



**Improving the impact of teachers on
pupil achievement in the UK – interim
findings**

September 2011

Executive summary

This summary describes the interim findings of a project commissioned by the Sutton Trust to develop policy proposals for improving the effectiveness of teachers in England, with a particular focus on teachers serving disadvantaged pupils. The research evidence shows that improving the effectiveness of teachers would have a major impact on the performance of the country's schools; this work aims to develop specific, evidence-based proposals to achieve this.

The project includes an international literature review (based largely on major academic papers already published) as well as new research findings for the UK. This summary draws out some of the implications of the findings for workforce policies for the teaching profession in England¹, from teacher training to the retention and promotion of highly effective teachers. The work is being undertaken by a group of leading education economists: Richard Murphy in conjunction with Stephen Machin at the Centre for Economic Performance at the London School of Economics, with advice from Eric Hanushek, based at the Hoover Institution at Stanford University in the United States.

Teacher impacts

- The difference between a very effective teacher² and a poorly performing teacher³ is large. For example during one year with a very effective maths teacher, pupils gain 40% more in their learning than they would with a poorly performing maths teacher⁴.
- The effects of high-quality teaching are especially significant for pupils from disadvantaged backgrounds: over a school year, these pupils gain 1.5 years' worth of learning with very effective teachers, compared with 0.5 years with poorly performing teachers. In other words, for poor pupils the difference between a good teacher and a bad teacher is a whole year's learning.
- Bringing the lowest-performing⁵ 10% of teachers in the UK up to the average would greatly boost attainment and lead to a sharp improvement in the UK's international ranking. All other things equal, in 5 years the UK's rank amongst OECD countries would improve from 21st in Reading to as high as 7th, and from 22nd in Maths to as high as 12th (0.22 Standard Deviations); over 10 years (the period a child is in the UK school system before the PISA examinations⁶) the UK would improve its position to as high as 3rd in Reading, and as high as 5th in Maths (0.41 Standard Deviations).

¹ Although our policy recommendations focus on England, many of the measures we discuss could be effective elsewhere in the UK and overseas

² A 'very effective teacher' is a teacher in the 84th percentile according to value added scores, which are a measure of the impact a teacher has on pupils' progress. We chose the 84th percentile because it is one standard deviation above the mean. Around one in every six teachers would be at or above this level.

³ A 'poorly performing teacher' is a teacher in the 16th percentile according to value added scores. We chose the 16th percentile because it is one standard deviation below the mean. Around one in every six teachers would be at or below this level.

⁴ Aaronson, Barrow, and Sander, 2007, Rivkin et al. 2005 and Rockoff 2004, Slater, Davies and Burgess 2009

⁵ Throughout this paper, we refer to performance as measured by value added scores

⁶ And therefore the time it takes for any change to take full effect

- It is very difficult to predict how good a teacher will be without observing them in a classroom; paper qualifications and personal characteristics tell us very little. Gender, race, teaching experience, undergraduate university attended, advanced degrees, teacher certification and tenure explain less than 8% of teacher quality⁷.

Teacher policies

These two underlying facts – that the difference between good and bad teachers is very large and that effectiveness is very difficult to predict before teachers enter the classroom – have major implications for the way in which the labour market for teachers should operate. Specifically, these facts should change the way we think about selection into teaching, the nature of teacher training, the professional development of teachers, and the management of under-performing teachers.

Furthermore the review highlights many of the problems associated with using solely test performance data to evaluate the effectiveness of teachers. Even value added teacher performance measures have been shown to be unstable⁸ and contain potential biases⁹. Personal evaluations, where the mentor has no incentive to misreport, are found to be highly correlated to future pupil learning¹⁰. Many of the pay for performance programmes that use only test scores have found little signs of improvement¹¹. Personal evaluations also avoid other issues associated with using test scores in pay for performance programmes, such as teaching to the test, narrowing of the taught curriculum and focusing on the marginal pupils¹².

The review of research evidence suggests that the following policies have the potential to improve teacher effectiveness. During the next stage of the project we will seek feedback from experts and teachers to develop these further.

- Major reforms are needed to the performance and pay system for teachers, with assessment based on three core factors: improvement in results in the classroom, reviews by headteachers, and external appraisals. Other factors such as previous qualifications, previous experience, or years spent teaching should be given far less importance.
- A new fast-track graduate entry route into teaching should be piloted in disadvantaged schools with aspiring teachers assessed in a classroom - either in newly created summer schools for children at the most disadvantaged schools, or in the new cadre of teaching schools. Fast track teachers would receive extra pay incentives - perhaps £5k more than current starting salaries - after completing a year at school to gain Qualified Teaching Status and provided they continue to teach in a disadvantaged school.
- Teachers should be able to opt out of the standard promotion and pay system, and instead choose a more radical version which rewards high performers with extra pay and opportunities for faster career progression, but penalises under-performance. As well as improving the performance of these teachers, this would make the profession a more attractive option for talented graduates.

