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Do trainee teachers harm pupil attainment? Isolating the effect of pre-service teachers on contemporaneous pupil performance in 'high-stakes' tests

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The prevalence of 'pre-service' or 'trainee' teachers in schools is rising in England, driven by the expansion of school-led routes to qualified teacher status and increasing demand for newly qualified teachers. This may have important implications for schools, which have historically been concerned with the impact of trainee teachers on their pupils' attainment. There are, however, confounding factors which affect both the decision to host a trainee teacher and pupil attainment. We empirically model the impact of trainee teachers on contemporaneous pupil attainment in 'high-stakes' exams, exploiting unique data combining national administrative data on pupil test scores with a survey of schools' involvement with initial teacher training over multiple academic years. We use school fixed effects to account for time-invariant school factors which may determine both schools' teacher training decisions and pupil attainment. Counter to schools' concerns, we find that pupil attainment in high-stakes assessments, on average, is not significantly affected by the number of trainee teachers. This is an important empirical finding, as it suggests that the rapid expansion of school-led teacher training is not likely to have a detrimental effect on pupil attainment in England, conditional on the set of schools that choose to engage with initial teacher training remaining similar: trainee teachers may still affect pupil attainment in schools that do not currently participate in initial teacher training, as these schools are typically more constrained.

Keywords: pupil attainment; trainee teachers

Introduction

There is consistent evidence that teacher effectiveness improves with experience, particularly in the first few years of teaching (Rivkin *et al.*, 2005; Kane *et al.*, 2008; Clotfelter *et al.*, 2010). It is therefore reasonable to hypothesise that 'pre-service' or 'trainee' teachers, with little or no teaching experience, are less effective than newly qualified and more experienced teachers. Indeed, Clotfelter *et al.* (2010) find that there is a significant positive relationship between teachers' certification and pupil achievement. This is consistent with the widespread reports from schools that the possible negative effect of trainee teachers on pupil attainment is a large barrier to

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participation with initial teacher training (ITT) in England (Brooks, 2000).[1] That said, some schools report benefits from being involved with ITT which might increase pupil attainment, such as trainees bringing fresh teaching ideas, increasing staff capacity and contributing to continued professional development for existing teachers (Allen *et al.*, 2014). These positive factors may offset or even outweigh the negative implications of involvement with ITT, such as pupils being taught by trainee teachers with less experience and the time diverted from pupils to trainee teachers by their mentors and other colleagues. Understanding the potential impact of trainees is of immense policy importance in England, with the number of trainee teachers in schools growing rapidly to meet increasing demand for newly qualified teachers and as more schools adopt school-led models of ITT (encouraged by government policy), which increase the time trainees spend in schools.

Our research question addresses this empirical question of whether the number of trainee teachers within a school or department significantly affects pupil attainment in 'high-stakes' assessments. We provide the first evidence for England (and to our knowledge across countries) based on rich administrative pupil-level data linked to survey information about the presence of trainee teachers and accounting comprehensively for school characteristics that influence both pupil attainment and the decision to host a trainee. The results are that, counter to schools' concerns, pupil attainment in high-stakes assessments is not significantly reduced by the number of trainee teachers, on average. This is an interesting finding in the context of schools' stated concerns about taking trainee teachers, which include the detriment to pupil attainment. The implication is that pupil attainment in high-stakes tests will be unaffected by an increasing number of trainee teachers in schools. These findings are generalisable only to schools with similar characteristics to those currently engaged in ITT and, as such, expansion to schools with less capacity to host a trainee teacher, for example, could still reduce pupil attainment.

