has a bigger impact on students in areas of lower socio-economic status (SES) because their schools are less likely to have in-field physics teachers. Data show that only 4% of students in the lowest SES quintile take physics A-level, compared with about 11% in the highest quintile, and that 70% of A-level physics students come from just 30% of schools^{vi}.

This is a costly waste of talent. However, it indicates that it is feasible to address the skills shortage in physics-powered businesses by improving the opportunities and outcomes for students in these schools. Tapping into that missing talent would yield better grades at GCSE and increase the number taking A-level by about 12,000 students per year – an increase of over a quarter (appendix 4).

The physics teacher shortage arises from longstanding challenges of under-recruitment and high attrition rates. Figures for physics teacher recruitment and retention continue to be among the worst across all subjects (figure 2) 44% have left after five years, compared with a loss of about 33% for teachers of all secondary subjects⁴. Without addressing this level of attrition, we will not be able to put right the shortage of physics teachers.

Students in the highest SES quintile are nearly three times as likely to take A-level physics as those in the lowest quintile

About 25% of state secondary schools do not have a single in-field physics teacher



ⁱⁱⁱThis can include a physics or engineering related degree or a pre-ITE subject knowledge enhancement course.

^{iv}This number is based on the schools that submitted data to Schools Workforce Census (SWC) in 2023, which excludes about a third of schools. Including those schools would increase this number.

^vIn this report, figures taken from SWC report teachers with a relevant post-18 qualification. Our working definition of an in-field teacher is broader than this and includes those who have retrained whilst in service. Including those teachers would decrease this number. ^{vi}Improved outcomes are grades at GCSE, progression to A-level and improved engagement of under-represented groups.

England's overall attrition rate means that its teachers have, on average, four years less experience than the OECD average⁶⁷: 13 years compared to an average of 17 (figure 7 on page 33). Given that more experienced teachers achieve better outcomes⁶, England's lack of experience matters⁷.

According to the government's own figures⁸, about a quarter of physics teachers who qualified in 2023 were not teaching in state schools a year later (figure 3).

About 44% of physics teachers have left teaching after five years which is a third worse than the figure of 33% for all secondary subjects.

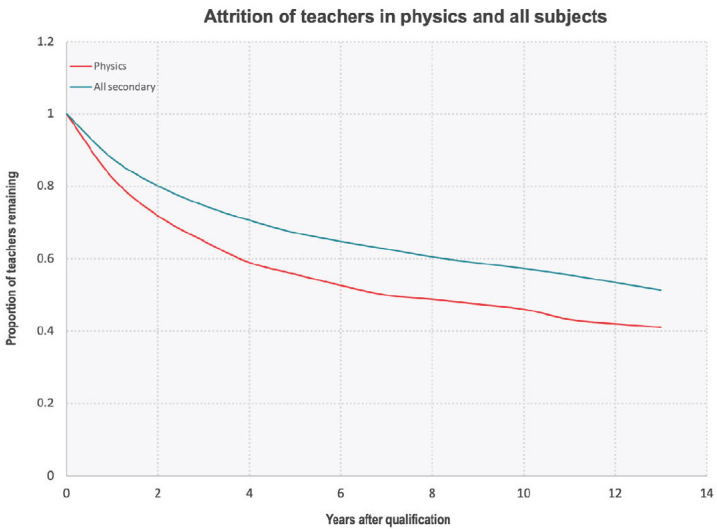


Figure 2. The attrition of teachers over the first 12 years of teaching. Each line is an average of the figures available from 2010. Source: School Workforce Census via NFER.

Improving access to and experience of in-field physics teachers will improve both GCSE grades and progression rates to A-level. Given the reach of a single teacher and the fact that all of their students will be working for 40 years, the beneficial effect on the long-term economy mounts up quickly. That is why modest investment now reaps enormous returns in the long run and should be a priority.

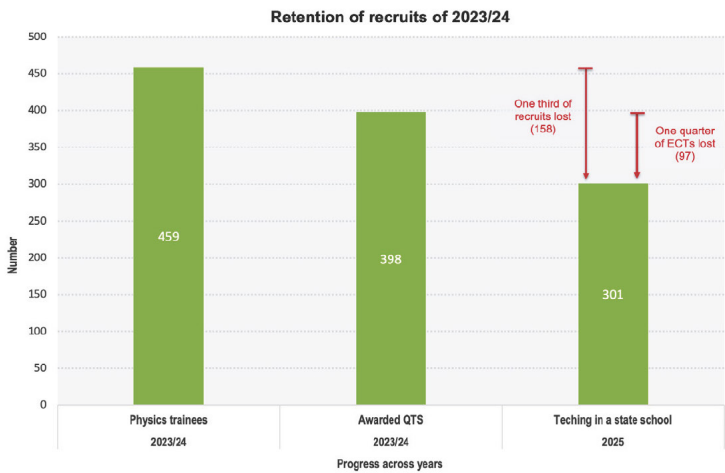


Figure 3. Attrition of the intake of trainees of 2022. Of physics teachers who achieved qualified teacher status in 2023, a quarter were not teaching in state schools a year later. Source: DfE data service⁸.

17/03/25

$$= F_d + U$$

↑ ↑

$$V_s \times \rho_s \times g$$

$$V_s \times \rho_s = m$$

$$F_d = 6\pi\eta r v$$

$$U = \frac{4}{3}\pi r^3 \rho_s$$

Terminal
velocity

Students in schools without any in-field physics teachers are about five times less likely to progress to A-level physics.

Recommendations

We recommend that, in order to put right, once and for all, the shortage of physics teachers in England, Government should:

- put in place a holistic ten-year plan to systematically address the problems raised here
- convene an expert group to develop the ten-year plan

To help the group shape that plan, we make the following 9 overarching recommendations under the headings of retention, recruitment, retraining and foundations. Within each recommendation, is a set of specific proposals which are discussed in section 2 and summarised overleaf. Appendix 8 provides some specifics of each of the proposals.

Retention

1. Reduce workload and improve wellbeing

To reduce the factors that drive attrition, to maximise the effectiveness of teachers, and to enable them to become expert more quickly.

2. Reconsider support and incentives for early and mid-career teachers

To make teaching more competitive against other professions, and to make more cost-effective use of existing incentive schemes.

3. Treat the sciences as separate disciplines – especially in Key Stage 4

To improve the way that teachers of the sciences are deployed, to reduce workload, and to improve the training experience for teachers.

Recruitment

4. Develop and support national recruitment programmes

To provide a way of managing the national targets by stimulating local activity, and to maximise the effectiveness of recruitment through programmes managed at a national level.

5. Put in place national incentive schemes for potential applicants, ITE providers and placement schools

To encourage and reward support for addressing the national problem of physics teacher shortage, and to open up some of the bottlenecks in the existing system.

Retraining

6. Turbocharge and intensify in-service retraining courses such as Subject Knowledge for Physics Teaching

To develop new physics teachers in schools where they are needed at a fraction of the cost of recruitment, and to help retain experienced teachers.

7. Improve effectiveness and use of data and evidence

To provide more knowledge of the system, enabling better practice and incentivising SLT to recruit physics specialists and deploy them to make best use of their capabilities.

8. Review accountability measures so that they work for the system as a whole

To reduce teacher workload, work intensity and stress, and to improve wellbeing, work-life balance and the reputation of teaching.

9. Make teaching more professional and rewarding

To make teachers feel more professional and valued, and to raise the standing and attractiveness of teaching compared with other professions.



A PHYSICS TEACHER IN EVERY PHYSICS CLASSROOM

RETENTION

Retention

1. Reduce workload and improve wellbeing

- a. Give early career teachers an entitlement to a timetable that matches their qualifications and interests
- b. Fund further systematic research on investigating effective uses of AI and technology to support teachers
- c. Develop mechanisms for supporting senior leaders to improve retention in schools

2. Reconsider support and incentives for early- and mid-career teachers

- d. Redesign the Early Career Framework (ECF) to focus on retention and to foreground subject-specific support in a way that integrates with ITE
- e. Put in place financial incentives to retain early- and mid-career teachers

3. Treat the sciences as separate disciplines – especially in Key Stage

- f. Timetable and teach the sciences separately at Key Stage 4 (including for Combined Science)^{vii}
- g. Schools recruit, deploy and record teachers as subject specialists in biology, chemistry and physics
- h. Allow ITE courses to focus on the chosen science discipline

Recruitment

4. Develop and support national recruitment programmes

- i. Reinvigorate pre-ITE Subject Knowledge Enhancement (SKE) courses in physics
- j. Turbocharge the Engineers Teach Physics programme
- k. Put in place a cross-department taskforce to manage, monitor and support international ITE recruits

5. Put in place national incentive schemes for potential applicants, ITE providers and placement schools

- l. Continue to fund scholarships and bursaries
- m. Provide incentives to providers for recruiting physics trainees
- n. Provide incentives to schools to provide placements for physics trainees

RECRUITMENT

A PHYSICS TEACHER IN EVERY PHYSICS CLASSROOM

Foundations

Retraining

6. Turbocharge and intensify in-service retraining courses such as SKPT

- o. Incentivise schools and teachers to take part in and complete a retraining programme
- p. Institute a means of enabling and supporting secondary specialisms across physics, computing and maths

Foundations

7. Improve effectiveness and use of data and evidence

- q. Initiate and manage a register of specialist physics teachers and record Subject Knowledge Enhancement (SKE) and formally recognised retraining courses in the School Workforce Census (SWC)
- r. Include progression figures and course destinations of 16-year-olds in the school dashboard
- s. Develop benchmarks and self-assessment tools for high-quality science departments
- t. Systematically collect specific standard data from school-level exit interviews
- u. Simplify access to and provision of raw and pre-processed data from the National Pupil Database (NPD), SWC and Longitudinal Educational Outcomes (LEO) database

8. Review accountability measures so that they work for the system as a whole

- v. Explore alternatives to inspection-based accountability as a means of driving improvement
- w. Reduce the amount and stakes of assessment by focusing on student need rather than school accountability

9. Make teaching more professional and rewarding

- x. Improve both support and agency of teachers at appropriate times in their career
- y. Include entitlement to work flexibly in contracts

^{vi}We note that, in some schools, there are valid educational reasons to allocate a single teacher to teach some groups; however, this should not be the norm and it should not be based on timetabling requirements.

Structure and scope of this report

Structure

This report provides an overview of our recommendations and the case that we make to support them. Each recommendation has a small number of detailed proposals; there are nine recommendations and a total of 25 proposals which are summarised above and discussed in section 2 with further specifics in appendix 8 – part of the extensive appendices which are available separately online.

Appendices

There are extensive appendices referenced throughout the text. These appendices can be found online at: lop.org/3RS

Scope of this report

The recommendations and proposals in this report are based on discussion with stakeholders, IOP's analysis of the literature and our experience of recruiting and supporting teachers, along with some new market research and modelling. Our proposals are intended as a starting point for discussion and development of actions. They will require further refinement and testing, in collaboration with teachers, schools and subject experts, before being put fully into practice.

Proposals i, v and w (relating to the Early Career Framework, Ofsted inspections and high-stakes exams) would require system-wide changes. We believe these changes are needed to address the shortage of physics teachers, they clearly affect the whole system and all subjects. Therefore, we have not developed fully-fledged replacements for the current systems (though we strongly support major overhauls). Such systemic changes will require a longer lead-in and more detailed discussions with a wide group of organisations – some of which may be better placed to lead on the issues.

Section 1: a ten-year plan

Several subjects face a severe shortage of in-field and specialist teachers^x; and physics is high amongst them. These shortages are a national problem across England, harming the education of hundreds of thousands of young people every year. The causes are deep, complex and system wide. Solving them will require a sustained, coherent and consistent effort. Therefore,

We are calling on government in England^x to put in place a fully funded, ten-year plan to rectify the shortage of teachers in a number of core subjects with critical shortages (including physics).

Developing such a plan aligns closely with the second recommendation in the recent report from the Parliamentary Accounts Committee⁹.

Advantages of a ten-year plan based on the 3Rs

Developing a ten-year plan will provide a cost-effective means to:

- Fulfil the government's aim to reduce the number of physics lessons taught by out-of-field teachers¹⁰ and put right the teacher shortage once and for all
- Provide access to specialist teachers in schools that are currently underserved
- Improve the quality of teaching and learning that takes place in those schools
- Underpin and drive innovation-based growth
- Increase the average productivity and lifetime earnings of people entering school now
- Improve the opportunities and future wellbeing of those young people
- Directly address four of the government's five missions: improving opportunities, growing the economy, becoming a world leader in green technologies, and rebuilding the NHS

The shape of the plan

The plan will identify a coherent set of interventions that specifically improve the pillars of Retention, Recruitment and Retraining – the 3Rs.

These pillars need to be built on firm foundations. Therefore, the plan will also address some of the systemic challenges within the education system that undermine these pillars – such as the accountability system and high-stakes exams. These system-wide features were not designed with teacher retention in mind, and they now work against maintaining a high-quality workforce.

Sector-wide change is needed to ensure that our accountability, improvement and assessment systems support rather than undermine efforts to provide all students with specialist teachers in all subjects – especially physics.

A holistic approach

Although there have been previous initiatives to address some of the issues raised in this report, they have often been short-term, single-focused and isolated. Given the emphasis that government is placing on educational opportunities, now is the time to make an extra effort and solve the shortages once and for all by addressing all the issues in a planned way.

^xIn this report, we are using 'in-field' to mean people who have a relevant post-18 qualification in physics (as used in government data); and 'specialist' as a broader term to include teachers who have retrained in service.

⁹This report focuses on schools in England; there will be subsequent reports that address the same issues in the nations and in Further Education establishments.

Specifically, we cannot achieve a realistic recruitment target without making significant improvements to retention; and, in the short-term, we can only ramp up to the 10,000 specialists that we need by implementing a fully-funded retraining programme (proposal o).

Similarly, there needs to be a holistic approach to implementing the proposals – particularly those that combine into dependent groups (see *A virtuous circle* below). There are certainly some quick wins within the proposals (such as matching timetables – proposal a), these should be seen as the first steps towards wholesale change rather than being sufficient change on their own.

Timing and phasing actions

We are not expecting all the proposals will be implemented at once. This is partly because some proposals will require considerably more planning and discussion than others, and partly because some proposals are dependent on each other so they will need to be introduced sequentially. For example, while there is an ambition that all science topics should be taught separately by subject specialist (at the level of biology, chemistry and physics) in Key Stage 4, that will require greater access to retraining routes, support with timetables and a reliable register of physics teachers before it is possible at all schools.

Developing the ten-year plan

To develop the ten-year plan, we recommend that the government establishes an expert panel with knowledge of, and a stake in, teacher wellbeing, quality and the needs of shortage subjects.

The panel would spend the next year developing the ten-year plan based on the recommendations in this, and other, reports. As well as improving retention and recruitment of physics teachers, the plan is likely to bring other, system-wide improvements that will result in improved teacher satisfaction, reduced workload, and better recruitment and retention across all subjects.

A virtuous circle based on benchmarks, retraining, and certification

Some groups of proposal depend on each other and form virtuous circles. One example is the interplay between those treating the sciences separately (proposal f), recording deployment by specialism (proposal g), a science benchmark (proposal s), and the availability of retraining courses (proposal o). It is important, therefore, that these dependent groups are preserved.

By treating and recording the sciences as separate subjects (proposal f) and providing benchmarks to schools about the way they deploy teachers to teach the sciences (proposal s), schools should be incentivised to acquire in-field physics teachers. In the short term, they may not be able to recruit a specialist physicist; however, they can meet this need by retraining an existing out-of-field teacher (proposal o) and, if necessary, recruiting a replacement who may also not be a physics specialist. In effect, they generate a new physics teacher – for them and for the nation.

This combination of proposals means that:

- Schools are incentivised to seek a physics specialist because of separate reporting of the sciences and the benchmark (proposals g and s).
- If they cannot recruit, there is an alternative solution to getting a specialist: the provision of a fully-funded retraining programme (proposal o).
- The benchmark (proposal s) provides a driver, at a school level, to solve the national problem of a physics teacher shortage.

Short-term and long-term returns

We are recommending that education is treated in the same way as long-term infrastructure projects: as a means to achieve long-term national gains. It is likely that investing in addressing the teacher gap for physics (and other shortage subjects) will provide the highest return on any investment that the government can make.