⁷Aaronson et al., 2007; 'teacher quality' refers to value added scores

⁸Koedel and Betts, 2007; find that 30% of teachers in the top quintile fall into the bottom quintile in the next year, whilst 31% who were in the bottom quintile move into the top 2 quintiles. Similar movements are found by Aaronson, Barrow, and Sander, 2007 and Ballou 2005.

⁹ Value added measures of individual teacher performance can be biased by school factors, non-random assignment to teachers and the scaling of tests.

¹⁰Rockoff and Speroni 2011, Rockoff et.al 2010

¹¹ Neal, 2011

¹²Koretz, 2002

- School heads should be required to submit an annual report to Governors detailing the performance of their staff under this new performance and pay system, including their plans for professional development of teachers. Governors and inspectors need to ask how well heads have used their powers to reward excellence and address under-performance at the school – and this would play a key part in assessing the head’s own performance and pay.

These recommendations chime with some of the proposals in the recent Government White Paper, *The Importance of Teaching*. In particular, we believe that making teaching more attractive to career changers, having trainee teachers spend more time in the classroom, and creating teaching schools to deliver initial and mid-career training would all go some way to address the challenges for the profession outlined here¹³.

However, we believe further reforms will be needed to attract more people to teaching, and to put in place effective mechanisms to select, reward, develop, and manage our teachers – mechanisms based on actual effectiveness in the classroom, rather than tenure or a well-polished CV.

¹³ See: <http://www.education.gov.uk/b0068570/the-importance-of-teaching>

Teacher impact

Improving the effectiveness of teachers would have a major impact on the performance of the country's schools, increasing the attainment of children across the education system. Teachers are by far the biggest resource in schools. Spending on teachers in 2009/2010 accounted for the majority of expenditure by schools, standing at £16.1bn (53% of school spending) with a further £3.9bn (13%) spent on support staff and £0.7bn (3%) spent on supply teachers (see appendix for full breakdown of spending)¹⁴.

There is a large body of research on how important teachers are to the academic outcomes of their pupils. The research finds that teachers are the most important factor within schools that policy makers can directly affect to improve student achievement¹⁵.

The most rigorous academic papers find consistent and significant results: having a very effective¹⁶, rather than an average teacher raises each pupil's attainment by a third of a GCSE grade (0.1-0.25 Standard Deviations)¹⁷. The GCSE gap between poor and non-poor students is 6.08 GCSE points. Assuming this was generated over 8 GCSE subjects, if the poor student had very effective teachers (75th percentile teachers) and the non poor student had underperforming teachers (25th percentile teachers), this would reduce the gap by half, or 3.4 points¹⁸.

The effect of having a very effective teacher as opposed to an average teacher is the same as the effect of reducing class size by ten students in Year 5 (ages 9-10) and thirteen or more students in Year 6(ages 10-11).¹⁹ One year with a very effective teacher adds 25-45% of an average school year to a pupil's math score performance²⁰. The effects of high-quality teaching are especially large for pupils from disadvantaged backgrounds, who gain an extra year's worth of learning under very effective teachers compared to poorly performing teachers^{21,22}.

The economic argument for improving the effectiveness of teachers is also strong. Hanushek uses a range of estimates of teacher effects on pupil test scores and the subsequent effect of test scores on earnings to calculate how much teachers of differing ability are worth in terms of future earnings for pupils and the economy as a whole²³. A teacher one standard deviation better than the average

¹⁴ Department for Education, 2009.

¹⁵ This encapsulates academic and non-academic achievement. Rivkin Hanushek and Kain 2005, Rockoff 2004

¹⁶ A 'very effective teacher' is a teacher in the 84th percentile according to value added scores, which are a measure of the impact a teacher has on pupils' results. We chose the 84th percentile because it is one standard deviation above the mean. Around one in every six teachers would be at or above this level.

¹⁷ Aaronson, Barrow and Sander 2007 (0.15-0.25), Rivkin Hanushek and Kain 2005 (Lower bound 0.11), Rockoff 2004 (0.10) Slater, Davies and Burgess 2009 (0.16-0.18)

¹⁸ Slater, Davies and Burgess 2009

¹⁹ Rivkin Hanushek and Kain 2005

²⁰ Aaronson, Barrow, and Sander, 2007

²¹ Hanushek, 1992

²² A 'poorly performing teacher' is a teacher in the 16th percentile according to value added scores. We chose the 16th percentile because it is one standard deviation below the mean. Around one in every six teachers would be at or below this level.

²³ Hanushek, 2011

teacher, with a class size of 30, generates annually over \$460,000 in present value²⁴ in terms of future student earnings.

We perform a parallel calculation for the UK using more conservative assumptions²⁵, and find that bringing a poorly performing teacher up to the average would increase the lifetime earnings of a single class of 30 by £240,000-£430,000 (in present value terms).