These findings contribute to the relatively little academic research on the impact of ITT on pupils. The existing research can be classified as perspectives of qualified teachers or quantitative estimates of the impact on pupil attainment. For the former, Brooks (2000) studies the impact of school-based ITT on pupils from the perspective of teachers, classified into four groups: head teachers, school-based subject mentors, professional mentors and classroom teachers. The quantitative part of this study sampled 800 teachers across these groups in 200 secondary schools throughout England and Wales, from 16 higher education institutions (with a response rate of 51%). Using a five-point Likert scale ranging from 'greatly increased' to 'greatly decreased', Brooks finds that most teachers reported 'no overall impact' of trainee teachers on four areas questioned: class discipline, pupil motivation, curriculum continuity and school status. There were differences across groups of teachers, however, with classroom teachers having a 'consistently more negative' view than other groups. For example, 23% of the teachers reported 'decreased' pupil motivation, compared with 15% of the subject mentors, 4% of the professional mentors and 7% of the head teachers. Around a quarter of classroom teachers reported a negative impact on class discipline, pupil motivation and curriculum continuity, and that pupils were the main bearers of the costs of involvement with ITT. In contrast, head teachers were most likely to report that 'the school as a whole' was the main bearer of the costs. The

qualitative findings of Brooks (2000) come from 24 semi-structured interviews across eight schools from four higher education institutions. These findings illustrate the benefits for pupils of the presence of trainee teachers, which counteract some of the costs. These benefits are the focus and preparation afforded to trainee teachers with no other responsibilities, fresh approaches and innovative materials in the classroom, assistance with extracurricular activities and reductions in the pupil-to-teacher ratio. The qualitative findings from Brooks (2000) also make clear that the costs to schools are influenced by the organisation of the school (with more efficient schools having lower costs) and the quality of the trainee.

Turning to the quantitative impact of trainee teachers on pupil attainment, Hurd (2008) investigates the relationship between the number of trainee teachers per school and average pupil attainment using historical Office for Standards in Education (Ofsted) data from the 958 schools inspected between 2000 and 2003 with complete data. Computing the correlation between the number of trainees and school-level attainment, conditional on observable school characteristics,[2] Hurd finds that there is no association between the number of trainee teachers and average pupil attainment at the end of compulsory (secondary) schooling or optional A-level qualifications, but that attainment at the end of Key Stage 3 (when pupils are aged 13/14) is positively affected by large numbers of trainees being present in the school. Hurd hypothesises that this is because this age group has the largest exposure to trainee teachers. There is a very small depressing effect (not statistically significantly different from zero) for schools with small numbers of trainees (below around 25). This was found using a quadratic specification for the number of trainees, justified by the theoretical prediction that the effect of the number of trainee teachers is non-linear. Similarly, Hurd *et al.* (2007) find that, conditional on school-level characteristics, there is no effect of trainee teachers on test scores at the end of primary school (Key Stage 2).

Allen and Allnutt (2017) identify the impact of Teach First participants on school and departmental exam performance by comparing schools that have Teach First participants with a suitable control group. The preferred control group is found using propensity score matching from a set of potential control schools from the same region that recruit Teach First participants at some point in the future and so have similar observable and unobservable characteristics. This matching design is combined with a difference-in-difference estimator to remove the effect of any unobserved time-invariant differences between Teach First and matched control-group schools. Allen and Allnutt find no impact of Teach First during the first year of Teach First participation (when the first cohort of trainees are in training) and a positive impact in the subsequent two years. This finding is generalisable to schools that choose to engage with Teach First, all of which serve disadvantaged communities and, in general, are likely to experience more severe recruitment and retention difficulties than the typical school.

Our article extends the existing research in two ways. First, compared with Allen and Allnutt (2017), we estimate the average effect of all trainee routes on a more generalisable set of schools. Second, in comparison with Hurd (2008), we account for all school characteristics that might affect pupil attainment and the decision to host a trainee teacher. This overcomes the issue that initially high-performing schools select into hosting trainee teachers, which causes omitted variable bias for estimates of the

effect of trainee teachers on pupil attainment if not accounted for. Hurd (2008) states this identification problem: 'Are student outcomes improved by the presence of trainee teachers or are trainees allocated to schools with high student outcomes?' We largely overcome this problem by accounting for all time-invariant characteristics of schools, including size and quality, through school fixed effects and therefore provide the most robust evidence to date on the quantitative effect of trainee teachers on contemporaneous pupil attainment.