The estimates we make for the return on investment rely on a lifetime of increased earnings of students whose outcomes are improved. As such they can seem distant.

This distance can make it hard for governments to justify even the relatively modest sums involved; a fact that always militates against investment in education. However, had they been made 30 years ago, we would now have an even more productive physics-powered sector and therefore a stronger innovation-led economy.

That is why we are calling for broad input to developing the plan and seeking cross-party engagement for its implementation.

We estimate that an investment in the order of £12m per year over the period of the plan will yield returns of at least £1.1bn per year in the long term. In all cases, the returns will begin about five years after the intervention, at an annual level slightly higher than the initial investment.

Although the most significant and compelling returns come through lifetime earnings, there are also short-term gains through reduced recruitment costs. We estimate that these are sufficient to offset the initial investment within eight years of the end of the plan.

In the 2024 Science Teaching Survey, 43% of teachers in England reported that a lack of specialist teachers has had a detrimental effect on student learning outcomes.



Making the case

Government missions

Four of the government's five missions are deeply dependent on improving the quality and outcomes of our education system – particularly in the sciences¹⁰. The fourth mission, about education opportunities, is directly dependent on giving young people access to high-quality teaching (in physics and all subjects). However, missions 1, 2 and 5, relating to growth, the green economy and the NHS, also rely on improved educational outcomes in the sciences, especially physics.

- M Economic growth is deeply dependent on innovation and the development of new technologies. As such, it requires people with scientific capabilities and technical skills.
- M Similarly, 72% of activity in the green economy is powered by physics¹¹. The UK cannot become global leaders in green energy without more well-motivated and creative young people with knowledge of the issues and capabilities in the sciences.
- M Finally, for mission 5, we will need to produce sufficient home-grown doctors and nurses to rebuild the NHS and drive improvements in diagnosis and treatment – many of which rely on physics innovation. Physics capability is vital in developing new techniques and hardware, and knowledge of physics is highly advantageous for those in the medical profession who use that technology.

To drive this growth, it is essential to address the shortages which are currently making it hard for employers to recruit to vacancies. Case study 4 in appendix 9 shows the effect that this can have on innovation.

The case for experienced in-field teachers of physics

Having an in-field physics teacher has a dramatic positive effect on student outcomes; as Coe describes in *What Makes Great Teaching*¹², the two qualities that have the biggest impact on students' outcomes are good pedagogic content knowledge (PCK) and high-quality instruction, both of which rely on excellent subject knowledge. As he puts it, "The most effective teachers have a deep knowledge of the subject that they are teaching". Having good subject knowledge and pedagogic content knowledge are, in effect, what defines a specialist teacher.

The data show that having an in-field teacher has a small but significant effect on grades at GCSE (see appendix 3). However, more dramatically, it improves students' engagement, identification and enjoyment of the subject, all of which result in a deeper understanding of its ideas and explanations. As such, it increases the chances of young people progressing to A-level (appendix 4).

The link between students' access to in-field physics teachers and their likelihood of progressing was first documented by Smithers in his 2006 report for Gatsby¹³. To update that work, the IOP conducted an analysis on a sample of schools with varying progression rates to A-level (appendix 5).

We surveyed 25 schools that were sectorised across five quintiles based on progression rates, randomly selecting a sample of five schools from each quintile. We asked them, amongst other things, how many in-field teachers they had. The results were then grouped by number of in-field teachers and we found the average progression rate for each group. The results are plotted in figure 4. They show that increasing from no specialists to a full complement more than doubles the chances of a student progressing to A-level.

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**The shortage of
physics teachers
will slow the
potential for growth
across our sector**
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Samantha Edmondson, Head of
People, Universal Quantum.

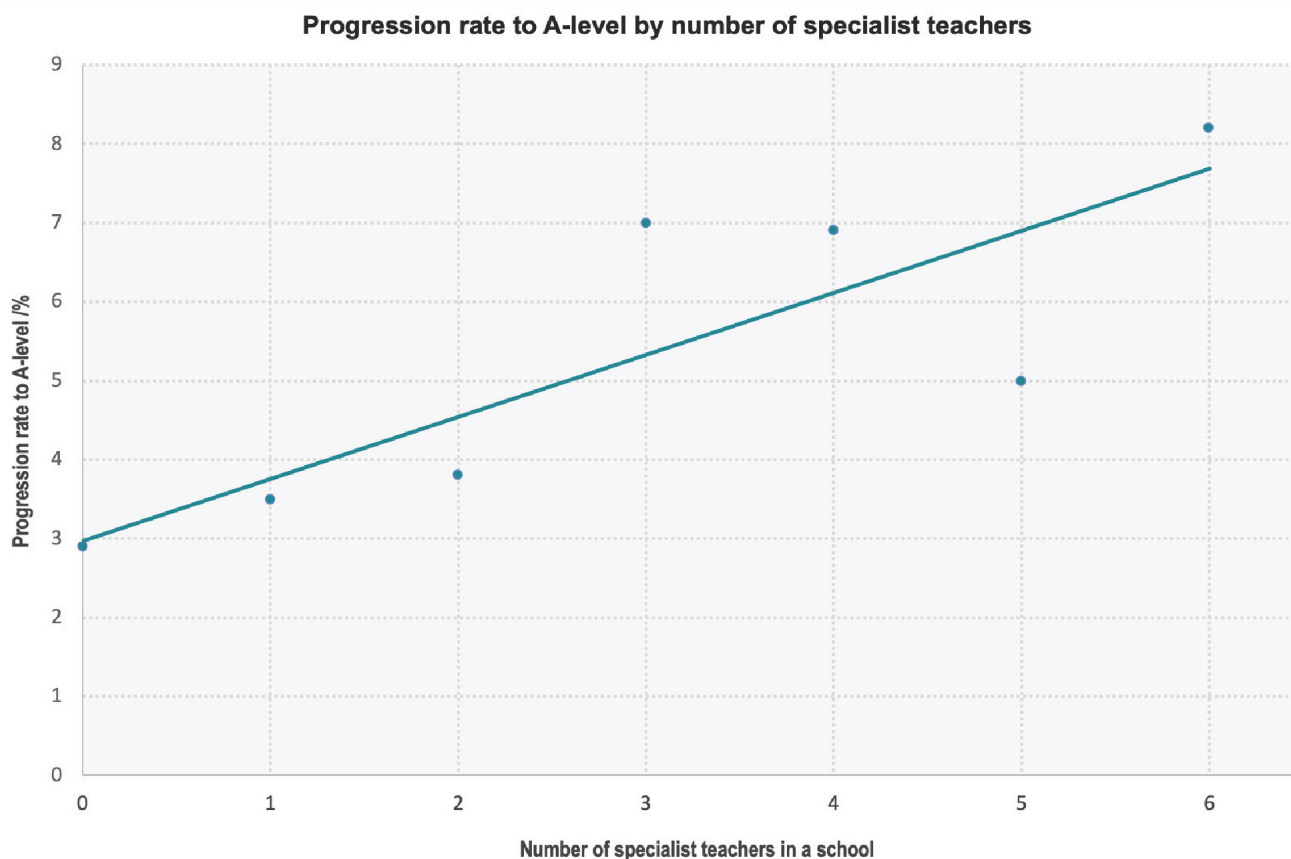


Figure 4. Graph of progression to A-level physics from schools with number of in-field teachers as reported in survey in appendix 4.

The findings show a clear correlation – which is very likely to be causal. This is based on a small sample and was skewed by a couple of schools. So it is possible that the effect will be bigger with a larger study. Within the timescale of producing this report, such a study was not feasible. Nevertheless, from the findings of this sample (albeit small), by not providing providing 58% of GCSE students with in-field teaching, we are denying them opportunities and losing talent. Were they to have that access, we would gain at least 12,000 extra A-level students (and, potentially, a similar number of technical apprentices) every year (appendix 4).

What are in-field and specialist teachers?

We take the view that there are many routes to being or becoming a specialist physics teacher. However, the data available on teachers only allow us to measure a fairly narrow definition of in-field: people with a post-18 qualification related to physics. This is not solely physics graduates; it quite rightly includes people with related degrees (such as engineering, maths and computing) who take a physics training route, or people who have taken a pre-ITE subject knowledge enhancement course and trained in physics.

However, the data do not include an important group of specialist physics teachers: those who have retrained in-service – either through a formal course or self-study. There is currently no record of these teachers' specialism and they may not regard themselves as specialists. However, provided they have developed the subject and pedagogic content knowledge for teaching physics (as outlined in the IOP's Framework for Teaching Physics¹⁴), we recommend that there is a route for them to be added to the register of physics teachers or their specialism noted in the School Workforce Census (SWC) – see proposal q.

The mismatch (between the data and practice) can cause ambiguity. Therefore, within this report, we will refer to those satisfying the narrower definition (with a post-18 qualification) as 'in-field physics teachers'; and to the broader group that also includes those who may have retrained in-service as 'specialist physics teachers'. We use an estimate that the broader group is 20% larger than the more tightly defined group that appear in official data.

What are the qualities of an in-field physics teacher?

The IOP's *Framework for teachers of physics*¹⁴, describes the knowledge and qualities that are essential to teach physics well. As Coe describes, it is certainly the case that a teacher with sound subject knowledge is more likely to improve student attainment and engagement with physics. However, a teacher who studied physics beyond 18^x brings or develops other characteristics that can result in better teaching. For example, they are more likely to be enthusiastic about the subject – they chose to study it after all; they will be confident and won't present the subject as difficult or strange; they will approach physics explanations in a physics way - by 'thinking like a physicist'; they will make connections between different areas of physics and across the science curriculum; and they will be able to think quickly on their feet.

All the above results in students being more motivated, confident and inspired by their teacher, and therefore more likely to identify with the subject and to choose to continue with it.

^xThis can include a pre-ITE or in-service subject knowledge enhancement course.

Costs, benefits and impact

Scope of our cost estimates

In appendix 7, we make some estimates of the costs of our proposals. Some of the interventions would have no cost, some could be funded by reallocating costs within the recruitment budget, and some would need new funding – which could come from savings in system-wide programmes (see below).

Most of the marginal running costs in our proposals arise from the incentives in recommendation 7. These, along with running costs in other areas, would require an additional investment of about £12m per year over the ten-year plan^{xii}.

Our modelling shows that, if fully implemented, our recommendations could result in a steady state of 10,000 physics teachers after ten years. The gross marginal cost over the ten-year period would be about £120m.

Potential immediate savings

Improving retention will reduce the recruitment need by an average of 200 per year over the ten-year plan (as the effects build up). Assuming a recruitment cost of £30,000 per teacher, the savings on recruitment would be £60m over the period of the plan. Therefore, the net marginal cost of ramping up from 6,500 to 10,000 teachers could be reduced to £70m. However, in this report, we will not rely on those savings so will use the gross marginal figure of £12m per year.

It is also worth noting that, with the recruitment requirement reduced by about 280 per year at the end of the ten-year plan, the savings will continue at over £8m per year. From these savings alone, the plan would have paid for itself within about nine years.

However, that is only the beginning of the returns. The main financial gains will be the increases in lifetime earnings of the students who benefit, and the growth they will drive within an innovation-based economy. These returns are in the order of £1.1bn per year.

Potential savings from systemic programmes

Although three of our proposals relate to systemic changes, we have not included them in our direct analysis of cost. They are Ofsted inspections, high-stakes exams, and the Early Career Framework.

The total cost of these three systems is currently well over £1bn. And, in each case, there are serious questions about whether they are returning value for money. With reform, each of these systems can perform its primary function more effectively and work more directly for the system as a whole (by improving retention).

However, it is also worth noting that reform could make considerable savings and release funds to support the costs discussed above.

Furthermore, given that the reforms would be across the system, it is likely that they would improve retention across the board – saving even more in recruitment costs.

ECF: The implementation of the Early Career Framework costs £130m per year. Early indications are that it has improved first-year retention by about 1 percentage point. This kind of improvement is less effective than retention payments; and is not enough to bring the changes we need (more like 9 percentage points - see proposal d). There is certainly room for improvement. However, in addition, a review is likely to yield savings.

^{xii}This is an indicative figure that should be taken to mean “somewhere between £10m and £14m (including start-up costs)”.

Ofsted: this costs the DfE £200m per year. There is a serious question of whether this is good value for money – particularly as it drives (rather than reduces) teacher attrition. Again, there are more effective alternatives which could well save money.

High-stakes exams: We currently spend at least £500m per year on high-stakes exams (A-levels and GCSEs). It costs the nation over £21m per year to assess GCSE students in physics alone. While there is certainly a need for some form of end-of-course assessment in physics, there is a question as to whether it is good value for money spending more on assessing physics than we currently spend on trying to retain physics teachers. And, again, a rethink could yield a more lithe system that is more effective, releases teaching time and yields savings that can be used to better effect.

Estimating the returns on investment

In this section, we make some ballpark estimates of the potential returns on investing in addressing the teacher gap in physics. This is, by necessity, an inexact analysis – partly because it makes assumptions that go a long time into an uncertain future; and partly because the numbers we have to use are themselves based on many assumptions.

Therefore, our calculations are not predictions: they are order of magnitude estimates. However, we view it as important to show that, on the face of it, this investment is likely to yield enormous returns and is therefore very well worth looking at.

Because, rough as they are, our estimates show that the scale of the returns is about two orders of magnitude larger than the investment. Therefore, we are confident that even a more refined analysis will still yield a high return.

Headline findings

An investment of about £12m per year for ten years can put right the physics teacher shortage.

Putting right the physics teacher shortage and improving retention will yield long-term economic returns of £1.1bn per year..

The investment will pay for itself (in reduced recruitment costs) within nine years of the end of the plan and continue to yield savings of £8m per year.

A strong case

Whether or not you subscribe to the assumptions and calculations we make, our reasoning still stands: most people agree that investing in education adds value. Similarly, it is accepted that the quality of an education system relies on the quality of its teaching¹⁵. Currently, the shortage of physics teachers is resulting in more than half of GCSE students not experiencing the quality of physics learning to which they are entitled. Consequently, both they and the nation are missing out on opportunities. With physics being such a high-value sector and contributing to about 10% of GDP, that loss is likely to have an enormous effect on future GDP and growth.

Methodology

We have used two methods to estimate the returns. In method 1 we estimate the potential lifetime earnings gains for students who benefit from improved teaching, and in method 2 we estimate the potential growth of physics-powered sectors. The two methods give similar estimates (£1.4bn and £0.6bn). Therefore:

In this report, we are using a value of £1.1bn – based on an average^{xiii} of the two methods.

Summary of methods

Method 1

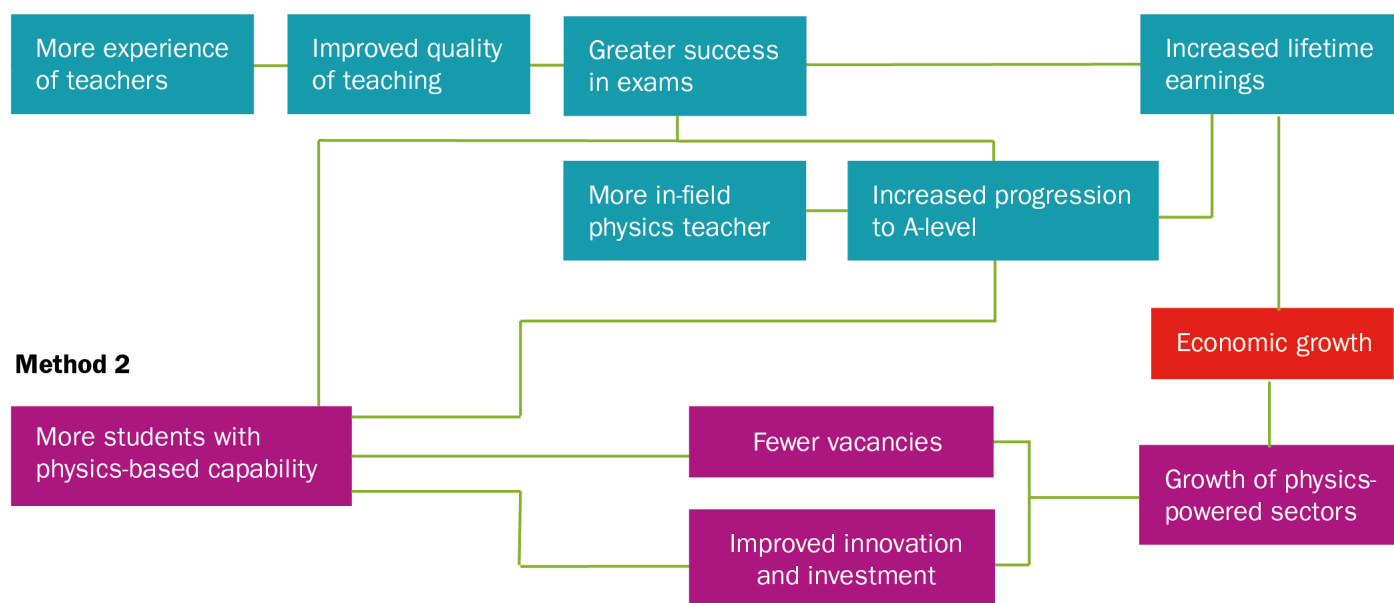


Figure 5. A logic model of how increasing the number and experience of in-field teachers will result in economic returns (using our two methods).