Figure 1: Impact on English classroom lifetime incomes by class size and teacher quality(compared with average teacher)

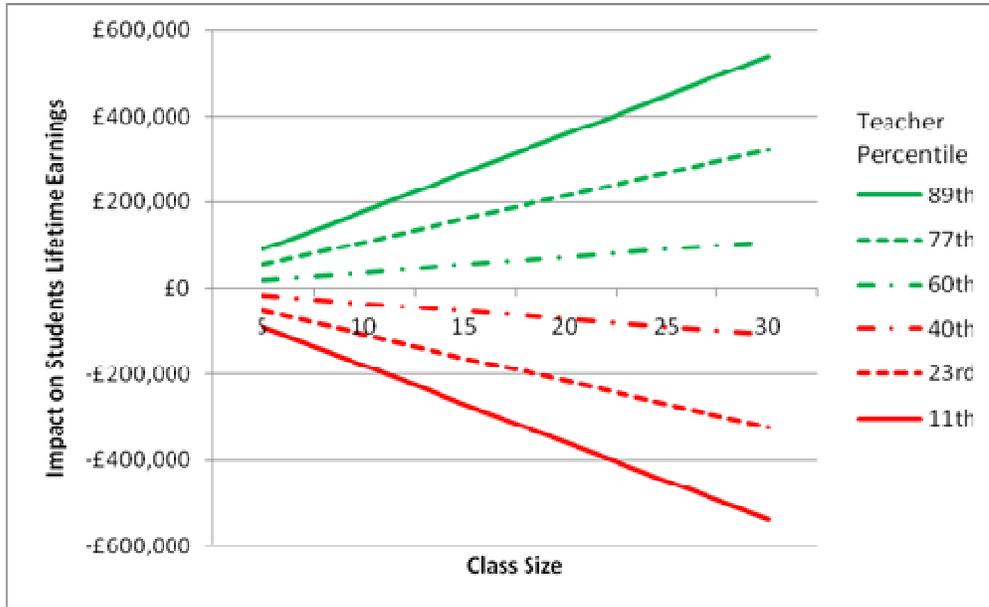


Figure 1 shows the impact that teachers of differing ability have on the lifetime earnings of classes of different size. The economic value of an effective teacher grows with larger classes, and the economic costs of having an ineffective teacher are substantial. This analysis assumes a 1 standard deviation increase in teacher quality increases student achievement by 0.2 standard deviations. (The percentiles refer to a teacher's positioning in terms of value added scores – in a group of 100, a teacher in the 23rd percentile would expect to have a higher value added score than 23 others, but a lower score than everyone else.)

Using the same magnitudes of teacher effectiveness, Hanushek (2011) considers what would be possible if we could truncate the bottom end of the teacher quality distribution, by training (or replacing) teachers to the level of a current average teacher. Improving the least effective 8% of teachers in the US would increase overall student achievement by 0.4 standard deviations, bringing American 15 year-olds into line with their Canadian peers, an improvement of 21 places in the

²⁴ Estimated future income is discounted at 3 percent per year to calculate the present value – this is done to reflect the fact that money today is worth more than money in the future

²⁵ Calculations use average income by age for all fulltime workers in the first quarter of 2010 from the Labour Force Survey. It is assumed that incomes rise 1 percent per year because of overall productivity improvements in the economy and that future incomes are discounted at 3 percent. It assumes: One standard deviation increase teacher quality translates into a 0.11 to 0.2 standard deviation increase in annual student improvement; the labour market return to one standard deviation higher achievement is 0.13 higher earnings; The depreciation rate on prior learning is 0.3.

international PISA rankings²⁶. Meanwhile, replacing 12% of the least effective teachers nationally would bring the US up to the level of Finland in the international rankings, an improvement of 26 places.

For this paper we have calculated the effects of bringing the bottom 10% of teachers in the UK up to the level of the average (10% equates to just over 40,000 teachers in England). Doing so could have a large effect on the UK's PISA test scores, greatly improving the UK's place in the international rankings (See Figure 2). All other things equal, in 5 years the UK's rank amongst OECD countries would improve from 21st in Reading to somewhere between 9th and 7th, and from 22nd in Maths to somewhere between 14th and 12th; over 10 years (the period a child is in the UK school system before the PISA examinations) the UK would improve its position to as high as 3rd in Reading, and as high as 5th in Maths (0.41 Standard Deviations).