Background

Since September 1994, trainee teachers in England (across all routes into teaching) spend at least three-quarters of their course time in schools (Department for Education, 1992). More recently, the government in England has promoted school-led routes to qualified teacher status (QTS), with the creation and subsequent expansion of School Direct. This route and its predecessor, the graduate teacher programme (GTP), together with school-centred initial teacher training (SCITT), place more emphasis on schools designing and leading ITT courses, as well as recruitment, which places more demands on schools' time. These school-led routes have increased rapidly because of the introduction of School Direct in 2012/13 and its expansion in 2013/14. In 2012/13, school-led routes accounted for around 20% of trainee teachers; by 2015/16, this had grown to 60%. This change has led to renewed research and policy focus on the effects of pre-service teachers on the school environment and pupil attainment, which emerged following the reforms of the early 1990s.

In most cases, trainee teachers are supernumerary (i.e. their presence is surplus to the minimum required number of teachers) and they therefore have teaching experience that is determined by their mentor. However, trainees on School Direct (salaried) routes and Teach First (also paid a salary) need not be supernumerary and teaching commitments for trainees on these routes are therefore more likely to be determined by the school timetable and demand for teachers. Existing evidence shows that School Direct (salaried) and Teach First trainees in secondary schools teach the equivalent of 34% and 68% of a newly qualified teacher during their training year, respectively (Allen *et al.*, 2014). Trainee teachers from School Direct are expected to be employed by the school after qualification (National College for Teaching & Leadership, 2013), but in the early years of the programme only 52% of the secondary schools expected to hire their trainees from this route (Allen *et al.*, 2014). This compares with around 60% of the Teach First trainees and around 30% of the trainees from other routes (Allen *et al.*, 2014).

Schools in England have a high level of autonomy and choose whether and how to become involved with ITT. For example, a school could decline to partner with a higher education institution (HEI) to provide placements for trainees on HEI-led routes to QTS. Also, a school would make an explicit decision to become involved with School Direct, become part of a consortium of schools delivering SCITT or join a Teaching School Alliance (distinct from SCITT in providing school-to-school support for ITT and professional and leadership development for teachers and leaders in the network).

The recent reforms to ITT in England have been made in part in response to the belief that school-led routes to QTS can address local recruitment pressures for schools (Department for Education, 2016). At a national level, demand for newly qualified teachers is increasing. This is because demographic trends imply that pupil numbers will rise significantly (Department for Education, 2015) while teacher retention in the state sector more generally is low (Allen *et al.*, 2016). Changes to the curriculum and incentives for schools to recruit foreign language teachers have also increased the number of newly qualified teachers in certain subjects (Education Datalab, 2016). These factors imply that determining the effect of trainee teachers on contemporaneous pupil attainment is increasingly important.

Modelling the influence of trainee teachers on pupil attainment

This section illustrates the mechanisms through which trainee teachers influence pupil attainment, considering the incentives for schools. As a starting point, we take a traditional value-added school production function, following Cunha and Heckman (2007) and Cunha *et al.* (2010):

$$y_{ist} = \alpha + \beta y_{ist-1} + \gamma X_{it} + \delta S_{st} + \omega T_{st} + \varepsilon_{its}, \tag{1}$$

where the attainment y_{ist} of pupil i in subject s at time t is a function of: prior attainment in that subject, y_{ist-1}; a vector of household characteristics, X_{it}; a vector of school characteristics, S_{st}; a vector of teacher characteristics, T_{st}; and a random error term, ε_{ist}.

The number of trainee teachers in the school can impact pupil attainment through two potential channels. First, trainee teachers can directly affect pupil attainment through their contribution to teaching, impacting teacher quality, T_{st}. This could have a positive impact if the teaching provided by the trainee is an improvement over the teaching that would have occurred in their absence. This is only likely to be the case if the trainee exerts sufficient effort or has higher innate ability compared with a qualified teacher that outweighs their fewer years of experience.

Second, a trainee teacher can indirectly affect pupil attainment through the 'resource transfer effect' discussed by Hurd (2008): experienced teachers' efforts are diverted from their own pupils through the time taken with trainee teachers. In practice, the time effort for pupils may be undiminished if the experienced teacher works longer hours to accommodate the trainee, but the productivity of that time could be lower due to increased fatigue. Brooks *et al.* (1997) conclude that the costs in terms of staff time to schools are large, finding for example that almost 50% of the ITT coordinators and subject mentors had 'greatly increased' demands on their time. Alternatively, the effort of experienced teachers could be increased by the presence of trainee teachers. Boyd (2002) finds that trainee teachers can increase existing teachers' reflection on teaching and provide a reminder about good practice. The presence of indirect mechanisms indicates that the analysis should be run at the school or department level rather than the classroom level to account for any spillovers.