Method 1: From a student perspective (bottom up): yields a long-term return of £1.4bn.

Our reasoning is that:

- A high-quality, specialist teacher will improve the educational outcomes of their students (qualification value at GCSE and the likelihood of progressing to A-level physics and further)
- Retaining teachers will increase the average experience in the workforce; teachers with more experience lead to students attaining higher grades at GCSE
- Students with improved outcomes have increased lifetime earnings – contributing more to the economy

Method 2: From the perspective of growing the physics-powered economy (top down): yields a return of at least £660m additional growth per year.

Our reasoning is that:

- More students gain the capability and qualifications to fill vacancies in physics-powered sectors; with their physics capability they drive or support growth
- The physics-based sector can fill vacancies, reach its potential, attract investment and grow further

More detail on methods

Method 1: Improved student outcomes leading to increased lifetime earnings

In this section, we look at the improved outcomes that the students of experienced, in-field physics teachers will achieve. We will use that improvement to estimate the economic benefits that a given cohort of students can expect in increased lifetime earnings.

There are three ways in which having additional and more experienced in-field teachers results in improved outcomes:

- a) An in-field teacher improves the ability of their students to get higher exam grades
- b) An in-field teacher will encourage more of their students to progress to A-level physics
- c) The more experience a teacher has, the higher the GCSE grades of their students

We will calculate the gains from moving from the current situation to the ideal situation for each of these mechanisms using the following numbers:

- Currently:
 - the number of specialist physics teachers in the workforce is 6,500. This comes from our modelling in appendix 1^{xiv}.
 - The average experience of a teacher in England is 13 years (OECD)⁶⁷.
- Ideally:
 - There would be 10,000 specialist physics teachers
 - Their average experience would be 17 years (the OECD average).
- The increase in lifetime earnings due to an improvement of one grade^{xv} at GCSE is £8,210 for physics and £7,357 for Combined Science¹⁶.
- The increase in earnings of someone with physics A-level is £28,000 more than other A-level students over their lifetime¹⁷

a) An in-field teacher and higher grades

In appendix 2, we show that the chances of having an in-field physics teacher teaching physics topics is about 72% for physics GCSE and about 33% for Combined Science. With a full complement of in-field physics teachers, both of those numbers will rise to 100% - thereby improving the outcomes for all the students who are currently denied an in-field physics teacher. In appendix 3, using Cawood's¹⁸ finding that a one percentage point increase in the chance of having a specialist teacher increases a student's GCSE grade by 0.0018, we show that having a full complement of in-field physics teachers will result in 8,696 physics students improving their GCSE by one grade; and 36,826 Combined Science students doing so.

With an increase in lifetime earnings of £8,210 for physics and £7,357 for Combined Science, this represents an increase in lifetime earnings for that year group of £342m (at 2025 values).

^{xiii}Noting that one is an increase in economic activity and the other is an increase in lifetime earnings; so the latter becomes the long-term annual return after forty years.

^{xiv}In this model we used the broad definition of 'specialist' by allowing for an additional 20% of physics teachers being in-field. The model showed that the number of in-field teachers is about 5,400.

b) An in-field teacher and improved progression rates

Using the data from the IOP survey (appendix 5), we have estimated that having a full complement of physics teachers up to GCSE will generate an additional 12,000 A-level students per year. In their report, *The Earnings and Employment Returns to A-levels*¹⁹, London Economics show that someone who takes a physics A-level will earn about £28,000 more than other A-level students over their lifetime. Therefore, increasing to a full complement of physics teachers will give a lifetime return of £336m per year group.

It is worth noting that we have not assumed that these students will go on to degrees, or included the increased economic contribution they would make as a result of doing so; therefore, this is quite a modest estimate of returns.

Additionally, we are not basing this increase on shifting students from other high-value A-levels; much of the increase in A-level uptake will come from extending opportunities (through access to in-field teachers) to people who are in schools that currently have very few students progressing to A-level physics or other high-value A-levels. That is, they are genuinely new blood.

c) Increased experience improves exam grades

In the *Myth of the Performance Plateau*²⁰, Papay and Kraft show that teacher experience improves student grades – not just at the start of a teacher's career but throughout it.

EPI have conducted some analysis for the IOP and shown that the size of this effect is an average additional lifetime income of £430 for each physics student who benefits from a teacher with an additional year of experience. If, on average, teachers have four more years' experience (to match the OECD average), then the additional average lifetime earnings could be as much as £1,720. About 160,000 students take physics GCSE in a year. Therefore, by retaining all our teachers for an additional four years, the additional experience of teachers of physics might result in an increase in lifetime earnings of £280m for each year group that they teach.

Using the same arguments, Combined Science GCSE, with increased earnings of £7,357 per grade and a candidature of 470,000 students would result in an increase of £483m per year group^{xvi}.

So the total increased lifetime earnings from improved teacher experience (within physics) would be £763m.

Note that this does not depend on them being in-field teachers – this is solely based on experience.

Total increase by method 1

From the three mechanisms above, the total increase in lifetime earnings for students in a system with a full complement of physics teachers and an increase in retention to the OECD average is £0.342bn + £0.336bn + £0.763bn = £1.4bn.

Once students have worked their way through the workforce, this number will be the annual return on investment.

In terms of the numbers, the reason why lifetime earnings scale up quickly is because a single teacher reaches about 300 students per year; and those students will work for 40 years. So, there is enormous gearing (of a factor of about 12,000) on the advantages that a single high-quality teacher can make to the futures, and future productivity, of their students.

^{xv}This is more than the existence of the grade; it is due to the increased knowledge and capability that was required to achieve the grade; i.e. it is not a feature of grade inflation

Method 2: Economic contribution of physics-powered sectors

Another way of estimating the return on investment in teachers is to look at the contribution of physics-powered sectors, and the impact that more well-qualified school leavers would have on enabling it to grow. Again, this is an indicative calculation to illustrate the potential order of magnitude of growth in physics-powered sectors.

Physics-powered sectors are productive: in 2019 they contributed £190bn to the economy in England²¹ and provided 1.4 million physics-related FTE roles across the nation^{xvii} which require a range of levels of physics-based qualifications – A-levels, apprenticeships, degrees and PhDs.

The growth in Gross Value Add (GVA) from physics-based industries was 21% from 2010 to 2019 (2% per year), while the increase in roles was 4%. With new industries (such as quantum) emerging, there is a greater potential for growth but also a renewed demand. That demand may be more physics-specific than in the past.

However, there is a shortage of school-leavers and graduates with the appropriate skills to meet the existing demand let alone one that grows. This shortage is impacting employers' ability to expand and innovate. The IOP's Paradigm Shift report²² found that there were 9,000 long-duration vacancies for physics-based roles (in the UK and Ireland) and two-thirds of physics-powered businesses reported suspending or delaying R&D activities in the previous five years due to skills shortages.

Two-thirds of physics-based businesses reported suspending or delaying R&D activities in the previous five years due to skills shortages.



Our best (though very rough) estimate, is that, in the immediate term being able to match the demand for physics-based roles would allow the sector to grow by 2.3% rather than the average experienced in the 2010s of 2%^{xviii}. That additional 0.3% of growth represents £600m per year.

It is worth noting that this is very likely to be an underestimate because it is based solely on filling vacancies. It does not account for a growth in R&D (in the two thirds of businesses who are currently limiting their investment in R&D due to a shortage of skills), and the motivation for physics-powered industries to invest that would come with a sufficiency of people with physics-based skills. Case study 4 provides an example of one such industry – Universal Quantum, a quantum computing company. Quantum is a physics-powered sector that has enormous potential for growth. Universal Quantum has doubled in size every year since its inception and aim to continue on that trajectory. In order to do so, it needs people with physics-adjacent backgrounds.

^{xvi}This is assuming that physics is worth two thirds of a grade within Combined Science

Feasibility check on the scale of the return

The size of the returns can seem unfeasibly large as they run into billions of pounds. However, we should not be surprised that improving young people's education leads to greater wellbeing and prosperity for them and the nation. High-quality education clearly underpins growth and success in a modern, technological economy. And yet, we are currently failing to teach physics properly to over a half of youngsters. So, as an order of magnitude check, it is perfectly feasible that the yield on extending opportunity to 58% of the population will be many £billions.

Furthermore, other recent reports have arrived at figures of a similar scale. For example, POST's estimate³ that shortages of STEM skills is costing £1.5bn per year closely aligns with our estimate that, within physics (which has the biggest shortage within STEM), the shortages are costing about £0.6bn per year.

Also, in their report for the Wellcome Trust²³ estimating the return on investment in teacher professional learning, EPI found a gearing of a factor of about 20 resulting in net social gains of £61bn. Our estimates give a similar proportional annual gain – between 40 and 90 times the annual investment.



^{xvii}This does not include the additional value of HE-based research and development

^{xviii}This is based on an annual increase in employment within the sector of 4% (56,000 roles); and an estimated vacancy rate of 7,200 in England. Had those vacancies been filled, the sectoral roles would have grown by 63,200 – which is 13% increase. If the annual GVA growth of 2% increased by 13%, that would be GVA growth of 2.3%. I.e. an additional 0.3 percentage points by filling vacancies.

Counterfactual

It is worth putting our proposals in the context of the counterfactual – what if we do not address the teacher shortage and the issues of attrition and low recruitment?

Firstly, the number of in-field teachers will likely continue to decline. The result will be that more students will not have access to in-field teachers and those students will tend to be in schools in less well-off areas; they will be more likely to teach Combined Science – and do so in a way that does not encourage progression to A-level; and therefore A-level physics will increasingly become the preserve of more comfortably off students. That is, physics will become increasingly two-tier in the way that it is taught and in the likely outcomes for students.

Not only is that outcome inequitable and denying opportunity to young people based on their postcode, it means that we will be losing talent and inhibiting innovation – thereby reducing the chances of future growth in an innovation-based economy.

For an extreme picture of the potential losses, we can ask ourselves whether physics-powered sectors would currently be contributing £190bn to the economy if 58% of students – as is the case now - had not had access to in-field teachers in the 1990s and early 2000s. The answer is that it is unlikely. Many of the physicists and engineers who established, built on and are exploiting emerging technologies such as quantum and AI would have been lost to the sector.

The second consequence is the continued costs of attrition: on teacher morale, on student outcomes and the financial burden of on-going recruitment (the direct wasted costs of which we estimate to be about £8m per year).



“We are a quantum computing company. About 50% of our workforce has a physics degree. However, the pool is limited and there is not an abundance of people with the skills that we need in an increasingly competitive recruitment market. This shortage will slow growth across the sector.”

Samantha Edmondson,
Head of People, Universal Quantum.



Section 2: the three pillars and their foundations

In this section, we discuss the rationale for, and gains from, the nine recommendations and 25 proposals shown on page 12 and 13.

Timescales, costs and impact

As we have discussed, we are not expecting all of the proposals to be implemented at once. There are some quick wins and some which will need addressing early in the plan. By the same token, our ambition that all science lessons should be taught by a disciplinary specialist will only become possible later in the plan.

Pillar 1: Retention

The area in which the government can and must urgently move the dial in a sustainable way is retention. Failure to do so is costly, wasteful and damaging to learning. Without addressing retention, we cannot solve the problems of a shortage of teachers in physics. It is for these reasons that we have made it the first pillar ahead of recruitment, which, with readily available annual statistics, often draws more attention.

Recommendations to improve retention

1. Reduce workload and improve wellbeing

- a. Give early career teachers an entitlement to a timetable that matches their qualifications and interests
- b. Fund further systematic research on effective uses of AI and technology to support teachers
- c. Develop mechanisms for supporting senior leaders to improve retention in schools

2. Reconsider support and incentives for early and mid-career teachers

- Redesign the Early Career Framework (ECF) to foreground subject-specific support in a way that integrates with ITE
- e. Put in place financial incentives to retain early- and mid-career teachers

3. Treat the sciences as separate disciplines – especially at Key Stage 4

Timetable and teach the sciences separately at Key Stage 4 (including for Combined Science)^{xix}

Schools recruit, deploy and record teachers as subject specialists in biology, chemistry and physics

- h. Allow ITE courses to focus on the chosen science discipline

^{xix}We note that, in some schools, there are valid educational reasons to allocate a single teacher to teach some groups; however, this should not be the norm and it should not be based on timetabling requirements.

About 44% of secondary physics teachers have left state-school teaching after five years (figure 2). Along with the USA, England is an international outlier as one of the worst in the OECD for retaining its teachers.

There are four main harmful consequences of this high rate of attrition:

- The loss of expertise from the system. More experienced teachers achieve better outcomes. Improving retention will increase the number of experienced teachers in the workforce, thereby increasing average experience (currently 13 years) to more like the average of OECD countries²⁴ (17 years).
- The high level of attrition puts a huge burden on recruitment. Improving retention to match the OECD average would reduce the recruitment requirement by 175 in the current situation (with 6,500 physics teachers in English state schools) and by at least 225 once the number of physics teachers has reached the required level of 10,000 (figure 14).
- It draws on a large number of expert person-hours for training and mentoring people who do not stay long in the profession; as well as direct costs, there is a significant opportunity cost of experienced teachers and tutors in supporting trainees and early career teachers (who do not stay long) when they could otherwise be doing development work to support their school or the wider system.
- It is very costly to continue to have to recruit to make up for so many teachers leaving state schools.

Improving retention is not only much more cost-effective than constantly recruiting, it also:

- **Improves student outcomes.** Kraft and Papay⁷ found that more experienced teachers improve student outcomes, thereby improving their opportunities and their contribution to an innovation-based economy (see *Estimating returns on investment* on page 23).
- **Greatly increases future earnings.** Based on some work EPI carried out for the IOP, we estimate that improved experience alone will contribute £760m in long-term earnings of students who benefit from it.
- **Is ethically desirable.** The high attrition rate means it is becoming ethically difficult for recruiters marketing the profession to good graduates. It is hard to justify recruitment initiatives that are knowingly recruiting good graduates into a job from which they have a 44% chance of leaving within five years.

Furthermore, the high attrition rate washes back into the graduate population: the knowledge of high attrition and its causes deters potential applications (see figure 19 on page 79). Therefore, addressing attrition and its causes will also improve the quality and number of recruits.

Reasons for leaving

In his paper *Why did they leave?* Whalley²⁵ found there is no single reason for physics teachers to leave. Rather, it is the case that a number of factors accumulate and, collectively, force the decision to leave teaching (or the state sector).

The highest of those contributing factors are shown in figure 6. We address each of these factors in our recommendations and proposals, which are described below.

Survey Item	Weighted average (N = 11)	Rank
Poor leadership (school level)	2.9	1
Lack of career progression opportunities	2.9	1
Overly prescriptive ways of working	2.7	3
Lack of consultation (involvement in decision making)	2.7	3
Salary	2.7	3
Marking workload	2.6	6
Administrative duties	2.6	6
Level of autonomy	2.6	6
Planning workload	2.5	9
Lack of flexible working opportunities	2.5	9
Having to teach out of specialism	2.4	11

Figure 6. The top factors cited by teachers who left teaching as reasons for leaving²⁵.

1. Reduce workload and improve wellbeing

It is worth exploring the notion of workload further: in The Teacher Gap²⁶, Allen and Sims found that teachers in England are content to work hard but are put off by workload that they see as being unnecessary or bureaucratic. The OECD²⁷ found teachers in England work an average of 47 hours per week, which is one of the highest in the OECD and 8 hours more than the OECD average of 39; and that teachers in England are spending more time than the OECD average on non-teaching tasks (figure 7).