Figure 2: Improvement in UK PISA test scores after 10 years, with the improvement of the least effective teachers

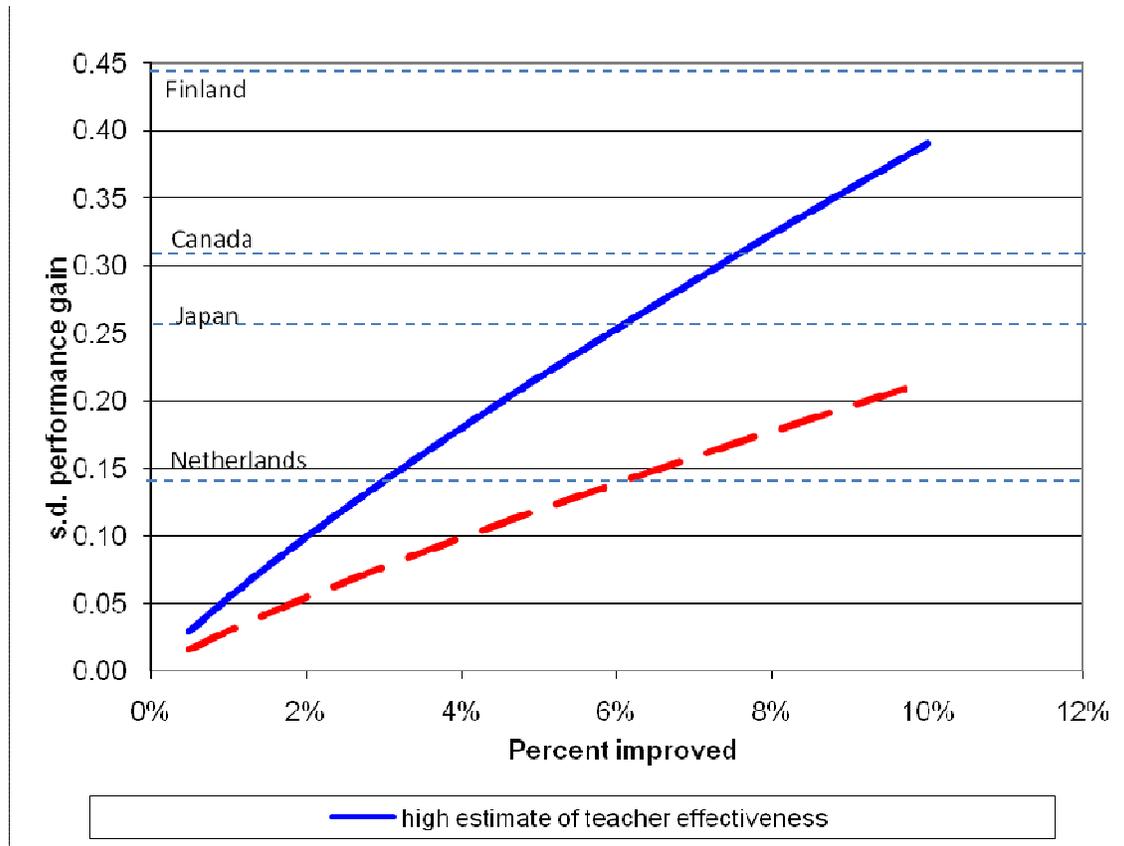


Figure 2 -These calculations use prior variance estimates to judge the impact of truncating the distribution. The high/low estimate of teacher effectiveness assumes one standard deviation in teacher effectiveness improves pupil outcomes by 0.2/0.11 standard deviations. The analysis applies to all teachers, so it can be thought of improving the effectiveness of teachers throughout the system. As such, it is assumed that the quality of teachers reinforces any gains that students make and the impacts of good instruction are cumulative over the 10 years of education prior to PISA testing. These

²⁶The international test scores used in the calculations are those produced by the OECD's Programme for International Student Assessment (PISA). These results are based on 2003 rankings.

variations come from maths performance on the 2009 PSIA tests (see summary data in Organisation for Economic Co-operation and Development, 2010). There are some variations in average country scores over time and across subjects, but these do not affect the calculations here. Authors calculations

From these calculations – which show only the effects of improving the least effective teachers – it is clear that increasing the effectiveness of all teachers would have a large and enduring effect on both the performance of schools and the economy as a whole.

We have assumed that the overall effectiveness of a teacher is comprised of two components – *teacher talent* and *teacher effort* – and examined the ways in which policymakers can improve teacher effectiveness by using policies that target these components. In this summary document we provide the initial policy conclusions with supporting evidence.

Teacher policies

Three pronged approach for teacher appraisals

Major reforms are needed to the performance and pay system for teachers, with assessment based on three core factors: improvement in results in the classroom, reviews by headteachers, and external appraisals. Other factors such as previous qualifications, previous experience, or years spent teaching should be given far less importance.

In the UK, great emphasis is placed on qualifications and tenure of teachers. To enter Initial Teacher Training (ITT) and receive Department for Education funding applicants must reach minimum qualification standards; once they have become teachers, their pay and prospects of promotion are determined to a great extent by higher qualifications and experience. This is despite the overwhelming evidence that shows that there is almost no link between teachers' prior education or experience and the achievement of their pupils (with the exception of the significant gains made in the first 3-5 years of a typical teaching career)²⁷. Even taking all the relevant information that we can gather without observing a teacher in the classroom (gender, race, teaching experience, undergraduate university attended, advanced degrees, teacher certification and current tenure), we can only explain less than 8% of teacher effectiveness²⁸.