In equation (1), ω represents the overall effect from these two channels of an additional trainee teacher on contemporaneous pupil attainment. However, the estimated empirical relationship, $\hat{\omega}$, will be biased if there are omitted confounding factors that affect both the school's ITT participation and pupil attainment. Confounding factors may arise because schools have autonomy on the decision whether to host one or more trainee teachers. As such, schools where trainee teachers are observed are those where the expected benefits of hosting a trainee teacher (or teachers) are greater than the expected costs. This careful decision by schools is likely to depend on the school context, in particular whether there are existing concerns about staff resources and pupil attainment. The expected costs are likely to be lower when school quality is high, as existing staff have the capacity to be involved with the trainee teacher and the capacity to maintain or improve the quality of teaching in the school/department. These expected benefits and costs may be correlated with pupil attainment, leading to omitted variable bias if appropriate school characteristics are not accounted for. The financial cost or benefit may also be a factor in schools' decisions.

Including school fixed effects in equation (1) is equivalent to accounting for all time-invariant school characteristics, which may be observed or unobserved to the researcher. This has the empirical advantage of reducing the role of selection of schools into involvement with ITT and the possibility of reverse causality. For example, is pupil attainment increased in schools with more trainees? Or are more trainees placed in schools with higher pupil attainment? Using school fixed effects eliminates any bias caused by factors that are constant over time and induces selection in ITT. Selection may still pose a problem if it affects the choice to take trainees in different years, however—for example, if there are changes in staff composition that affect capacity at the school (or in the department). This is discussed further in the next section.

Data and methodology

Identifying the impact of trainee teachers on pupil attainment requires information about the presence of trainee teachers and measures of pupil attainment, as well as a detailed set of school- and pupil-level control variables. To obtain this, we utilise a unique data set which combines a survey of schools with the National Pupil Database. These sources of data are described in turn, before the methodology used in this article is discussed.

Survey of schools

We use information on the presence of trainee teachers from a survey of school and subject leaders in primary and secondary schools. This survey was sent to primary and secondary schools with and without experience of school-led ITT. In the 2013/14 academic year, respondents were asked about the presence of trainee teachers in their school/department from each training route, for three academic years: 2011/12, 2012/13 and 2013/14. We focus on English and maths departments for secondary schools, as these subjects are mandatory for all schools.

The sample was stratified by route, using information about the presence of ITT routes available from administrative data. For School Direct (salaried and unsalaried), we used management information on the number of allocated places (rather than actual placement of trainees) for 2013/14. For Teach First, we used information provided by Teach First about the presence of trainees in 2012/13. For SCITT, we used the Department for Education website for lead schools and subsequent internet searches to find partner schools.

Table 1 shows the achieved sample size for primary and secondary schools (the latter shown separately according to whether the ITT coordinator, at least one subject leader or both the ITT coordinator and at least one subject leader responded to the survey). Response rates were lower than predicted at the beginning of the project, particularly for primary schools. This was primarily because of the burden of responding to the survey for head teachers and senior staff. The achieved samples are of similar sizes across routes, however, and the responding schools are broadly representative of schools involved with each route. The results from the survey are likely to be generalisable to the wider population of schools involved with each ITT route in England.