	Average experience in teaching (years)	Report stress	Total working hours	Teaching hours	Non-teaching hours
Singapore	11	23	46	18	28
England	13	38	47	20	27
USA	14.6	26	46	28	18
Finland	16	14	33	21	12
Austria	18.2	12	37	19	18
Slovenia	20	16	39	19	20
OECD average	17	18	39		

Figure 7. Average experience is an indicator of retention. England is well below the average for that figure and well above the average for non-teaching hours. Source: OECD Education GPS²⁸.

Key

Teacher gain icon 	Scale 1 - 5	Estimated teacher gain (per year - whole scale) 1 - 250
Cost icon £	Scale 1 - 5	Estimated cost (whole scale) £1000 - >£2m
Timescale icon 	Scale 1 - 3	Time period Short, medium and long term

Wider benefits

Science department, whole school, science

Teachers



New Cost



Timescale



Wider benefits

Science department

a. Give early career teachers an entitlement to a timetable that matches their qualifications and interest

Gains

- Reduces workload for physics teachers
- Having more repeat lessons in a week reduces preparation time
- It will enable early career teachers (ECTs) to gain expertise more quickly
- As such, reduces stress and improve teachers' confidence and self-efficacy
- improves student outcomes by providing them with a greater proportion of their science lessons being taught by in-field teachers

Figure 2 on page 8 shows that there is a higher rate of attrition amongst physics teachers than for the general population of secondary school teachers. One reason is likely to be the burden and reduced satisfaction for some physics teachers of having to teach biology and chemistry as well as physics_{xx}.

Timetabling research in 2017₂₉ found that, in nearly half (48%) of schools, teachers are expected to teach across the sciences. Although it is inevitable that, in the short term, some physics lessons have to be taught by out-of-field teachers, it is not inevitable that physics teachers should have to teach biology and chemistry.

In their first five years, physics teachers leave at 1.3 times the rate of all secondary teachers



Physics teachers are teaching the other two sciences not because there is a shortage of biology and chemistry teachers, but as a timetabling decision. This requirement makes no sense because physics teachers are in short supply: it underuses the rare specialist skills of in-field physics teachers.

Encouragingly, it can be put right with a little effort and at very little cost by matching their timetable to their experience, past qualifications and preferences_{xx}.

xxIt is the case that some teachers enjoy teaching all three sciences; and that is encouraging. However, it is not the case for all practising or potential physics teachers; and should not be an expectation.

This will reduce their workload by:

- Allowing them to focus on teaching content with which they are already familiar
- Reducing their preparation time – they will have more repeat lessons and therefore fewer distinct lessons to prepare

Additionally, it will:

- Allow them to gain expertise more quickly as they are repeating lessons and can reflect on them at the end of a week
- Improve job satisfaction – they will be teaching the subject that they themselves chose to study
- Increase their confidence and self-efficacy

It is worth noting that this recommendation does not prevent teachers who prefer to teach more than one of the sciences from doing so. However, it should not be a requirement that they should teach outside their specialism if that is not their preference.

It is likely that schools will need support in altering their timetable blocks so that ECTs can be given lessons that match their experience, expertise and preferences. This support should be made available to them. It would be helpful to set up a timetabling task and finish group to analyse the extent of the practice (of expecting physics teachers to teach biology and chemistry at GCSE) and to support schools in moving away from it.

“

As a consequence of matching our department timetable so that teachers taught within their specialism, the results of the Combined Science students improved. The teachers preferred teaching in this way, feeling more confident and able to respond to students' needs and they enjoyed a massive reduction in their workload.

”

Beth, former head of science.

Teachers



New Cost



Timescale



Wider benefits

Whole school

b. Fund further systematic research on investigating effective uses of AI and technology to support teachers

Gains

- Reducing teacher workload on repetitive, tedious tasks
- Bringing more new ideas into teaching and learning

The government recently announced funding for researching the use of AI to reduce teacher workload³⁰. A recent trial from the EEF³¹ found that teachers using ChatGPT experienced significantly lower lesson and resource preparation time than a comparison group of teachers who were asked not to use GenAI tools to plan their lessons.

This is very encouraging, and we support the DfE programme, welcome anything that will save time without compromising quality, noting that it is not a substitute for teachers having excellent subject knowledge so that they can check the accuracy of any AI outputs. We also recommend that there is training available to equip teachers with the skills to be better able to proactively mitigate the biases that tend to creep into AI-generated text and to manage the implications and risks of AI being readily available to students.

Areas that might be particularly fertile ground for exploiting the capabilities of AI are:

- Lesson planning
- Lesson preparation
- Marking
- Administrative tasks
- Tasks that would require immense patience from a human.

Teachers



New Cost



Timescale



Wider benefits

Whole school

c. Develop mechanisms for supporting senior leaders to improve retention in schools

Gains

- Improved teacher agency and sense of professionalism
- Reduced feelings of working in an oppressive atmosphere – especially for early career teachers
- Teacher retention becomes a priority for SLTs and attrition is reduced

It is certainly concerning that perceptions of the behaviour of senior leadership teams rank so highly as a reason given by physics teachers for leaving teaching (figure 6). Sims and Allen²⁶ found that attrition driven by leadership can be a particular problem for early career teachers who find themselves in an atmosphere that can be oppressive and based on a “surveillance culture”. Additionally, teachers – especially experienced teachers – cite agency as a motivating factor for staying in a school or in the profession. Therefore, overly rigorous structures relating to how lessons are taught or behaviour policies that do not treat students with respect are both ineffective and a deterrent for teachers.

It is likely that many of the attrition-driving behaviours would be ameliorated by addressing the oppressiveness of the crowded curriculum, high-stakes exams, and inspection system described in section 8 below. However, in line with our recommendations for reforming school improvement mechanisms, we recommend instituting a systematic means of supporting senior leaders to focus on creating a culture where staff demonstrably thrive, including specifically focusing on retention – both as an outcome and as an indicator of success. They might be supported by a mentoring network of experienced senior leaders, and we recommend looking at and revisiting the positive aspects of the National College of School Leadership³² which was merged into a largely regulatory body in 2013 and dissolved in 2018.

Teachers



New Cost



Timescale



Wider benefits

Whole school

2. Reconsider support and incentives for early- and mid-career teachers

d. Redesign the Early Career Framework (ECF) to focus on retention and to foreground subject-specific support in a way that integrates with ITE

Gains

- Retention in the first year of teaching is improved (from 81% to 90%)
- Early career teachers (ECTs) get specific support in the subject they are teaching, improving their confidence and self-efficacy – particularly those in schools that do not have an existing in-field physics teacher
- There is less repetition from the ITE year
- ECTs are more likely to stay in the profession

While the initial Early Career Framework³³ (ECF) document was a welcome and thoughtful contribution to supporting early career teachers (ECTs), its implementation has been expensive and ineffective. The emphasis has shifted from a programme to support retention at the beginning of a teaching career to being more about ensuring that all ECTs had been through a uniform programme of preparation.

We strongly recommend that its principal aim is refocused on retention and that, in order to reduce the recruitment target to a manageable level, it is set a target of improving first-year retention from 81% to 90% (see appendix 1). Early indications show that IOP support for early career scholars meets this target (proposal I).

ECF should be set a target of improving first year retention from 81% to 90%



Additionally, when the programme was contracted out, the contracts lost the vital element of subject-specific support. Therefore, this has not been included by most of the contracting organisations.

The ECF delivery contracts cost in the region of £130m. As a measure to specifically reduce attrition, the early evidence is that the ECF as it stands is very poor value for money. It has reduced

attrition by just 1 percentage point. Given DfE's expenditure on recruitment initiatives as noted in the NAO report³⁴, that 1% improvement in retention amounts to a saving of in the region of single digit millions of pounds.

In a poll of ECTs, Teacher Tapp³⁵ found that as many teachers agreed that the ECF was likely to put them off teaching as described it as being helpful to keep them in teaching (figure 8). Teachers found much of the content to be repetitive and unhelpful, and noted the absence of activities that they would find helpful. Evidence from Gatsby³⁶ and Teacher Tapp³⁵ confirms that, amongst other things, they would welcome greater subject-specific support. There have been some successful trials of such support; however, it had to be added onto the existing generic support, increasing the burden on ECTs. For those reasons, we are recommending that the ECF programme needs to be redesigned with subject-specific support as an integral part.

Teacher Tap findings

Teacher Tap conducted a survey in 2022³⁷. They found that:

- Two thirds of participants felt they hadn't learnt anything new from ECF
- Three quarters felt it added to their workload
- Only 25% of participants (and 10% of mentors) thought that the ECF would reduce attrition
- 17% said it increased the likelihood of them leaving.
- While mentors and school leaders are generally supportive of the concept of the ECF, only 8% of mentors would keep it as it is

92% of secondary teachers disagreed with the statement that there doesn't need to be more subject-specific support.

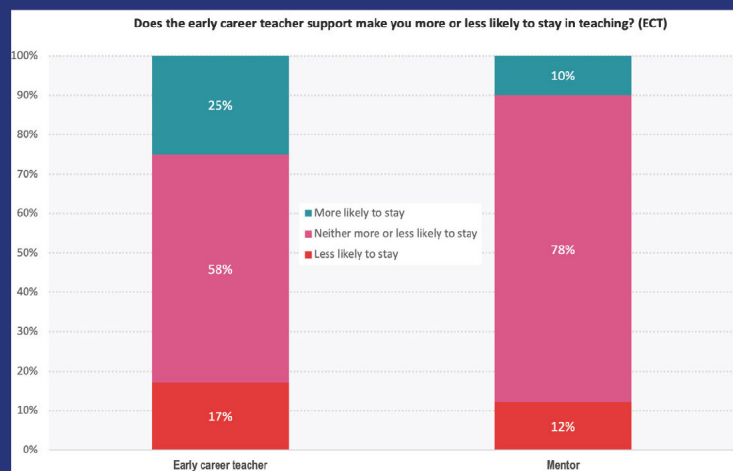


Figure 8: Poll by Teacher Tapp of ECF participants³⁵.

The recent move to merge the Core Content Framework (CCF) in Initial Teacher Education (ITE) with the Early Career Framework into a single ITTECF framework³⁸ is welcome. Although it is still focused on generic requirements for teachers to work through – rather than providing subject specific support, this should go some way to reducing repetition and to providing some continuity between ITE and ECF. It is worth considering taking this a stage further and integrating the programmes, with ITE providers given suitable funding to oversee the ECF support offered to early career teachers. As well as being more effective, integrated and local, this approach is likely to be less expensive than a major contract with national contractors.

Above all, early career teachers of the sciences should be entitled to a timetable that matches their experience and interests (proposal a).

What is the alternative to ECF?

It is worth looking at three recent programmes to get a sense of what works: IOP's Early Career Professional Learning programme funded by Gatsby and evaluated by Sheffield Hallam University³⁹, IOP's early career support for its scholars, and the Ogden Trust's Teaching Core Physics programme. All of these successfully supplemented the existing ECF with subject-specific support provided, where needed, by a mentor outside the school. This support was designed to be frequent, collaborative and subject-specific. Each of these features was found to be important in Gatsby's review. Additionally, there is emerging evidence that the scholar support has improved retention rates.

These programmes were successful and demonstrated the value of subject-specific support. However, they were hampered by the fact that they had to be bolted onto the existing ECF commitments of teachers rather than replacing them, and participants felt that the main body of the ECF was taking up too much of their time.



Teachers



New Cost

£ £ £ £ £

Timescale



Wider benefits

None

e. Put in place financial incentives to retain early- and mid-career teachers

Gains

- Retaining an ECT is considerably less costly than recruiting and training a new teacher
- Retention keeps teachers in the system so that they gain experience and improve student outcomes

In their evaluation of teacher retention payments and variations in eligibility, Sims and Benhenda⁴⁰ found that teachers eligible for the payments were 23% less likely to leave the profession while they were eligible. The payments were set at 8% of starting salary and the policy cost 32% less per teacher retained than recruiting and training a new teacher.

In surveys of teachers, the level of salary often comes low down the list of reasons to consider leaving. However, it is worth noting that these are surveys of people who chose to go into teaching knowing the salary prospects – so there is an element of selection bias. The IOP has some new evidence that the knowledge of salaries – particularly the longer-term prospects – within teaching has an effect on recruitment and, in turn, affects retention (see facing page).

Currently, incentive payments are available only to teachers in pupil premium schools. However, given that the shortage of physics teachers is a system-wide problem, and the payments are cost-effective, we recommend that they are extended to all early career teachers in physics (and shortage subjects) for two their first two years. We also support similar calls from Gatsby and NFER⁴².

Survey of recent physics graduates:

We surveyed 92 recent physics graduates who did not go into teaching (figure 9 and appendix 6) and found that nearly half felt that the starting salary (compared with the starting salary of other options) was moderately or very influential in their decision not to go into teaching. Whereas the long-term prospects were moderately or very influential for 70% of respondents.

Their concerns are justified. According to the Government's Longitudinal Education Outcomes - Graduate Industry dashboard⁴¹ for the tax year 2021/22, the median starting salary of a physics graduate becoming a secondary teacher was £20,800 ; whereas a physics graduate going into financial services commanded a salary of £37,600 (75% higher) and into the energy sector, £29,900 (44% higher). After five years, salaries in the same two industries are 80% and 46% higher respectively; and after ten years, the salary in the financial sector is twice that of a teacher – that is, a bigger gap is opening up.

We note that, in recent years, a teacher's starting salary has increased significantly and, in 2025, is over £31,000.

Years after graduation sector	1	5	10
Secondary teachers	20,800	31,000	37,200
Financial services:	37,600	56,200	78,800
Manufacturing	27,400	37,600	42,000
Energy	29,900	42,300	47,400
Information & communication	28,900	45,300	58,800

Figure 9: Median salaries of first degree graduates in astronomy and physics from 2020/21 in selected sectors years after graduations. It is worth noting that, for teachers, there is not much variation in the salaries whereas in the other sectors, the variations mean that the maximum salary is likely to be considerably more than the median.

Note that this table shows median starting salaries (taking account of, amongst other things, part-time working). The teaching salary is therefore less than the full-time starting salary in 2021. However, this allows for a fair comparison across the sectors.

3. Treat the sciences as separate disciplines – especially in Key Stage 4

A theme that runs through much of the decline in physics teacher numbers and the consequent uptake of physics after the age of 16 is that, for many students, the discipline has become subsumed into the catch-all bucket of a subject called ‘science’.

This enforced coalescence has several consequences:

- It has contributed to the decline of in-field physics teachers
- It enables any science teacher to be deployed to teach physics within GCSE Combined Science or general science courses
- It requires trainee teachers in any of the sciences to learn to teach all of the sciences (adding to their workload)
- It does not make the best use of teachers’ experience, expertise and enthusiasm
- It results in in-field physics teachers having to teach the other sciences

It is for these reasons that teaching by specialism (at the level of biology, chemistry and physics) has been and remains a long-term aim of the science policy community. It will take some time to reestablish that as an achievable expectation in schools and would be helped by changes to the curriculum^{xxiii} as we outlined in our response to the curriculum and assessment review⁴³. However, it will yield huge improvements to teaching quality, teacher satisfaction and students’ perception of the sciences; and it will reduce workload, improve recruitment and reduce attrition. And it can be achieved over the period of the ten-year plan.

We explore the concerns in more detail below.

The decline in in-field physics teachers

The first consequence of the sciences being merged into a single subject is how it has contributed to the decline of in-field physics teachers – which, in turn, is associated with the decline in A-level numbers (figure 10).

Teaching by biology teachers now makes up nearly 60% of teaching in the sciences



It has always been difficult to recruit in-field physics teachers. However, with the introduction of a subject called ‘science’ in the late 1980s, it became easy for schools (and the system) to recruit ‘science’ teachers rather than disciplinary specialists. Without a driver to recruit in-field physics teachers, the number declined from the late 80s. At the same time the number of in-field biology teachers rose. About a half of science teachers now have a biology specialism; and teaching by biology teachers now makes up nearly 60% of the teaching in the sciences⁴⁴. Over the same period, the number of A-level biology students has nearly doubled while the number for physics has dropped, reaching its nadir in 2006. In 1989, physics had the highest number of A-level entries of the three sciences.