The evidence suggests that qualifications and tenure should not play such a major role in determining a teacher's prospects. In other professions employees are rewarded according to how productive they are in the workplace. In the case of teachers this would mean relating employment and payment to a combination of factors – including value-added test scores showing pupil progress for teachers, but also judgement by expert peers, made up of both headteacher appraisals and assessment by external teachers.

One of the primary goals of a teacher is to improve the academic performance of his or her pupils. In the past it was assumed that this could be measured easily using test scores, but recent research has revealed several shortcomings of this approach. Value added measures of teacher effectiveness, which assess progression rather than just the absolute level of attainment, have faced criticism in terms of their validity, stability and precision²⁹. Despite these issues, these value added measures can be significantly improved if they are averaged over multiple years, and make good indicators of effectiveness.³⁰ However evaluating performance according to specific targets may encourage teachers to focus on 'gaming' the system – for example by focussing only on particular pupils or 'teaching to the test' – rather than on educating their pupils in the true sense³¹.

The other way to assess teaching ability is through personal evaluations. These can be informal, with impressions of teaching ability being formed over time by a head of the school or head of department. The advantage of this method is that it is harder for the teacher to manipulate, as the

²⁷ Hanushek, 2003

²⁸ Aaronson et al., 2007

²⁹ Ballou, D. 2009, Goldhaber D. and M. Hansen, 2010, Rothstein, J. 2009, 2010

³⁰ Kane, T.J., D. Staiger, 2008, Rockoff and Speroni, 2010

³¹ Koretz, 2002, Neal 2010, 2011

evaluation would have less specific targets and also include non-academic components. The drawbacks of this approach are that it may be costly to implement and subject to the personal biases of school heads. However many schools already have internal evaluation systems of teacher performance in place, in the form of Performance Management. Moreover some schools currently have independent external high performing teachers, come in to evaluate practicing teachers. To reduce the scope for personal biases heads could be incentivised into rewarding high performing teachers by relating their pay to overall test score gains made by pupils.

Appraisals and measured performance in the classroom have been found to be highly correlated: teachers with high value added tend to receive good evaluations from heads³². Therefore there is a strong argument for measuring teachers' performance using a combination of these two, with each approach compensating for the shortcomings of the other, but also incorporating a third element – external teacher appraisals.

Fast track entry route into teaching

A new fast-track graduate entry route into teaching should be piloted in disadvantaged schools with aspiring teachers assessed in a classroom - either in newly created summer schools for children at the most disadvantaged schools, or in the new cadre of teaching schools. Fast track teachers would receive extra pay incentives - perhaps £5k more than current starting salaries - after completing a year at school to gain Qualified Teaching Status and provided they continue to teach in a disadvantaged school.

The evidence suggests that it is very difficult to predict who will make a good teacher according to their characteristics on paper³³. Therefore for initial teacher training it is unclear what minimum qualification standards should be put in place. However, some research shows that personal evaluations of new trainees based on an interview and a mock classroom interaction are very good indicators of future teacher quality³⁴. This approach could be used to identify unsuitable candidates and keep trainee numbers and hence the cost of training down.

As stated before, the classroom is the best place to evaluate a teacher's effectiveness, which suggests the award of QTS (Qualified Teacher Status) should be based more on classroom evaluations and pupil value-added measures over an extended period of time.

Furthermore there is reason to believe that the selection process should be toughened. Countries that traditionally perform well in international league tables often have high failure rates amongst trainee teachers. In Singapore, 1 in 6 applicants successfully becomes a teacher and in Finland only 1 in 10³⁵. This large failure rate may put off applicants if there are large upfront costs to entering the selection process, such as certification (which has shown little beneficial effects on teacher quality in itself). Therefore any such costs should be removed where possible, such as being paid a salary during the training period alongside a good starting salary.

There is a lot of potential for increasing the use of in-the-field evaluation of trainee teachers. Of the 40,000 new recruits into ITT in 2009/10, only 6,500 (16%) took employment-based courses (See table 2); this increases to 8,300 (21%) when including School Centred Initial Teacher Training (SCITT)

³²Harris and Sass, 2009; Rockoff and Speroni, 2010; Tyler, Taylor, Kane, and Wooten, 2010

³³Aaronson et al., 2007

³⁴Rockoff and Speroni (2011)

³⁵McKinsey 2007- Page 17, Exhibit 7 and 8

courses (which are college-based courses but with a significant amount of time spent in the classroom). The vast majority of those on the employment-based route are participating in the Graduate Teacher Programme (79%), which was “designed to offer a high-quality and cost-effective route into the teaching profession for suitable graduates who do not want to follow a traditional pre-service route” (TTA, 1996:1)³⁶ (See Appendix Table 2). They provide a direct route into teaching, where salaries are paid (£15,000-£26,000) from the beginning of the training, which has proved to be appealing to young professionals – demand for places has consistently exceeded supply. A small but growing route into teaching is Teach First, representing 1.2% of new recruits to teacher training annually. Teach First is a charity run programme, who select and train in six weeks, high achieving graduates and places them in schools in ‘challenging circumstances’³⁷ for a period of two years. Little empirical research has been done on the impact of Teach First trainees, but what has been done has found that these trainees generally scored as well as other more experienced teachers and headteachers were positive about the programme. The equivalent programme in America has been more heavily researched and found that these trainees performed as well traditional teachers when accounting for experience³⁸.