Appendix Tables A1 and A2 show that the observable characteristics of schools in our sample (staff composition, pupil composition, pupil attainment and

Table 1. Stratified sample and response rates: (a) primary schools; (b) secondary schools

Route	Sampled	Achieved sample	Response rate
(a)			
BEd	596	52	8.7%
HEI-led PGCE	597	49	8.2%
SCITT	697	68	9.8%
School Direct	1,099	122	11.1%
Teach First	0	N/A	N/A
(b)			
Subject leader			
BEd	0	N/A	N/A
HEI-led PGCE	1,800	124	6.9%
SCITT	1,800	122	6.8%
School Direct	3,600	310	8.6%
Teach First	1,794	106	5.9%
ITT coordinator			
BEd	0	N/A	N/A
HEI-led PGCE	300	63	21.0%
SCITT	300	67	22.3%
School Direct	600	133	22.2%
Teach First	299	57	19.1%
Both subject leader and ITT coordinator			
BEd	0	N/A	N/A
HEI-led PGCE	300	38	12.7%
SCITT	300	42	14.0%
School Direct	600	89	14.8%
Teach First	299	27	9.0%

Source: Survey of primary head teachers, secondary ITT coordinators and secondary subject leaders.

progression, effectiveness and quality measures from the most recent Ofsted inspection) are generally similar to those of the schools sampled for the survey. There are some exceptions where characteristics are statistically significantly different, although these are generally small in magnitude. For example, primary schools that respond to the survey for School Direct and SCITT have statistically significantly better Ofsted grades than all schools sampled for these routes, but the difference is typically less than one-fifth of an Ofsted grade. School Direct and SCITT schools that respond to the survey also have better performance on national tests at Key Stage 2, but the difference is less than one-fifth of a standard deviation of the national school-level distribution. The direction of these differences suggests that schools that respond to the survey may have greater capacity to accommodate trainee teachers. However, for school-led routes, these differences may be due to non-random response to the survey or to non-random participation in the ITT route, as sampling was based on expressed interest in the route rather than successfully recruiting a trainee. That is, the average for sampled schools may be artificially worse, as schools with less capacity may not have recruited a trainee. For HEI-led routes, the number of variables with significant differences between sampled and responding schools is within the range that would be expected due to random sampling variation.

National Pupil Database

Our analysis relies on observing multiple years of national assessment data from schools that participated in the survey. This information is available through the National Pupil Database, which contains an annual record of pupil attainment and pupil characteristics for each state-maintained school in England. Pupil attainment is measured at the end of primary school (for pupils in Year 6 at the end of Key Stage 2, aged 10 or 11) and at the end of secondary school (for pupils in Year 11 at the end of Key Stage 4, aged 15 or 16). Unfortunately, for the purpose of this study, pupil attainment at Key Stage 3 is measured through teacher rather than externally marked assessments during our period of study. We choose not to analyse attainment at Key Stage 3, as the findings would be incomparable with other key stages and the data employed by Hurd (2008) for an earlier period. We standardise our dependent variable (pupil attainment) according to the national sample of pupils to have a mean of 0 and a standard deviation of 1. This means that the coefficient of interest reported below is interpreted as the effect of the presence of a trainee teacher on each pupil's attainment relative to the national population in terms of standard deviations, rather than test points.

The National Pupil Database was merged with information on the presence of trainee teachers over three academic years using the unique school identifier (local authority number and school establishment number). All schools with pupils taking Key Stage 2 or Key Stage 4 tests were successfully matched. That is, schools unmatched to the National Pupil Database had no pupils in the relevant examination cohort (mainly infant schools for Key Stage 2 tests and middle schools for Key Stage 4 tests). For all specifications, we restrict the final sample to schools that provided full information on the presence of trainee teachers across academic years. Detailed

information on the match between the survey of schools and the National Pupil Database is provided in Appendix A.

Methodology

Our analysis is at the pupil level, using ordinary least squares to relate each pupil's attainment at the end of primary/secondary school (at the end of Key Stage 2 or Key Stage 4, respectively) to their prior attainment (at the end of Key Stage 1 or Key Stage 2, respectively), a subset of their characteristics, school fixed effects to account for all time-invariant school characteristics and the number of trainee teachers. The number of trainee teachers is defined at the school level for primary schools and the department level for secondary schools. Table 2 shows the mean and standard deviation for each variable included in our model, for the three cohorts of pupils used in the primary and secondary school analysis. There is minimal missing data in each sample. Where variables have cases of missing data, the missing observations are assigned a non-missing value and a binary variable (0 if the variable is non-missing and 1 if the variable is missing) is included in the regression to account for this imputation.