While the student numbers have partially recovered from 2006, physics entries are still 7% below their 1989 level and are now just half the number of those taking biology.

^{xxiii}A related issue is the way in which Combined Science is graded: students do not get a separate grade in each of the sciences. Having separate grades will help schools to move to separate teaching of each of the sciences. We have called in our response to the Curriculum and Assessment Review for that to be the case.

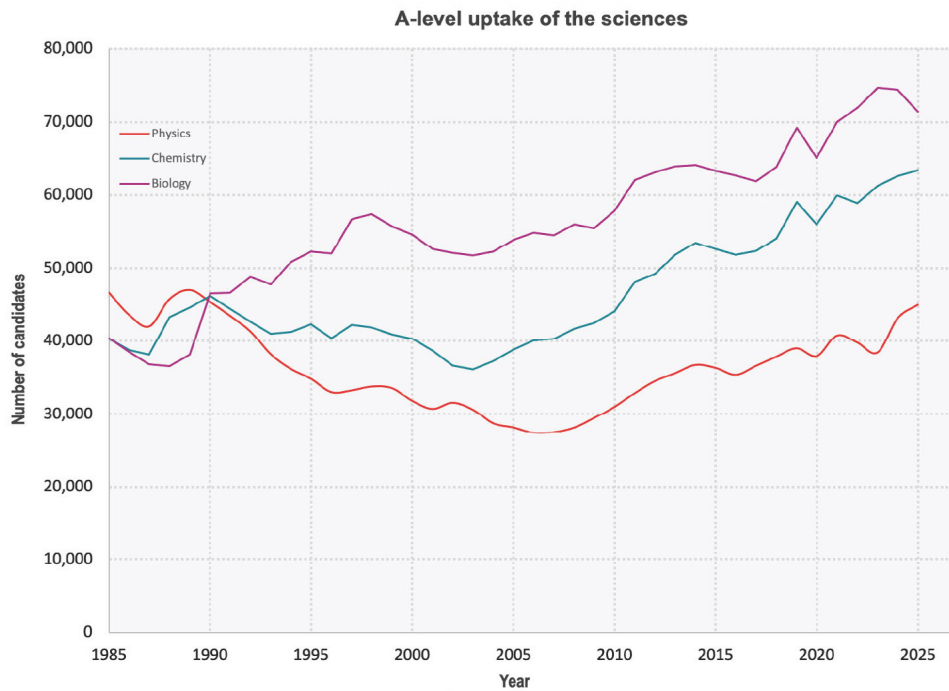


Figure 10. A-level uptake in UK in the sciences since 1985^{xxiv}. It is interesting to note that physics was the most popular up to 1989 – coinciding with the point at which the sciences began being taught as ‘science’ at GCSE level.

^{xxiv}The graph uses UK numbers because the full data is only available for UK as a whole. The shape of the graphs is the same for England, tracking the UK numbers at about 92% of their value. There were 39,937 entries to A-level physics in England in 2024.



Teachers



New Cost



Timescale



Wider benefits

Science

f. Timetable and teach the sciences separately at Key Stage 4 (including for Combined Science)

Gains

- Better quality teaching and learning of each of the sciences
- Improved student outcomes in physics (both attainment and progression rates)
- Improved retention of specialist physics teachers (proposal m)
- A driver at school level to recruit in-field physics teachers

Separating the way that the sciences are timetabled, taught and recorded will, above all, give students a better experience of the sciences as distinct disciplines, partly by increasing their chances of having a disciplinary specialist teaching them each of the disciplines. Additionally, it will reveal shortages of disciplinary specialists (most likely in physics) to school leaders and the system, provide parents and policymakers with better knowledge of how the sciences are being taught in schools, and motivate schools to find – or retrain – physics specialist teachers to cover physics topics. It will also allow schools to give teachers more matched timetables (see proposal a).

In proposal a we have recommended establishing a timetabling working group which could contribute to researching and implementing this both proposal a and f.

While we acknowledge that there may be some GCSE groups benefit from having a single teacher to establish rapport with the group and manage their motivation and behaviour, this should be the exception. In general, at Key Stage 4, whenever possible, the expectation should be that the sciences are taught by separate teachers and every effort is made to allocate three subject specialists to each class. If there is a shortage of physics teachers in the school, then the leadership can consider sending an out-of-field teacher on a retraining course (proposal o). This recommendation is aimed mainly at the way the sciences are taught in Key Stage 4. There are also advantages to teaching them separately in year 9 and possibly year 8; however, schools can be more flexible at this age.

Teachers



New Cost



Timescale



Wider benefits

Science

g. Schools recruit, deploy and record teachers as subject specialists in biology, chemistry and physics

Gains

- Knowledge of the subject specialism of teachers allocated to teach Combined Science lessons
- Improved retention of specialist physics teachers
- Increased motivation for schools to deploy (and therefore recruit) in-field physics teachers

The second consequence of teaching a subject called 'science' is that it allows schools to deploy a teacher in any of the sciences to teach any topic within the Combined Science GCSE and mark this down as a 'specialist teacher'. For example, a biology graduate teaching a physics topic as part of the Combined Science GCSE is classified as a subject specialist.

This attribution is misleading, as it is unclear whether the teacher has a post-16 qualification in physics, as we have found, is unlikely (appendix 2).

By contrast, and more faithfully, the same biology graduate teaching the same physics topic as part of a physics GCSE will be correctly reported as a non-specialist. That is, the same teacher is considered a specialist in one context and a non-specialist in another, despite teaching the same material. It means that students studying Combined Science are getting a raw deal – without anyone knowing about it. Contrary to the government reporting that nearly 94% of Combined Science lessons are taught by specialists, we estimate that, for physics, this proportion is more like 33% – in other words, two thirds of physics classes in Combined Science are taught by out-of-field physics teachers.

Students on the Combined Science GCSE are 3 times less likely to progress to A-level than those taking physics GCSE



^{xxx}Comparing progression rates of students with grades 7, 8 and 9 in physics GCSE (31%) with students with similar grades in Combined Science (11%). Using the comparison with grades 8 and 9 in Combined Science (16%), the progression rate is still twice as high from separate physics GCSE.

A raw deal for Combined Science students

Students on the Combined Science GCSE are three times less likely to progress to A-level than those taking physics GCSE_{xxv}; the fact that they are also half as likely to be taught physics to GCSE by an in-field physics teachers will be contributing to that lower progression rate. They are being let down and this is going unnoticed.

Given that there are four Combined Science students for every physics student in the most deprived areas; and only two Combined Science students for every physics student in the least deprived areas, it is students from lower SES families who are losing out. These students deserve better access to high-quality physics teaching and the opportunities, such as high-paying careers and social mobility, it affords.

Two thirds of physics lessons within Combined Science are taught by out-of-field teachers.



Teachers



New Cost



Timescale



Wider benefits

Science

h. Allow ITE courses to focus on the chosen science discipline

Gains

- Trainees (and their tutors) have three times as much time to focus on their main subject
- Trainees are better prepared for their first placement and teaching job
- Trainees are able to learn the skills of teaching without having to take on new subject knowledge outside of their subject specialism
- Trainees' self-efficacy and confidence improves, and drop-out rates reduce
- Recruitment improves because the course looks more attractive to many physics and engineering graduates

The third impact of merging the sciences is that, as things stand, it is likely that an in-field physics trainee will have to teach all three sciences in their first job. This means that initial teacher education courses in physics must also prepare them to teach all three disciplines. Typically, trainees have between one and 15 days focused on subjects; the time available to focus on their main subject (i.e. physics) is therefore reduced, typically, to less than five days.

Furthermore, knowledge of the requirement to teach – and train to teach – all three sciences washes back into the decisions that undergraduates make about whether or not to teach and which subject to teach. In a poll of 92 recent physics graduates, the IOP found that 50% of those who considered teaching but chose a different path cited the requirement to teach the other sciences as a factor in their decision (appendix 6). We also know that 20% of physics graduates who do go into teaching choose to teach maths rather than science or physics.

It is our ambition that within the period of the ten-year plan, early career teachers will have an entitlement to a timetable that matches their qualification, experience and preferences (proposal a). Once that is embedded in schools, it is our hope that ITE providers can spend more time developing the knowledge and skills to teach the main subject of a PGCE – in this case, physics.

Pillar 2: Recruitment

Recommendations to improve recruitment

4. Develop and support national recruitment programmes and reduce reliance on a market-based approach

- i. Reinvigorate pre-ITE Subject Knowledge Enhancement (SKE) courses in physics
- j. Turbocharge the Engineers Teach Physics programme

Rut in place a cross-department taskforce to manage, monitor and support international ITE recruits

5. Put in place national incentive schemes for potential applicants, ITE providers and placement schools

- l. Continue to fund scholarships and bursaries for physics trainees
- m. Provide incentives to providers for recruiting physics trainees
- n. Incentivise schools to provide placements for physics trainees

On average, over the last 30 years, we have recruited 500 new physics teachers per year; this is 200 short of what was needed to maintain physics teacher numbers.



Recruitment of physics teachers has been a long-term challenge. There have been a number of policy initiatives to address the problem. The healthiest four years of recruitment came from 2011 after the simultaneous introduction of a separate target for physics and the teacher training scholarships. Also significant were the long-form pre-ITE Subject Knowledge Enhancement courses introduced in the early 2000s (figure 11).

However, the recruitment figure has averaged about 500 since 1990, which has resulted in the decline of the population to the current – stable, but damagingly low – level of 6,500.

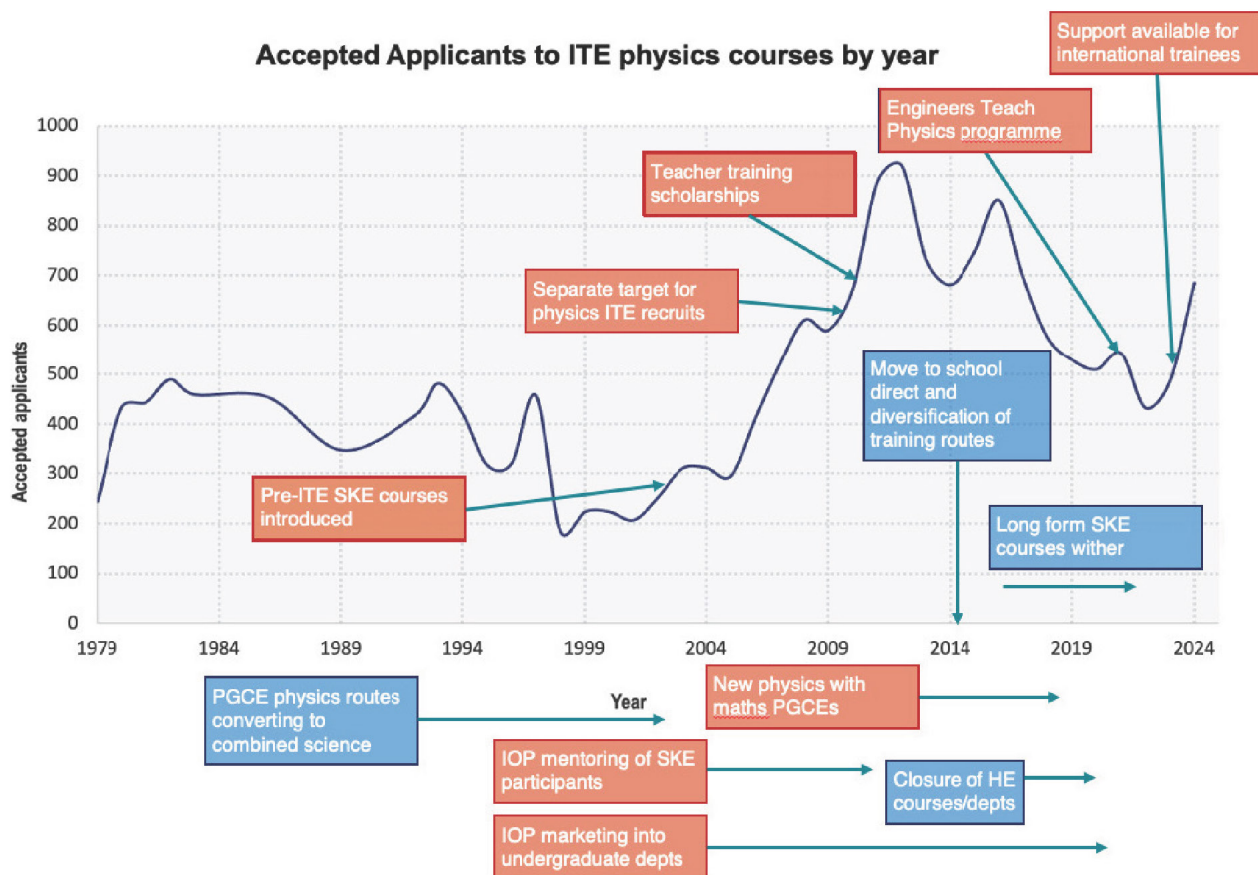


Figure 11. Graph of physics teacher recruitment since 1979 highlighting the low average and some of the interventions over the years.

Changes to the way in which teachers were recruited resulted in a drop from 2017^{xxvi}. Although the recruitment targets remained, there was no way of managing them at a national level. Figure 12 shows how the targets were steadily increased without having any impact on recruitment numbers and they became unfeasibly high (up to 2,800). The sole result of this ratcheting up was that they were missed by an increasing amount. In 2022 and 2023, the proportional attainment was only 17%. In 2025, the target was set at a more realistic 1,400.

Recruitment year	Postgraduate recruits	Recruitment target	Performance against target
2019/20	529	1,265	42%
2020/21	510	1,336	38%
2021/22	543	2,530	21%
2022/23	432	2,610	16%
2023/24	468	2,820	16%
2024/25	685	2,250	30%
2025/26		1,410	

Figure 12. Recruitment targets and how well they were met. Source: ITT Census 2024-25

Addressing the shortage

In appendix 1, we have developed a model that predicts the recruitment needs of the existing system (with its shortage and low retention), and various scenarios with and without improved retention. Our findings are summarised in figure 13.

Our model is built to match retention data from the last fifteen years, along with the OECD figure for the average experience of teachers in England being 13 years. It shows that:

- a. In the ideal situation in which we have 10,000 physics teachers, we would need to recruit 715 new physics teachers every year. This has only been achieved 5 times in the last 30 years.
- b. Were retention to be improved, that requirement would fall to 440.
- c. The existing situation (with 460 recruits per year and no change to retention) supports a physics teaching population of about 6,500 – which falls short of the requirement by 3,500.
- d. In order to reach the ideal level of 10,000, we will need a ramp-up period; this could be ten years (to coincide with the ten-year plan while retention is being improved). During that time, we will need to over-recruit (to put right the deficit as well as replacing leavers).
- e. If the Subject Knowledge for Physics Teaching course is turbocharged (see Pillar 3: Retraining), the recruitment need will be 790 at the start of the ramp-up period falling to 410 at the end.

All of these are feasible targets with a boost in the short-term from international recruitment.

Number of teachers	Recruitment requirement		Reduction in recruitment target
	Current retention: average experience = 13 years	Improved retention: average experience = 17 years (OECD average)	
Status quo: 6,500	460	285	175
Ideal: 10,000	725	440	285
Ramp up from 6,500 to 10,000	1075 (with SKPT 790)	700 (with SKPT 410)	375 (with SKPT 380)

Figure 13. Modelling of required recruitment target under various conditions – with and without improved retention.

xxviThe introduction of the school direct training routes meant that schools (rather than providers) were responsible for recruiting trainees.

Figure 14 shows how the recruitment requirement could change during the ramp-up period.

It is important to note the essential part that improving retention plays in reducing the targets to the levels shown in the graph. If retention is not improved over the period of the ten-year plan, the recruitment target will remain at about 790 at the end of it (figure 13).