We believe a new fast track entry route into teaching for graduates could be piloted alongside these existing routes with aspiring teachers assessed on their teaching in a classroom environment - either in newly created summer schools for children based at the most disadvantaged schools, or in the newly established cadre of teaching schools. Fast track teachers would receive extra pay incentives - perhaps £5k more than current starting salaries - after completing a year in one of the schools to gain Qualified Teaching Status.

High stakes option for teachers

Teachers should be able to opt out of the standard promotion and pay system, and instead choose a more radical version which rewards high performers with extra pay and opportunities for faster career progression, but penalises under-performance. As well as improving the performance of these teachers, this would make the profession a more attractive option for talented graduates.

If we aim to produce large numbers of qualified teachers through a highly selective process, we will need to attract very large numbers of applicants in the first instance. Clearly we could boost demand for places by increasing teacher salaries³⁹ or improving working conditions, for example by reducing overtime. However increasing teacher pay by itself will not improve pupil outcomes⁴⁰. The studies repeatedly show that large salary increases have done nothing to improve the quality of American teachers; the argument that we should just “pay teachers more” does not work.

The problem is that raising salaries will make teaching more appealing to all, regardless of whether they have the potential to do the job well. The best that policymakers can hope for is that increasing basic pay attracts high quality applicants who might otherwise have gone elsewhere; the key is that there should be selection mechanisms in place to distinguish between high- and low-potential applicants. Increasing the non-pecuniary benefits of teaching would raise similar issues.

³⁶There is also the Registered Teacher Programme is the parallel route for non-graduates.

³⁷Challenging circumstances’ were defined as, less than 25% of pupils receiving 5 A*-Cs (including maths and English) and/or where at least 30% of the pupils are eligible for free school meals.

³⁸Boyd, Grossman, Lankford, Loeb,&Wyckoff,2006; Kane, Rockoff & Staiger, 2008

³⁹Dolton 1990, 2007

⁴⁰Hanushek 1986, Betts 1995, Grogger 1996, Ballou and Podgursky 1997. Ballou and Podgursky, 1997.

Higher wages are also important for retaining good teachers. One study found that the likelihood of a teacher leaving the profession is closely related to relative wages⁴¹. The researchers estimate the elasticity of leaving a teaching job with respect to relative wages to be about –1.5, meaning an increase in teacher relative teacher wages of 10% would reduce the quit rate by 15%.

We believe that if teachers were given the option of a more flexible promotion and pay system, it would have the potential to attract and retain more high quality applicants into the profession.

Performance and professional development report

School heads should be required to submit an annual report to Governors detailing the performance of their staff under this new performance and pay system, including their plans for professional development of teachers. Governors and inspectors need to ask how well they have used their powers to reward excellence and address under-performance at the school.

School heads should be given a variety of options to manage struggling teachers. Initially, poor performance should be addressed through professional development and support. Research on professional development suggests that the right kind of approach can increase teacher quality significantly⁴².

Heads should be encouraged to use their powers to prescribe specific training programmes for struggling teachers and the range of training resources should be expanded so that teachers receive the support they need to improve. In particular, schools should seek to develop a culture of feedback and best-practice sharing amongst teachers, and the teaching schools proposed in the recent White Paper should be required to develop mid-career training courses to address common problems highlighted in teacher evaluations.

Where struggling teachers fail to improve over successive years, dismissal should also be considered. A recent survey commissioned by the Sutton Trust showed that the majority of senior teachers believe that there is not enough freedom for them to dismiss poorly performing teachers⁴³, although other surveys suggest that part of the problem is that head teachers believe they need permission to do things that are already within their power.

Other research evidence suggests that giving administrators more freedom to dismiss teachers who they feel are underperforming would increase pupil performance. Using a policy change in Chicago that allowed principals to dismiss probationary teachers without need for documentation or a court hearing, one study found that principals were significantly more likely to dismiss teachers with low value added scores or poor evaluations⁴⁴. A further study showed that training headmasters in value added measures and providing them with the appropriate data increased the probability that they would dismiss teachers with low value added estimates⁴⁵. The research also found that schools which had dismissed teachers went on to improve more quickly than schools which had not.

⁴¹ Dolton and van der Klaauw (1999)

⁴² Taylor and Tyler (2011)

⁴³ Nearly three out of four headteachers and senior teachers believe there is not enough freedom for schools to dismiss poorly performing teachers in the survey carried out by NFER.