Table 2 shows that, as expected, there are roughly equal proportions of female and male pupils and of those born in different months of the year. A higher proportion of pupils in our primary school sample are eligible for free school meals, which is consistent with the sample of schools involved with ITT (see Appendix Tables A1 and A2). Around one-fifth of pupils in the primary and secondary samples have a registered special educational need. Around one-fifth of pupils (slightly higher in the primary school sample) have an ethnic group classified as non-White, with Asian the second most common ethnic-group classification. The sample of pupils in primary schools is slightly more concentrated in the most disadvantaged neighbourhoods, which is consistent with higher population density and higher concentration of schools in these areas. The measure of prior attainment for pupils in the primary and secondary school samples is close to 0 (the national mean of the standardised variable), which means that pupil attainment in our sample, on average, is close to the national average. Around 5% of the pupils in primary and secondary schools in our sample have a missing measure of prior attainment.

We estimate the following reduced-form model of the education production function model as outlined in the previous section:

$$y_{ist} = \alpha + \beta y_{ist-1} + \gamma \boldsymbol{X_{it}} + \theta t_{st} + \boldsymbol{\mu S_s} + \varepsilon_{ist} \qquad (2)$$

The number of trainees, t_{st}, is entered as a continuous variable. This gives the most statistical power but constrains the impact of an additional teacher to be linear. (That is, the impact of moving from one to two trainee teachers is the same as moving from two to three trainee teachers, and so on.) In robustness checks, we allow the impact of the number of trainee teachers to be non-linear by including a set of binary variables for the number of trainees at the school. This is a more flexible specification than the quadratic specification used by Hurd (2008). School fixed effects, denoted $\boldsymbol{S_s}$, reduce omitted variable bias for the coefficient of interest, $\hat{\theta}$. These school fixed

Table 2. Pupil-level variables for primary and secondary school analysis

Variable	Description	Primary		Secondary	
		Mean	Standard deviation (Pupil-year)	Mean	Standard deviation (Pupil-year)
Month of birth					
September	*Set of binary indicators for*	8.4	27.7	8.7	28.2
October	*pupil's month of birth*	8.6	28.0	8.5	27.9
November		7.9	27.0	8.0	27.1
December		8.3	27.6	8.2	27.5
January		8.7	28.1	8.6	28
February		7.5	26.3	7.8	26.8
March		8.1	27.2	8.3	27.6
April		8.2	27.4	8.1	27.3
May		8.6	28.0	8.4	27.7
June		8.5	27.9	8.2	27.5
July		8.7	28.2	8.7	28.2
August		8.6	28.0	8.5	27.9
Male	*Binary indicator equal to 1 if male and 0 otherwise*	51.0	50.0	49.4	50.0
Eligible for free school meals	*Binary indicator equal to 1 if pupil is eligible and registered for free school meals and 0 otherwise*	17.2	37.8	12.5	33.0
Eligible for free school meals (missing)	*Binary indicator equal to 1 if information is missing for pupil's eligibility for free school meals and 0 otherwise*	0.3	5.4	1.2	11.0
Special educational need	*Binary indicator equal to 1 if pupil has a special educational need and 0 otherwise*	21.1	40.8	19.1	39.3
Special educational need (missing)	*Binary indicator equal to 1 if information is missing for pupil's special educational need status and 0 otherwise*	0.3	5.4	1.2	11.0
Ethnic group					
Asian	*Set of binary indicators*	13.5	34.2	8.2	27.5
Black	*for pupil's ethnic group*	4.4	20.6	4.3	20.3
Chinese		0.3	5.6	0.4	6.4
Mixed		4.5	20.7	3.7	18.8
Unclassified		1.1	10.6	1.8	13.1
White		74.2	43.7	80.2	39.9
Any other		1.9	13.7	1.4	11.9
English as an additional language	*Binary indicator equal to 1 if pupil has English as an additional language and 0 otherwise*	21.9	41.4	12.4	32.9

Table 2. (Continued)