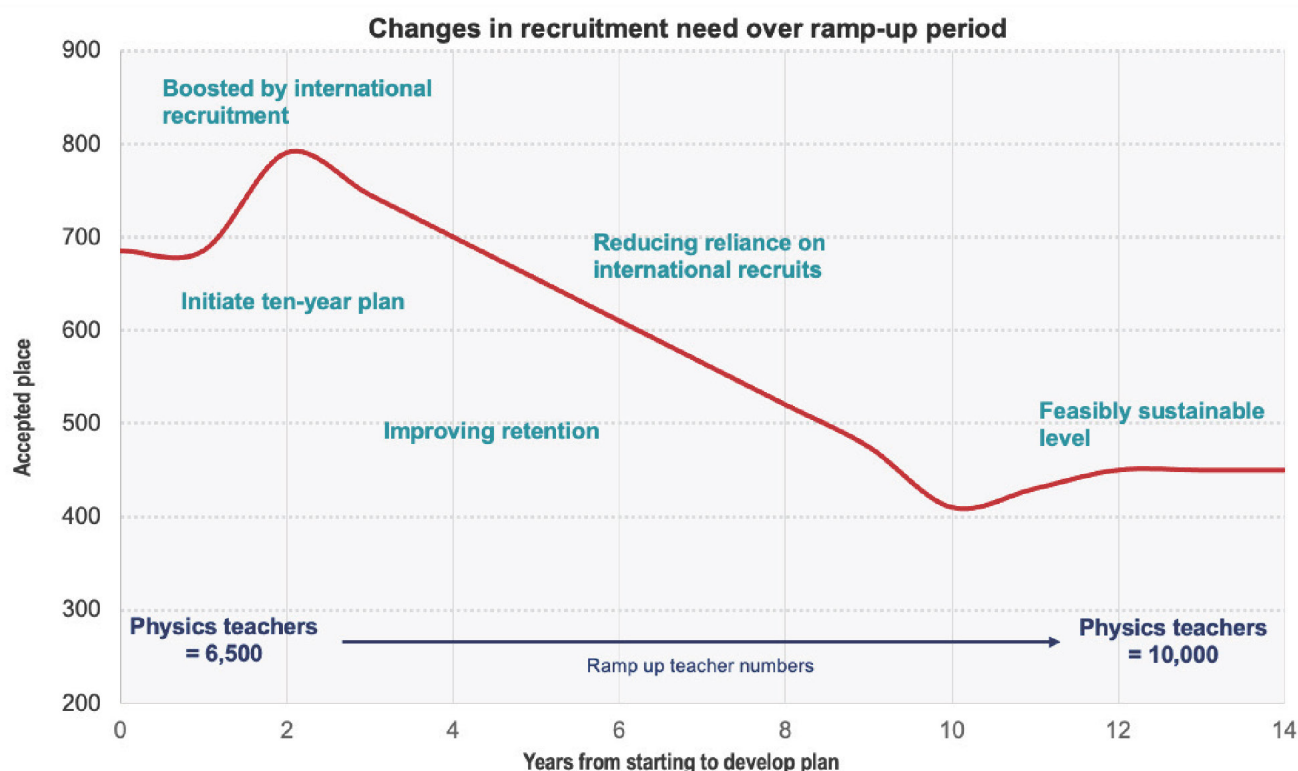


Figure 14. How teacher numbers can be increased from 6,500 to 10,000 over a ten year ramp up as retention is improved. Showing the requirements both with and without the Subject Knowledge for Physics Teaching course.

In the short term, the target will remain high and the best way of meeting it will be to make the most of international recruitment from non-EEA countries (which has surged in the last two years). However, this is a short-term solution and should be phased out while the rate of teacher attrition is reduced significantly. It also requires specific support whilst it is a part of the recruitment plan (proposal k).

In recommendations 4 and 5, we propose how to meet the targets over the next ten years with national programmes to increase the pool of potential teachers, and incentives for them, providers and placement schools to attract those potential teachers into the profession and support them during their training.

Teachers



New Cost



Timescale



Wider benefits

None

4. Develop and support national recruitment programmes

With around 4,000 UK domiciled physics graduates each year, of whom about 6% already go directly into teaching (which is on a par with other subjects), a target of 1,000 new teachers cannot realistically be achieved, and certainly not sustained, from the graduate physics population alone. Therefore, we have been looking at ways of increasing the recruitment pool.

The main methods are long-form (24 week), pre-ITE Subject Knowledge Enhancement (SKE) courses to retrain graduates in other subjects, recruiting engineering graduates and, in the short term, recruiting non-EEA international students.

i. Reinvigorate pre-ITE Subject Knowledge Enhancement (SKE) courses in physics

Gains

- A considerable increase in the pool of graduates who have post-18 qualifications in physics and who are interested in pursuing a physics teaching career

Long-form (24 week) Subject Knowledge Enhancement (SKE) courses were introduced for physics in the early 2000s. They were positively evaluated for the DfE⁴⁵ in 2013 and by 2012, numbers had grown so that more than 200 physics trainees per year had come through a long-form course (figure 15).

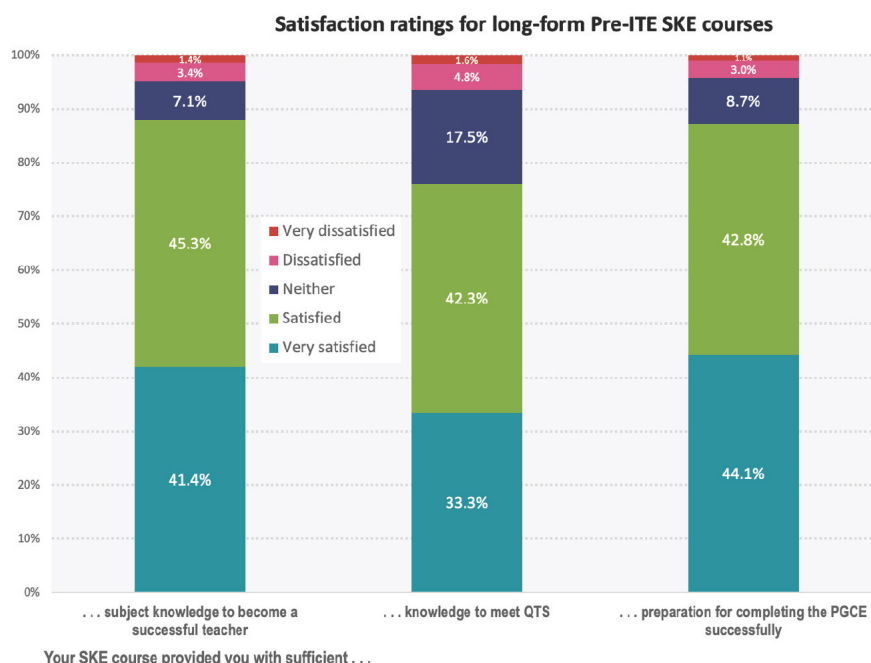
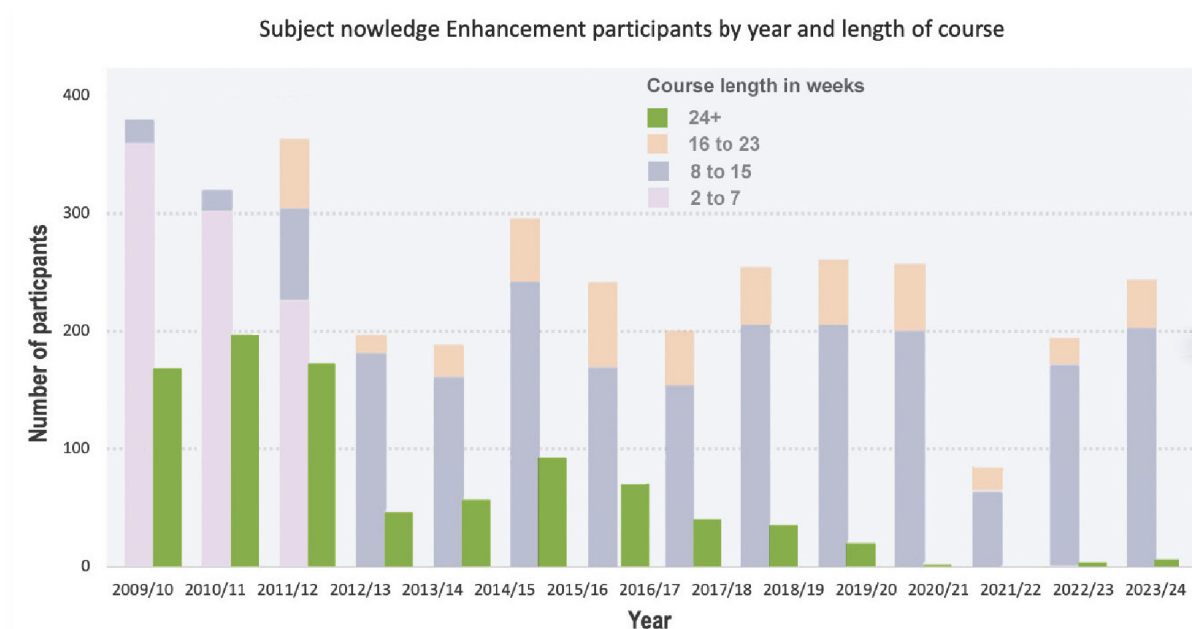


Figure 15: Chart showing overall satisfaction with 24-week SKE course. Source: DfE evaluation.

However, since 2012 the long-form courses have withered. In 2013, the number of people on 24-week courses dropped to 52 and has not gone above 10 in recent years (green bars in figure 16). Changes to the training system to be replaced by shorter, less costly courses, most of which are online only. These shorter courses have never been evaluated but clearly cover less content and do not provide as good a foundation for becoming a physics teacher. Furthermore, the online courses do not provide any opportunity to engage in practical work or to discuss any issues person to person.

Regenerating the long-form courses – through a nationally supported programme in which participants are funded to take part – would, once again, yield up to 200 trainee physics teachers per year.



The SKE experience.

“

Before I started the course, I certainly wasn't capable of A level standard maths. I now feel able to attempt any mathematical problem. GCSE level is a breeze. I feel very confident in my ability to teach at a GCSE level.

”

“

I am happier recalling information without having to check it from a source first. I can explain in detail certain processes, using different comparisons etc for different levels.

”

Teachers



New Cost



Timescale



Wider benefits

None

j. Turbocharge the Engineers Teach Physics (ETP) programme programme

Gains

- Recruiting engineers will increase the pool from which to recruit high-quality graduates with relevant post-18 experience of physics
- Engineers have the potential to make excellent physics teachers
- Engineers bring additional disciplinary knowledge and stories to the physics classroom and give students a flavour of what it is like to be an engineer

We are working with the DfE on a targeted programme to recruit more engineers into teaching. The programme aims to tap into the 12,000 engineering graduates who have physics A-level. Currently, about five of those choose to teach physics directly from their degree.

The pilot programme showed promise; however, since 2023, the programme has been somewhat dominated by the international recruitment bubble. We are recommending that a separate programme is set up for international recruitment (see facing page) and the ETP programme is intensified and refocused on engineering undergraduates based in universities in England.

Background

The premise of this programme is that there are nearly 32,000 students who take both maths and physics A-levels and progress to a degree; however, only about 4,000 of those students go on to take a degree in physics or astronomy; this is too small a population from which to recruit sustainably at the levels needed in order to address the shortage over a 10 year timeframe.

If just 1% of the 12,000 students graduating from engineering (with the right A-levels) were to go directly into physics teaching, that would be an increase of 120 physics trainee teachers. This would be an important contributor to a sustainable recruitment programme and represents a 15% increase in physics teacher recruits.

Not only do these graduates have the right background to become a physics teacher, we know they have the potential to make excellent teachers – they often have exactly the right skillset to become a teacher (excellent communicators, good at working in teams, and capable of thinking on their feet and solving problems). Furthermore, they can contribute a different perspective on the applications and pathways from physics to their students – and encourage them to consider engineering.

Teachers



New Cost



Timescale



Wider benefits

None

k. Put in place a cross-department taskforce to manage, monitor and support international ITE recruits

Gains

- International recruits are more likely to find a job in a state-funded school in England and to remain in the profession in England
- There is better knowledge of whether international recruits become teachers in state-funded schools in England
- Money invested in training international recruits reaps rewards for students in England

In 2023, there was a rise in applications to physics teaching from non-EEA international graduates (figure 17). In 2024, there were 242 trainees recruited from these applicants. They were excellent trainees and will make good physics teachers. However, they had to be selected from a pool of 4,445 applications – which was an enormous burden on ITE providers.

Furthermore, the trainees faced several difficulties when they started their training and they then had trouble getting visa sponsorship when they applied for jobs at the end of their training (case study 5). We are concerned that a high proportion may have been lost in the transition from training into teaching because they could not get a visa. We are recommending that ITE providers, international applicants, international trainees and qualifiers are all given specific support to ensure that the system is neither overwhelmed nor loses high-quality trainees who cannot get jobs or are put off by our system.

Relying on international recruits cannot be a long-term solution to the shortage of physics teachers. However, it can be effective in the short term as part of the plan to ramp up the numbers (from 6,500 to 10,000). In the longer term, with attrition rates reduced and when a steady state of 10,000 physics teachers is reached, we estimate that the recruitment target will fall to about 440 (provided attrition has been reduced). In that situation, we would no longer need to rely on international recruits.

Such support would require a cross-departmental taskforce that would include both the DfE and the Home Office.



I was offered a job at a school. However, when I met with HR, the requirement for a Visa came up and the job offer was withdrawn.



Abbi, IOP scholar and physics trainee.

Challenges

As alluded to above, there have been a number of challenges with the growth in applications from international graduates. They include:

- a vast number of unrealistic applications; in 2024, there were 4,445 non-EEA overseas applications and only 242 started. This is a massive load on providers
- trainees landing in England and being unable to access any funds or find accommodation
- providers having to help with accommodation and access to funds
- some schools being resistant to provide a placement for overseas students
- difficulties in getting schools to sponsor visas (at the end of their training)

Furthermore, there is no specific tracking of international trainees; therefore, as things stand, it is not possible to determine quickly how many have taken their first job in this country and how long they remain in our state education system. This makes it extremely difficult, or impossible, to evaluate the success of the international recruitment programme.

Case study 3 tells the challenges faced by Abbi who applied and moved continent to become a physics teacher in England in 2024.

Time period	Total postgraduates	Total undergraduates	EEA national postgraduates	UK national postgraduates	Other nationality postgraduates
2019/20	527	2	34	456	27
2020/21	507	3	31	442	17
2021/22	536	7	29	468	29
2022/23	427	5	22	347	23
2023/24	465	3	20	307	104
2024/25	681	4	25	362	242

Figure 17: DfE census of physics trainees showing uplift in 2024 driven by a large growth of non-EEA international students.

Teachers



New Cost

£ £ £ £ £

Timescale



Wider benefits

Science

5. Put in place national incentive schemes for potential applicants, ITE providers and placement schools

As well as increasing the pool, we are recommending a number of national incentives to help drive recruitment and open up bottlenecks.

I. Continue to fund scholarships and bursaries

Gains

- Scholarships have increased the number of high-quality physics teachers
- There are indications that they are a cost-effective retention mechanism

Scholarships and bursaries have been successful as a marketing tool and as an incentive to graduates to consider teaching physics. The 2023 NFER report *The Impact of training bursaries on teacher recruitment and retention*⁴⁶ found that the scheme, as well as improving recruitment onto training, has contributed to an increased number of teachers. They found that the retention rate of those with scholarships and bursaries is no worse than the general retention rate along with no evidence of ‘bursary tourism’.

The scholarship programme has also allowed the IOP to provide subject-specific support to scholars in their early career. The indications are that this type of support has improved retention. Hence our recommendation that this type of support forms the basis of the ECF (proposal d)^{xxvii}.

^{xxvii}IOP analysis shows that the first year retention rate is between 90% and 96%. Which meets the target we have recommended for ECF retention on page 39.

Teachers



New Cost



Timescale



Wider benefits

None

m. Provide incentives to providers for recruiting physics trainees

Gains

- DfE know at the beginning of the cycle whether the recruitment target can be met
- They can put in place remedial measures if the total number of places is lower than the target
- Providers have an incentive to recruit physics trainees
- ITE trainers can address specific barriers to recruitment

The boom years of physics teacher recruitment took place between 2011 to 2013 (figure 11). The increases in these years were helped by setting individual recruitment targets for ITE providers at the level of biology, chemistry and physics (rather than science). This initiative had no cost to government.

The current landscape is now very different, with lots of small providers rather than a few large ones (figure 18). Consequently, there is currently no means of genuinely managing the national target by dividing it up and passing allocations through to those responsible for actually doing the recruitment – ITE providers.