⁴⁴ Jacob (2010)

⁴⁵ Rockoff et.al (2010)

References

- Aaronson, D., L. Barrow, and W. Sander (2007) "Teachers and student achievement in the Chicago public high schools", *Journal of Labor Economics*, 25(1), 95–135.
- Ballou, D. (2009) "Test scaling and value-added measurement" *Education Finance and Policy* 4 (4): 351–83.
- Ballou, D. and M. Podgursky (1997) "Teacher Pay and Teacher Quality." *W.E. Upjohn Institute for Employment Research*, Kalamazoo, MI.
- Betts, J. (1995) 'Does school quality matter? Evidence from the National Longitudinal Survey of Youth', *Review of Economics and Statistics*, 77, 231–47
- Boyd, D., Grossman, P., Lankford, H., Loeb, S., and Wyckoff, J (2005). How reduced barriers to entry into teaching changes the teacher workforce and affects student achievement National Bureau of Economic Research working paper 11844, Cambridge.
- Clotfelter C. T. H.F. Ladd J.L. Vigdor (2006) "Teacher-Student Matching and the Assessment of Teacher Effectiveness" *NBER Working Paper* 11936 , <http://www.nber.org/papers/w11936>
- Dolton, P. (1990). 'The economics of UK teacher supply', *Economic Journal*, 100: 91–104
- Department of Education (2009) "Education and Training Statistics for the United Kingdom: 2009
- Dolton, P. (2007) 'Recruiting and retaining teachers in the UK: An analysis of graduate occupation choice from the 1960s to the 1990s' *Economica*, 74, 69–96
- Dolton, P. and W. van der Klaauw (1999) 'The turnover of teachers: A competing risks explanation.' *Review of Economics and Statistics*, 81(3): 543–50.
- Goldhaber D. and M. Hansen (2010) "Using Performance on the Job to Inform Teacher Tenure Decisions." *American Economic Review: Papers and Proceedings* 100 (2) (2010): 250–255
- Goodman, S, and L. Turner (2010) "Teacher Incentive Pay and Educational Outcomes: Evidence from the NYC Bonus Program", Program on Education Policy and Governance Working Papers Series, PEPG 10-07
- Hanushek, E. (1986) 'The economics of schooling: Production and efficiency in public schools.' *Journal of Economic Literature*, 24(3):1141–77.
- Hanushek E.A. (1992) "The trade-off between child quantity and quality" *Journal of Political Economy* 100, no.1 (February):84-117
- Hanushek, E.A (2006) "School Resources" *Handbook of the Economics of Education*, Volume 2 Chapter 14, DOI: 10.1016/S1574-0692(06)02014-9
- Hanushek, E.A (2011) "The economic value of higher teacher quality" *Economics of Education Review*, doi:10.1016/j.econedurev.2010.12.006
- Hanushek, E.A and L.Woessmann (2011) "How much do educational outcomes matter in the OECD" *Economic Policy*, no. 67 (July): 1-65.

- Harris, D. N., and T. R. Sass (2007) "Teacher Training, Teacher Quality and Student Achievement?" *Calder Center Working Paper 3*
- Harris, D. N., and T. R. Sass (2009) "What Makes for a Good Teacher and Who Can Tell?" *Calder Center Working Paper 30*.
- Jacob, B. A. 2010. "Do Principals Fire the Worst Teachers?" *NBER Working Paper 15715*.
- Kane, T.J., D. Staiger (2008) "Estimating Teacher Impacts on Student Achievement: An Experimental Evaluation" *NBER Working Paper 14607*
- Kane, T.J., J.E. Rockoff, and D.O. Staiger (2008) "What does certification tell us about teacher effectiveness? Evidence from New York City" *Economics of Education Review 27*, 615–631
- Koretz, Daniel M. (2002) "Limitations in the Use of Achievement Tests as Measures of Educators' Productivity." *Journal of Human Resources 37:4* 752-777
- McKinsey (2007) "How the best performing schools come out on top." *McKinsey*, September
- Neal, D. (2010) "Aiming for Efficiency Rather than Proficiency." *Journal of Economic Perspectives* Volume 24, Number 3—Summer 2010—Pp 119–132
- Neal, D. (2011) "The Design of Performance Pay in Education." *Handbook of the Economics of Education*, Vol 4 Edited E.A.Hanushek, S.J.Machin and L.Wossmann, North Holland
- Rivkin, S. G., E. A. Hanushek and J. F. Kain (2005) "Teachers, Schools and Academic Achievement." *Econometrica*, 73(2), 417-458.
- Rockoff, J.E. (2004) "The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data." *American Economic Review Papers and Proceedings*, 94(2): 247-252.
- Rockoff, J.E., and C. Spironi(2010) "Subjective and Objective Evaluations of Teacher Effectiveness." *American Economic Review*, 100(2): 261–66. DOI:10.1257/aer.100.2.261
- Rockoff, J.E., D.O.Staiger, Kane,T.J., E.S Taylor, (2010) "Information and Employee Evaluation: Evidence from a Randomized Intervention in Public Schools", NBER Working Paper No. 16240, July 2010
- Rothstein, J. (2009) "Student sorting and bias in value-added estimation: Selection on observables and unobservables." *Education Finance and Policy 4* (4): 537–71.
- Rothstein, J. (2010) "Teacher Quality in Educational Production: Tracking, Decay, and Student Achievement." *The Quarterly Journal of Economics*, 125(1): 175-214doi:10.1162/qjec.2010.125.1.175
- Slater H., N.Davies and S.Burgess (2009) "Do Teachers Matter? Measuring the variation in teacher effectiveness in England" *CMPO Working Paper 09/212*
- Smith, J., J. Brooks-Gunn, and P. Klebanov (1997) "The Consequences of Living in Poverty on Young Children's Cognitive Development." in *Consequences of Growing Up Poor*, edited by Greg