Variable	Description	Primary		Secondary	
		Mean	Standard deviation (Pupil-year)	Mean	Standard deviation (Pupil-year)
English as an additional language (missing)	*Binary indicator equal to 1 if information is missing for whether pupil has English as an additional language and 0 otherwise*	0.4	6.5	0.9	9.5
IDACI decile					
Most disadvantaged	*Set of binary indicators for pupil's deprivation in the l*	14.8	35.5	10.9	31.2
2nd decile	*ocal area, measured by the*	11.1	31.4	9.2	29.0
3rd decile	*decile of Income Deprivation*	11.2	31.5	10.2	30.2
4th decile	*Affecting Children Index*	13.5	34.1	11.1	31.4
5th decile		5.9	23.6	6.6	24.8
6th decile		7.8	26.8	9.5	29.4
7th decile		8.6	28.1	11.2	31.6
8th decile		8.5	27.8	9.7	29.6
9th decile		9.3	29.0	9.6	29.5
Least disadvantaged		9.0	28.6	10.4	30.6
Missing		0.5	6.9	1.4	11.9
Key Stage 1 average points score	*Standardised average points score at Key Stage 1 (age 6/7) with mean 0 and standard deviation 1. Coded to 0 (which is the mean in the national population) if missing. Used in analysis for primary schools only*	0.0	0.9		
Key Stage 1 average points score (missing)	*Binary indicator equal to 1 if Key Stage 1 average points score is missing. Used in analysis for primary schools only*	5.0	21.7		
Key Stage 2 average points score	*Standardised average points score at Key Stage 2 (age 10/11) with mean 0 and standard deviation 1. Coded to 0 (which is the mean in the national population) if missing. Used in analysis for secondary schools only*			0.1	0.9
Key Stage 2 average points score (missing)	*Binary indicator equal to 1 if Key Stage 2 average points score is missing. Used in analysis for secondary schools only*			4.8	21.4

Source: National Pupil Database pupil-level data on attainment at KS2 and pupil characteristics from academic years 2011/12, 2012/13 and 2013/14, merged to survey of primary schools. National Pupil Database pupil-level data on attainment at KS4 and pupil characteristics from academic years 2011/12, 2012/13 and 2013/14, merged to survey of secondary schools. The sample size (pupil-years) is 28,436 for primary schools and 68,801 for secondary schools. Note that columns may not sum to 100 due to rounding.

effects account for all time-invariant school characteristics that influence both pupil attainment and the number of trainee teachers, such as quality and staff capacity, which may be observed or unobserved to the researcher.

School fixed effects require there to be variation in the number of trainee teachers within the school (or department) across the three years of interest. This is satisfied. In our sample, 85% of the primary schools have variation in the number of trainees in the school over time and 20% have variation in the presence of a trainee. For English (maths) departments, 81% (75%) have variation in the number of trainee teachers and 21% (25%) have variation in the presence of a trainee teacher over time. Table 3 shows the number of trainee teachers in primary schools in our final sample in each school year. Primary schools are most likely to have low numbers of trainees per year (13.5% have no trainees in a given year and the modal number is two trainees per year), but a non-negligible number choose to have more than five trainees per year. Schools with large numbers of trainees are more likely to host trainee teachers from the Bachelor of Education (BEd) route, who tend to have shorter placements in schools.

Table 4 shows the equivalent figures for secondary school English and maths departments. Again, most departments have low numbers of trainees per year, but there is variation over time and some departments choose to have more than five trainees per year.

In our chosen specification, school quality is assumed to be time invariant (S_s). Omitted variable bias will still be present if, instead, school quality varies over time and this in turn determines the decision to host a trainee. For example, there may be changes in staff composition that affect capacity at the school (or in the department) and, in turn, pupil attainment and the decision to host a trainee. We argue that omitted variable bias will be lower when accounting for school fixed effects, even in the presence of time-varying school characteristics. To show this, denote school quality in year t as $S_{st} = S_s + S_t$. Without school fixed effects, the error term is a function of time-varying and time-invariant school characteristics:

$$\bar{\varepsilon}_{ist} = (S_s + S_t) + \varepsilon_{ist}. \tag{3}$$

Table 3.   School-level variables for primary school analysis

Variable	Description	N	% (School-year)	Cumulative
Number of trainees present				
0	*Set of binary indicators for the*	65	13.5	13.5
1	*number of trainee teachers*	70	14.5	28.0
2	*present in the school per year*	89	18.4	46.4
3		73	15.1	61.5
4		44	9.1	70.6
5		37	7.7	78.3
6 or 7		46	9.5	87.8
8–15		47	9.7	97.5
16–30		12	2.5	100.0

Source: Survey of primary schools.