We have carried out some work with ITE providers and found that there are a variety of bottlenecks to recruiting physics trainees. In some areas the limitations are shortages of school placements, in others it may be the constraints on laboratory space, and in others it might be opportunities to work with their local undergraduate department. This makes the provision of a fixed purpose for an incentive susceptible to unintended consequences. Hence the suggestion that the incentive is agreed by discussion.

This would allow a large department to take on a person to manage or implement whatever intervention has been agreed. Smaller ITE providers might be encouraged to form consortia to allow them to pool their incentive payment and collaborate on obtaining suitable school placements. That designated person would undertake agreed activity to open bottlenecks. That activity might include:

- Marketing
- Interviewing
- Identifying placement schools
- Working with the universities' physics and engineering undergraduates

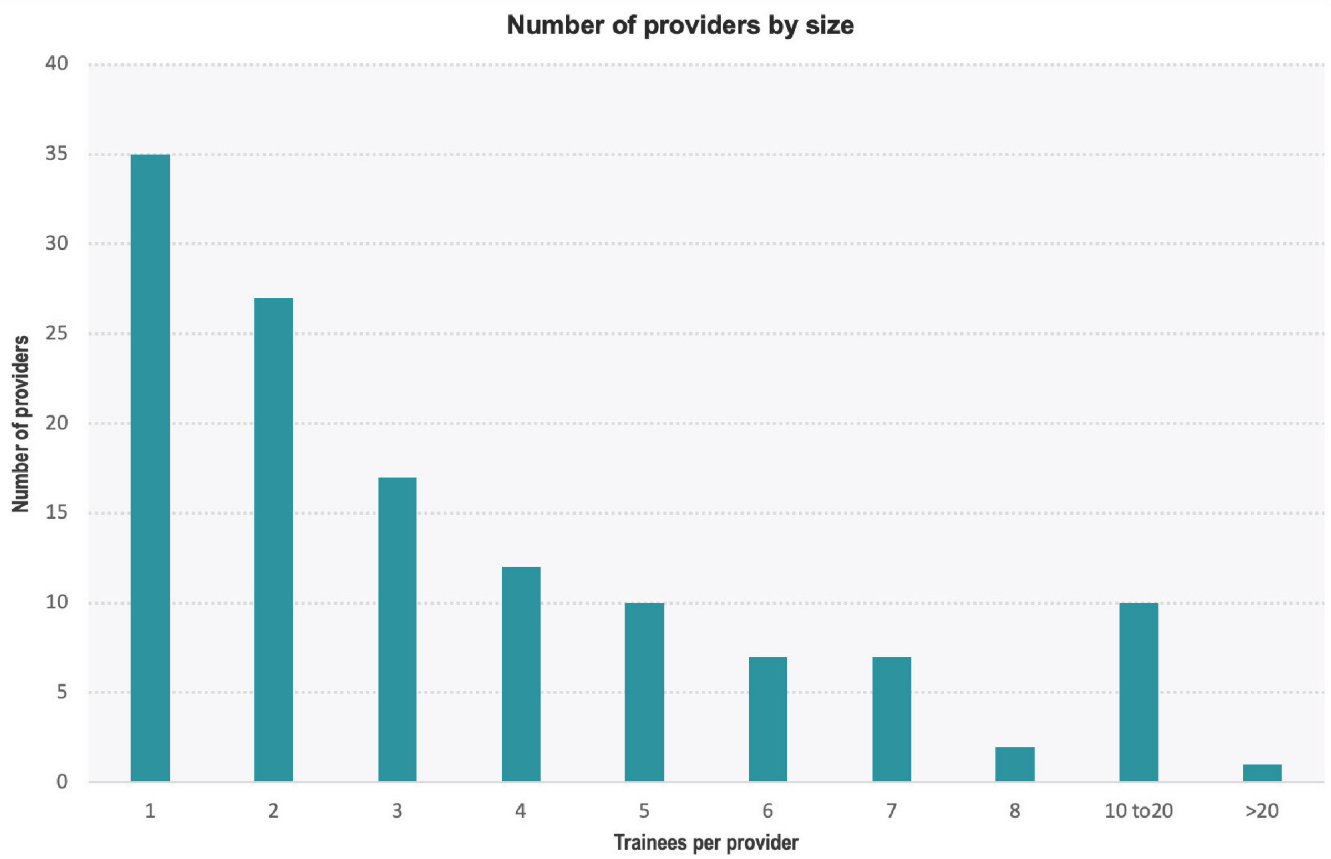


Figure 18: Histogram of number of providers of different size



Teachers



New Cost



Timescale



Wider benefits

None

n. Provide incentives to schools to provide placements for physics trainees

Gains

- An increase in the number of high-quality placements will increase the number of training places that ITE providers' can offer
- There will be less overlap between ITE and ECF mentoring

Similarly, given that there is a shortage of schools with well-staffed physics departments, it is hard for providers to find placements for their trainees. Therefore, we are recommending a nationally managed scheme to incentivise schools to provide placements in physics and other shortage subjects.

Pillar 3: Retraining

Recommendations to make the most of retraining

- 6. Turbocharge and intensify in-service retraining courses such as SKPT** o. Incentivise schools and teachers to take part in and complete a retraining programme p. Institute a means of enabling and supporting secondary specialisms across physics, computing and maths

6. Turbocharge and intensify in-service retraining courses such as SKPT

In a recent report for the IOP (and in their blog⁴) NFER estimate that about 25% of secondary schools in England do not have an in-field physics teacher^{xxviii} and this is often the case in deprived areas of the country. Currently the students in those schools are unlikely to progress to A-level physics (appendix 4) cutting off many opportunities for further study as well as impacting lifelong earning potential.

It is also true that it is hard for those schools to recruit a physics teacher. And there is evidence that, given the difficulty of recruiting a physics teacher and the high cost of advertising, many do not even advertise for one (instead advertising for a science teacher).

There is an effective, low-cost solution for these schools, that will help them and their students, and contribute to addressing the national shortage of physics teachers: retrain an existing out-of-field teacher of physics on an in-service retraining course.

A high-quality retraining course already exists: the Subject Knowledge for Physics Teaching (SKPT) programme, which was developed by the IOP and is currently delivered by the Ogden Trust on behalf of DfE. We are recommending that this course is intensified and potentially extended to also prepare some participants to teach A-level physics.

^{xxviii}Someone with a post-18 physics-related qualification.

Teachers



New Cost



Timescale



Wider benefits

None

o. Incentivise schools and teachers to take part in and complete a retraining programme

Gains

- By targeting schools without an existing physics specialist, SKPT generates a new physics specialist in a school that needs one
- The teacher is already established and has a proven capability and experience in general pedagogy, typically in another science subject
- Experienced teachers are more likely to remain in the profession for five years than a newly qualified teacher
- 200 retrained teachers effectively reduce the recruitment target for physics by about 280, when we factor in attrition of new teachers (see figure 13 on page 52)
- It costs less than recruiting and training a new physics teacher

The core offer of the Subject Knowledge for Physics Teaching (SKPT) programme adopts a blended learning approach with in-person and online elements. It comprises 6 modules, each of which can be taken individually and require 20 hours of professional learning. Currently, there is funding of £600 per module available to schools to cover costs and the IOP offers an optional Subject Knowledge Award at the end of each module.

SKPT is an effective programme; however, it faces some challenges. These include ensuring teachers get release to attend sessions and study for the course, encouraging teachers to complete all six modules, and finding the right schools with whom to work. To address those challenges and ensure at least 200 participants complete all six modules, we recommend that the programme is turbocharged by:

- Targeting schools in need of physics support – using data from NPD
- Fully funding schools to release teachers for the equivalent of half a day a week over a year i.e. 20 days
- Providing teachers with incentives to complete the course
- Funding the programme for at least three years at a time running across the academic year
- Subject-specific mentoring for retrained teachers
- Establishing a community of physics teacher educators for all those who lead the SKPT programme
- Establishing a nationally recognised certification for teachers completing the course
- Extending the programme to upskill teachers to teach A-level physics, once the GCSE programme is well established

Turbocharging the programme in this way will:

- Reduce the recruitment target for physics teachers by 280
- Improve the ability to target and market the programme
- Ensure buy-in from schools and enable them to release teachers to retrain
- Increase the number of participants completing all six modules
- Allow participants to develop a physics teacher identity, improve their self-efficacy in teaching physics and relieve workload
- Raise the status of the programme and give currency to the IOP's endorsed completion certificate
- Improve student outcomes in areas of disadvantage

Retraining is a cost-efficient way of generating new physics teachers. It is less expensive than recruiting a new teacher and it has the additional advantage that, by targeting schools without an existing physics teacher, it addresses the problem at the point of need. Retraining develops a new physics specialist, who is already a proven and experienced teacher, in a school that needs one. Furthermore, as we found in our modelling, these teachers are likely to stay in the profession longer than a newly qualified teacher. That is why, in our model, retraining 200 in-service teachers reduces the recruitment target by 280.

Background

A brief history of physics retraining courses

Over the past fifteen years, several significant retraining initiatives have been implemented across England, including the Science Additional Specialism Programme (SASP) and Subject Knowledge Enhancement Plus (SKE+)⁴⁷ that have led to the ongoing Subject Knowledge for Physics Teaching (SKPT)⁴⁸. A recent evidence review by Sheffield Hallam University highlights multiple benefits from these programmes, including enhanced subject knowledge and improved teacher retention⁴⁹.

The SASP physics programme (2009-2011) was a particularly comprehensive approach. It combined direct teaching, self-study, and observation of expert practice. Participants could earn formal recognition through a reflective assignment worth 60 university credits.

SHU recently reviewed the long-term effects of the SASP programme⁵⁰ which cultivated not only competence but also genuine enthusiasm for teaching physics.

The SASP model's success stems from several core elements: regularly scheduled sessions that schools could plan around, substantial funding that covered both programme and school costs, experienced facilitators with both subject expertise and teaching experience, and sustained engagement that allowed teachers to cycle between learning, practice, and reflection.

From SASP to SKPT

The current Subject Knowledge for Physics Teaching programme (SKPT) was developed by the IOP and is now led by the Ogden Trust on behalf of DfE as a retraining initiative for teachers of physics at Key Stage 3 and 4 in English state schools.

Incentivising completion of the course

We recommend that the existing Subject Knowledge Award (SKA) for SKPT is developed into a more formal certification or qualification that officially recognises physics teacher status. As things stand, there have been few participants who have completed all six modules and the SKA as there is no

incentive for them to do so and the SKA lacks currency with senior leaders compared to NPQs, for example.

Certification would improve participation via official, independent recognition for alumni as a specialist physics teacher. Teachers would then be added to the physics teacher register (discussed in proposal q) and, when it has been adapted, they should be added to the SWC (proposal g); and provided with a certificate that will help them to get a job as a physics (combined) specialist. By recognising their status of an additional specialism in physics, these teachers would contribute to (or offset) the government's recruitment target for physics.

Build on Knowledge Frameworks

Physics retraining should be organised around coherent knowledge frameworks that map key conceptual relationships, progression pathways, common misconceptions, and connections between mathematical representations and physical concepts. The IOP's existing frameworks provide a strong foundation for this approach¹⁵.

Mentoring for retrained teachers.

When the newly retrained teachers return to their schools as a physics specialist, we recommend that they have at least a year of subject specific support and that this community of practice is supported to provide sustainable peer-to-peer support. The mentoring provision would align well with the subject specific support provided through a reconfigured ECF programme (proposal d).

Retraining versus CPD

We are making a distinction between a retraining course and Continued Professional Development (CPD). As we discussed in Subjects Matter⁵¹, all teachers (including in-field teachers) should be entitled to and have access to high quality subject-specific CPD throughout their career. This is about treating them as professionals, supporting them with specific elements of their practice and helping them get better. Retraining courses (such as SKPT) are major interventions to give them a new specialism. That is, SKPT is not Continued Professional Development (CPD) in its purest sense; it is retraining. And, as such, it needs to be treated differently by government, schools and teachers.



Teachers



New Cost



Timescale



Wider benefits

None

p. Institute a means of enabling and supporting secondary specialisms across physics, computing and maths

Gains

- Teachers have the option to teach secondary specialisms that are within their comfort zone
- It will increase appeal and satisfaction for graduates of physics, maths and computing (increasing both recruitment and retention).
- It will improve quality of teaching and learning in these subjects.
- It will help address the shortage of computing teachers

Currently, most teachers of physics are expected to teach biology and chemistry as secondary subjects. However, in most cases, they have not studied biology beyond 16.

We also know that 20% of physics graduates who go into teaching choose to teach maths rather than physics.

In terms of experience up to and beyond 18, graduates in any of physics, maths and computing are more likely to have capabilities and interests in these three subjects than the combination of physics, biology and chemistry. As such, offering each of them as a secondary specialism for the other is more likely to appeal to – and be comfortable for – graduates in those subjects. Developing this combination is likely to improve job satisfaction for those graduates and result in improved retention and recruitment, as well as leading to better student outcomes.

Foundations

In this section, we make recommendations and proposals for systemic changes that are required to underpin the physics-specific proposals that make up the three pillars.

Recommendations to improve the foundations

7. Improve effectiveness and use of data and evidence

- q. Initiate and manage a register of specialist physics teachers, record Subject Knowledge Enhancement (SKE) courses, and formally recognised retraining courses in the School Workforce Census (SWC)
- r. Include progression figures and course destinations of 16-year-olds in the school dashboard
- s. Develop benchmarks and self-assessment tools for high-quality science departments
- t. Systematically collect data from school-level exit interviews
- 6. Simplify access to and provision of raw and pre-processed data from the National Pupil Database (NPD), School Workforce Census (SWC) and Longitudinal Educational Outcomes (LEO) database.

8. Review accountability measures so they work for the system as a whole

- v. Explore alternatives to inspection-based accountability as a means of driving improvement
- w. Reduce the amount and stakes of assessment by focusing on student need rather than school accountability

9. Make teaching more professional and rewarding

- x. Improve both support for and agency of teachers at appropriate times in their career
- y. Include an entitlement to work flexibly in contracts

7. Improve effectiveness and use of data and evidence

The National Pupil Database (NPD) and School Workforce Census (SWC), contain a wealth of data relating to student outcomes and some reasonable data on teacher qualification and deployment. However, there are barriers to making the best use of these data:

- The data contain important and severe gaps
- It has become extremely hard to access the data
- We have lost capacity in the system to provide quick analysis and look at implications

In this recommendation and its associated proposals, we suggest some simple changes that could greatly enhance the positive impact of the data in a cost-effective way.

Teachers



New Cost



Timescale



Wider benefits

Science

q. Initiate and manage a register of specialist physics teachers and record Subject Knowledge Enhancement (SKE) and formally recognised retraining courses in the School Workforce Census (SWC)

Gains

- Allows DfE and researchers to unambiguously identify specialist physics teachers
- Helps senior leaders identify and employ in-field and specialist physics teachers
- Motivates teachers to take a course and earn a secondary specialism
- Improves the accuracy and utility of the SWC for future workforce planning, including to schools and geographic areas under-resourced in physics education

There has been ongoing difficulty in identifying whether a teacher is a specialist in teaching physics (or any subject). Qualified Teacher Status does not have a subject attached to it; this is extremely rare amongst OECD countries. Furthermore, there is no record in the SWC of a teachers' proven ability. It records a teacher's degree and PGCE subject but not whether they have retrained in physics (either before or during their service).

We take the view that there are many routes to being or becoming a specialist physics teacher (page 19). However, the data available on teachers only allow us to measure the narrow definition of in-field – based on recorded post-18 qualifications related to physics. Even within this report, this over-simplification within the data limits the accuracy of what we know and necessitates clarifications about the definition that we use at different times.

In the long run, we recommend certification by a disciplinary professional body for being a specialist teacher in that discipline. Teachers should be able to hold certification in multiple subjects, provided they meet the criteria set by each relevant certifying organisation.

The IOP has written a framework for teaching physics¹⁵. This framework is intended as an addendum to the Teachers Standard to add detail to the requirement for teachers to “have good subject knowledge” (see *What are the qualities of an in-field physics teacher* on page 20). Additionally, the IOP is developing a certification process based on this framework to signify unambiguously specialist status for a teacher of physics – particularly someone who has been formally retrained.