Springer, M.G., Ballou, D., Hamilton, L., Le, V., Lockwood, J.R., McCafrey, D., Pepper, M., and Stecher, B. (2010) "Teacher Pay for Performance: Experimental Evidence from the Project on Incentives in Teaching," Nashville, TN: National Center on Performance Incentives at Vanderbilt University.

Stecher, Brian M. (2002) "Consequences of Large-Scale, High-Stakes Testing on School and Classroom Practice," in Hamilton, Laura S., Stecher, M. Brian and Stephen P. Klein (Ed.) Making Sense of Test-Based Accountability in Education, National Science Foundation

Taylor, E.S., Tyler, J. H. (2011) "The Effect of Evaluation on Performance: Evidence from Longitudinal Student Achievement Data of Mid-Career Teachers", NBER working paper #16877.

Tyler, J.H., E.S. Taylor, T.J.Kane, and A.L. Wooten. 2010. "Using Student Performance Data to Identify Effective Classroom Practices." *American Economic Review*, 100(2): 256–60.

U.S. Department of Education, 2000 "NAEP 1999 Long-Term Summary Data"

Appendix: Table 1: Expenditure on Teachers and Support Staff 2009-10 (£bn)

School Type	Total Expenditure on teachers	Total Expenditure on supply teachers	Total Expenditure on educational support	Total Gross Revenue Expenditure
Primary	£7.2	£0.5	£2.3	£14.4
	50%	4%	16%	
Secondary	£8.9	£0.3	£1.6	£15.9
	56%	2%	10%	
Total	£16.1	£0.8	£3.9	£30.2
	53%	3%	13%	

Source Consistent Financial Reporting (CFR) Data 2009-10

Table 2: Recruitment to Initial Teacher Training in England

Year	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Grand Total ITT	40,740	42,010	40,920	39,830	38,360	37,810	39,500
College Based Courses							
Total	33,930	34,520	33,700	32,460	31,350	31,220	33,040
Undergraduate	7,850	8,250	8,230	7,960	7,620	7,690	7,920
Postgraduate	25,780	25,870	25,050	24,510	23,730	23,530	25,110
<i>of which school centred</i>	<i>1,540</i>	<i>1,740</i>	<i>1,760</i>	<i>1,730</i>	<i>1,650</i>	<i>1,650</i>	<i>1,810</i>
Fast Track	300	400	420	0	0	0	0
Employment Based Courses							
Total	6,810	7,490	7,220	7,370	7,010	6,590	6,460
GTP	5,230	5,470	5,490	5,360	5,300	5,120	5,110
RTP	210	280	220	180	150	120	120
OTTP	1,220	1,560	1,330	1,580	1,300	980	750
Teach First	160	180	170	250	260	370	480

Note: GTP – Graduate Teacher Programme, RTP – Registered Teacher Programme, OTTP-Overseas

Appendix: How the PISA figures were attained.

We calculate how the performance of the students would be improved under different assumptions of teacher effectiveness whilst varying the proportion to be improved upon. We take a one standard deviation increase in teacher effectiveness to cause a 0.11 standard deviation increase in pupil scores as a lower bound and 0.2 increase as the upper bound. Assuming the distribution of teacher effectiveness to be normally distributed (0,1) we calculate the mean of the distribution after the bottom x% has been truncated (with the bottom 10% removed the new mean is 0.195). This is then multiplied by the effectiveness of teachers to obtain the gains in student achievement in standard deviations over the whole country in one year. Removing the bottom 10% increases student achievement by 0.021-0.039 standard deviations, using the upper and lower bounds. As this analysis applies to all teachers, so it can be thought of improving the effectiveness of teachers throughout the system. As such, it is assumed that the quality of teachers reinforces any gains that students make and the impacts of good instruction are not assumed to die out as the student progresses to a higher grade. Instead later teachers build upon the stronger average achievement of all children and set their instruction accordingly. Therefore this effect is then multiplied by the number of year that the student would be under the supervision of this truncated distribution of teachers (10years). Thereby improving student grades by 0.214-0.39 of a standard deviation.

These gains are then converted into improvements in the UKs PISA scores, using the current mean and standard deviations in performance (Maths:492, 87 ; Reading: 494, 95; Science: 514, 99).