Teachers



New Cost



Timescale



Wider benefits

Science

r. Include progression figures and course destinations of 16-year-olds in the school dashboard

Gains

- These data would provide a more powerful and nuanced view of student outcomes than using solely students' exam performance
- They provide an important measure of successful teaching: inspiring students to continue to study a particular subject
- They will drive teaching practices that are more rewarding and satisfying for teachers and their professional view of themselves
- They will drive pedagogy that results in deeper understanding and enjoyment of the subject
- They will encourage schools to recruit and deploy in-field teachers with the requisite skills to teach and inspire students in physics

In the current system of accountability, pre-eminence is given to exam results. This misses the important measure of the destinations of a school's 16-year-old students at a subject level. This is particularly hidden for 11–16 schools. The number of students progressing to A-level physics (or any subject) is a better indicator of the quality of teaching in that subject than raw grades, because it implies that the teaching was inspiring and deep – and it includes, by necessity, success in the exams.

Relying solely on exam results and the consequent focus of SLTs on those results both narrows the styles of teaching and shortens the time spent on acquiring new capabilities (see proposal w below). This can be demoralising for teachers.

By contrast, including progression rates as well as exam results will shift the balance of priorities towards providing deep understanding and teaching students in a way that gives them confidence and helps them identify with the subject. This will be more satisfying for both students and teachers.

Teachers



New Cost



Timescale



Wider benefits

Science

s. Develop benchmarks and self-assessment tools for high-quality science departments

Gains

- Encourages school leaders to make an effort to recruit specialist teachers and to deploy them to teach within their specialism
- Encourages teaching that focuses on progression as well as exam results

Under Recommendation 8, we discuss the importance of driving school improvement through collaborative and supportive advice at a subject level. As part of such a system, it would be helpful for schools, science department leads and science advisers to know how well their department is performing against some benchmarks, and to get a sense of how they might address any shortcomings (for example, progression rates to A-level physics and other post-16 courses), or a shortage of physics teachers.

The benchmarks would be part of a virtuous circle of proposals: a school will be incentivised to have a full complement of specialist teachers; if they cannot recruit, then they can retrain an existing teacher via SKPT (proposal o). As well as improving the experience and prospects of their own students, this will help to solve the national shortage (see *A virtuous circle based on benchmarks, retraining, and certification* on page 16)

Teachers



New Cost



Timescale



Wider benefits

Whole school

t. Systematically collect specific standard data from school-level exit interviews

Gains

- A large and valuable database of reasons for leaving teaching
- Better knowledge, at a national level, about the reasons people leave schools or leave teaching
- The ability to address common concerns in a system-wide way

Over 40,000 teachers leave the state sector every year. However, the recent DfE report – *The Factors Affecting Teacher Retention: A Qualitative Report*⁵² – is based on a survey of 80 teachers, and most academic analyses of the reasons for teachers leaving the profession are also based on surveys or polls.

Most schools conduct exit interviews. There is a wealth of untapped information about teachers' motivations in these interviews, which is not systematically collected. Additionally, there are currently no standard questions in exit interviews (to allow for comparable analysis of this large dataset). Given that so many teachers are employed in schools, it would seem propitious and advantageous to systematically collect and analyse the data from these exit interviews and include some standard questions.

Teachers



New Cost



Timescale



Wider benefits

Whole school

u. Simplify access to and provision of raw and preprocessed data from the National Pupil Database (NPD), SWC and Longitudinal Educational Outcomes (LEO) database

Gains

- Better understanding of the dynamics and influences within the system
- Improved evidence base for new and innovative interventions to improve student outcomes and teacher retention
- Encouraging and inspiring innovative and valuable investigations of the data from as many people as possible

The ONS and DfE hold data on pupils and teachers. The expectation is that most analysis is done by third parties. However, in our experience, the time and cost barriers have made it next to impossible to carry out quick or efficient analyses of the data. Even if the third party is an ONS-accredited researcher, it is prohibitively slow to get permission for a new use of data.

Even the most straightforward of projects requires forms and processes that can take up to a year to pass through. Much of the cost of doing any research is to cover the time it takes the accredited researcher to complete the paperwork.

Much of the analysis that would be carried out is for the benefit of the education system. Therefore, it is in the interest of the government to make it as easy as possible – within the bounds of data privacy – for researchers to access and analyse the data.

8. Review accountability measures so that they work for the system as a whole

There is a pair of related big issues that undermine our ability to retain and recruit teachers: Ofsted inspections and high-stakes exams. These combine to create an accountability system that is burdensome and off-putting to all teachers and those considering teaching – not just physics.

It will be impossible to address the teacher gap in physics (and other shortage subjects) without addressing these systemic issues that contribute to attrition across the board. We argue, as have others^{xxx}, that these systems are ineffective and cause damage, with an adverse effect on retention and recruitment.

As well as being harmful to the system as a whole, they are not particularly effective at achieving their primary purposes⁵³. And therefore, given their cost, there are serious questions to be asked about whether they represent good value for money. Although beyond the scope of this report and our costings, an overhaul could release considerable and valuable funds while improving the overall effectiveness of the education system.

However, within the scope of this report, the most important point is their effect on retention and recruitment. We will argue that by redesigning the approach to accountability, school improvement and student assessment, the Government could:

- Reduce disruption and increase the time available for teaching and learning by at least 20%⁷⁵
- More effectively drive improvements to schools and the quality of teaching and learning
- Improve teacher morale and reduce attrition
- Make teaching more attractive and improve recruitment
- Potentially save hundreds of millions of pounds on direct costs related to accountability measures

^{xxx}For example, ASCL in *The Future of Inspection*⁵⁴ and the NEU in *Beyond Ofsted: An inquiry into the future of school inspection*⁵⁵.

Teachers



New Cost



Timescale



Wider benefits

Whole school

v. Explore alternatives to inspection-based accountability as a means of driving improvement

Gains

Reducing judgmental inspections would:

- Increase teacher morale
- Improve the status and appeal of the teaching profession
- Reduce the culture of trepidation, liability and culpability in schools
- Encourage greater innovation and experimentation to improve teaching and learning

Using an alternative, more collaborative approach to driving improvement would:

- Enable more candid discussion and effective improvements
- Result in direct improvements to teaching and learning
- Engender an atmosphere of collaboration and support
- Potentially save (or better use) up to £200m of education funding

Solving all the issues relating to Ofsted inspections is a bigger task than can be fully dealt with in this report. However, not addressing them would be an omission because of the impact school inspections have on recruitment and retention by adversely affecting school culture, teacher morale, and teachers' sense of professionalism. These concerns go beyond physics. We note, therefore, that there are several organisations that are well placed to make the case for more detailed models of systemic reform – such as ASCL's *The Future of Inspection*⁵⁴ and the NEU's *Beyond Ofsted*⁵⁵.

As we laid out in our recent response to the DfE's enquiry⁵⁶, we strongly support the notion that schools need to be accountable and that parents and carers should feel their children are safe and being properly looked after. However, as the NEU points out, it is unhealthy for schools and their teachers to live under the shadow of looming inspections.

Therefore, we are adding our voice to the call to replace the existing system of inspection-based accountability and school improvement, so that it works in support of (not against) the education system's goals as a whole, especially those relating to recruiting and retraining teachers.

The system has lost the confidence of parents and carers⁵⁷; and of teachers. Teachers feel de-professionalised because schools expect every teacher to conform to standardised teaching schemes, lessons and strategies to avoid risk of upset in inspections. A poll of physics teachers found that more than half thought that inspections have an adverse effect on teacher workload and morale and 45% thought that teachers were leaving the profession because of Ofsted.

Is Ofsted burdensome on teachers?

In Beyond Ofsted⁵⁸, a survey of 6,708 teachers found that:

- 93% of teachers experienced high levels of personal stress during an inspection
- 93% agreed that inspection increased workload
- 84% disagreed with the suggestion that inspections empowered them
- 76% thought that inspections have a negative impact on retention
- 92% disagreed with the statement that Ofsted is a reliable and trusted arbiter of standards.

It should be noted that these are not the comments of the disaffected, as 81% of the survey participants were from Good or Outstanding schools.

We advocate a system in which some aspects of school activity (leadership, governance, probity and safeguarding) should require external inspection, whilst school improvement is driven directly through supportive visits by advisers – either within Multi-Academy Trusts or in a locality. The advisers would work at a teacher and department level in a collaborative way to help teachers and departments get better.

The principles underpinning inspection-based accountability should be that:

- It is at a high level in a school – concentrating on leadership, governance, probity, and safeguarding
- It is designed to provide reassurance to parents and carers about the safety of their children and that the leadership, ethos, and structures of the school allow for high quality teaching and learning; and to government about probity of the school governance and oversight
- Its audience are existing parents and carers and the government, rather than as a marketing tool for prospective students or their families

The principles for school improvement should be that:

- It is addressed directly rather than being driven by a fear of being shamed
- It is supported, at both a department and teacher level rather than at a whole-school level
- It is driven by networks of peers and advisers with expertise in that subject
- It is collaborative, supportive, and trust-based with no grades or shaming
- It puts schools at the heart of their improvement by giving them ownership of their improvement plan
- It focuses on developing departments and teaching by providing advice on how to improve
- It is ongoing rather than periodic and unexpected

Teachers



New Cost



Timescale



Wider benefits

Whole school

w. Reduce the amount and stakes of assessment by focusing on student need rather than school accountability

Gains

- Reduces the stress of teachers and students
- Improves teachers' faith in the system, their role within it and improves their self-efficacy
- Releases about a third of the time of a GCSE course for more learning rather than preparation for or sitting of exams
- Encourages deeper learning beyond what can be assessed in a written end-of-course exam
- Drives higher quality teaching and learning and makes teaching more purposeful and rewarding

The existing examination system is very costly with the state spending at least £500m per year on GCSEs and A-levels^{xxxi}. As with Ofsted, it is right to question whether it is providing value for money in terms of educational outcomes. A large secondary school will spend about £200,000 a year on exam entries, which could be used for other, more beneficial purposes, such as recruiting up to four additional members of teaching staff. Furthermore, reducing the stakes will make available considerable time that is currently devoted to coaching and preparing students for exams and then sitting them. This time could be used for teaching.

However, for the purposes of this report, we will focus on the mechanisms that result in high stakes exams having an adverse impact on teacher recruitment and retention.

These are detailed in the box on the next page. In summary, they add, unproductively and unnecessarily, to workload, stress, and a sense of de-professionalisation, and they reduce teachers' faith in the system and their role within it.

This sense is exacerbated by the fact that, being based solely on written exams, existing GCSE assessments are very narrow and mainly test short-term recall. It is hard to argue that these written exams assess, for example, a young person's capability to set up a practical in a science lab, or their ability to use reason and logic, work in a group, or critique an explanation.

We propose that the government should look to reduce the number of national exams, with some being scrapped altogether and others being replaced with different methods, many of which will be internal to the school, such as group work, practical activities, long-form written tasks, critique and argumentation, and so on. In this way, a broader range of student abilities can be measured, and teachers and students can spend more time working on developing those talents.

^{xxxi}Using average entry fees and total entries in England. This does not include costs of remarks.

This approach to assessment (and the effect it will have on teaching) will reduce teacher stress and workload, increase their satisfaction and sense of agency. All of which will have a positive effect on retention.

These approaches are used successfully in other high-performing jurisdictions; with some schools in England, such as Latymer (case study 3) are reducing the number of public exams their students take and manage their assessments at 16 internally.

The effect of high-stakes assessment system on teachers

The English education system tops the OECD league table for the number of tests its pupils take⁵⁹. It also has one of the highest rates of teacher attrition. The exam system contributes to this by:

- Adding to teachers' workload (some feel unnecessarily)⁶⁰
- Adding to their stress as they feel judged by the need for their students to perform well⁶¹
- Reducing their sense of agency and professionalism by having to focus so much on narrow forms of assessment
- Reducing their faith in teaching by reducing the quality of learning taking place⁶²
- Being pressured by senior managers to improve exam performance over other aspects of teaching and learning⁶³
- Reducing the time available for deep learning and teaching and learning new capabilities
- Being pressured to enter students for courses that will help with school data rather than serve the students' needs (The Workload challenge⁶⁴)
- Its hyper-focus on exams and exam technique which is dispiriting for teachers and has reduced their sense of agency – as well as increasing their levels of stress
- Built-in inequities, including, but not limited to, the use of costly tutors for those who can afford it

A survey by The Edge Foundation⁶⁵ in 2020 that found that, amongst other things:

- 85% of teachers said the school system would be fairer if schools could focus less on written exams and include alternative methods of assessment
- 92% agreed that the assessment system needs to recognise the full range of a young person's strengths and skills
- 84% believed that teachers should be trusted to assess their pupils against a set of criteria with marks checked for quality assurance

9. Make teaching more professional and rewarding

There is a severe shortage of physics graduates and, given their sought-after knowledge and skills, there is a lot of competition for them as they leave university. Since the Covid-19 pandemic, many employers have offered attractive new conditions of service, such as part-time working and working from home.

Meanwhile, teaching suffers from many ongoing structural challenges to working conditions: new and growing responsibilities, dilapidated buildings, cold classrooms and so on. Additionally, there is a sense (both within the profession and more broadly) that teaching is increasingly directed – i.e. it has become de-professionalised.

The result is that, to many graduates, teaching does not compare well with alternative professions in terms of long-term prospects, status, agency and flexible working conditions. This perception of teaching contributes both to the challenge of recruiting teachers and their high attrition rate.

It is worth noting that attrition is particularly high amongst career changers who already have experience of the world of work and are aware of the agency and conditions they have sacrificed by going into teaching.

In a survey of recent physics graduates who had considered teaching but chose not to go into it, we found that most agreed that workload (74%) and working conditions (60%) were influential in their decision not to become teachers.

Issue	Percentage of those who considered teaching citing as an influence on decision not to teach
Workload	92%
Value given to teachers by governments	94%
Having autonomy in their working life	91%
Working conditions	86%
Long-term salary potential	58%
Having to teach the other sciences	50%

Figure 19. Results of an IOP survey of recent (past 5 years) physics graduates; n=66. The survey is discussed in appendix 6.

Therefore, we are recommending that steps are taken to make teachers feel more professional, with increased agency and professional support; and that they are given entitlements to work flexibly within their contracts.

Teachers



New Cost



Timescale



Wider benefits

None

x. Improve both support and agency of teachers at appropriate times in their career

Gains

- Early career teachers feel properly supported and enhance their expertise and confidence, thereby improving their self-efficacy
- Experienced teachers have greater agency and feel valued for their expertise

Many experienced teachers (and potential returners) cite the lack of agency within teaching as a reason for not continuing in, or returning to, the profession. Given the high-stakes assessment at 16, schools are reluctant to encourage teachers to take risks. Teachers have become curriculum deliverers rather than curriculum makers⁶⁶. Indeed, the phrase ‘delivering a lesson’ predominates over ‘teaching a lesson’ in general school discourse. In many cases, lessons are ‘delivered’ using ready-made slideshow presentations from predefined or purchased schemes of work. This approach is disheartening, demoralising and de-professionalising for teachers, and contributes to them losing faith in their role.

The OECD Education GPS⁶⁷ for England in 2018 notes that “England has one of the lowest proportions of teachers who agree that they have control over determining course content (62%, rank 48/50)”.

While it is true that early career teachers may appreciate the support of a well-made scheme of work, it ought to be the case that experienced and trusted teachers are given more agency with what they teach. This links closely with the hyper-focus on rigorously defined exam specifications. This is particularly true in the sciences in which specifications are written as a long list of bullet points comprising declarative statements about physics. Often these lists (and the sequence in which they are written) are used as the basis and limit of what needs to be memorised without consideration for the deeper understanding that lies behind them.

Teachers



New Cost



Timescale



Wider benefits

Whole school

y. Include entitlement to work flexibly in contracts

Gains

- Teaching can compete with other occupations that offer flexible working
- Teachers feel trusted and professional

On the face of it, teaching does not lend itself to flexible working. However, it is feasible, and is being implemented successfully in some settings. In the DfE's 2022 survey on the Working Lives of Teachers⁶⁸, there was a correlation between flexible working and life satisfaction, with 44% of those who had high satisfaction having some form of flexible working. However, there were mixed views on whether school senior leadership teams (SLTs) enable flexible working, with only around a third of teachers (36%) believing their SLT to be supportive of flexible working. Therefore, we are recommending that it is a statutory entitlement and written into teachers' contracts by including it in the statutory School Teachers' Pay and Conditions Document and guidance on teachers' pay and conditions.

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Samantha Edmondson	Universal Quantum
Sarah Poore	University of Brighton
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