Table 4. Department-level variables for secondary school analysis

Variable	Description	N	% (School-year)	Cumulative
Number of trainees present in English department				
0	*Set of binary indicators for the*	18	11.3	11.3
1	*number of trainee teachers present in*	56	35.2	46.5
2	*the English department per year*	52	32.7	79.2
3		17	10.7	89.9
4		14	8.8	98.7
5 or 6		2	1.3	100.0
Number of trainees present in maths department				
0	*Set of binary indicators for the*	31	13.4	13.4
1	*number of trainee teachers present in*	62	26.8	40.3
2	*the maths department per year*	80	34.6	74.9
3		32	13.9	88.7
4		18	7.8	96.5
5–8		8	3.5	100.0

Source: Survey of secondary schools.

Accounting for school fixed effects, the error is

$$\bar{\varepsilon}_{ist} = S_t + \varepsilon_{ist}. \tag{4}$$

Comparing equations (3) and (4), we see that under the realistic assumption that time-invariant school characteristics are positively correlated with the presence of a trainee teacher, omitted variable bias will be reduced by including school fixed effects. In the absence of a randomised controlled trial that assigns trainee teachers to schools, it is not possible to account for all time-varying factors that may influence a school's decision to host a trainee teacher. We argue that accounting for time-invariant school fixed effects eliminates the largest source of omitted variable bias and that our estimates are therefore the closest to the causal impact of trainee teachers on pupil attainment in the existing literature.

Results

Table 5 shows the estimated relationship between the number of trainee teachers in the school and pupil attainment at Key Stage 2. Column 1 shows our preferred specification. The coefficient of 0.006 has the interpretation that each additional trainee teacher increases pupil attainment by 0.006 of a standard deviation, on average, conditional on all else remaining equal. This effect is linear in the number of teachers, so for example an increase of two teachers would increase pupil attainment by 0.012 standard deviations, on average. This estimate is very small and not statistically significantly different from zero, such that we cannot reject the hypothesis that the impact of an additional teacher is zero. The 95% confidence interval on this estimate is −0.008–0.020. That is, we can rule out even moderately sized positive or negative effects of hosting a trainee teacher on pupil attainment.

Table 5.   Impact of presence of primary school trainees in the school on pupil attainment at Key Stage 2 (standardised average points score)

Independent variable of interest	(1) Main specification	(2) Including training school	(3) Number of trainees per KS2 classroom	(4) Presence of trainees	(5) Non-linearities in number of trainees
Number of trainees	0.006 [0.007]	0.006* [0.004]			
Number of trainees per KS2 class			0.008 [0.007]		
At least one trainee at school				0.013 [0.032]	
Presence of 1 trainee					0.023 [0.044]
Presence of 2 trainees					−0.008 [0.035]
Presence of 3 trainees					0.018 [0.036]
Presence of 4 trainees					−0.039 [0.048]
Presence of 5 trainees					0.042 [0.043]
Presence of 6 or 7 trainees					0.052 [0.053]
Presence of 8–15 trainees					0.007 [0.059]
Presence of 16–30 trainees					0.234 [0.150]
Year	Yes	Yes	Yes	Yes	Yes
Pupil characteristics	Yes	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes	Yes
Number of pupils	18,502	18,667	18,502	18,502	18,502
Number of schools	161	162	161	161	161

Note: The dependent variable is standardised to have a mean of 0 and a standard deviation of 1 in the population. Standard errors are presented in square brackets and are clustered at the school level. Pupil-level characteristics accounted for in the regression are: month of birth, sex, eligibility for free school meals, special educational needs status, broad ethnic group, English as an additional language status, decile of deprivation index (Income Deprivation Affecting Children Index) and prior attainment at KS1 (average points score).
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.
Source: National Pupil Database pupil-level data on attainment at KS2 and pupil characteristics from academic years 2011/12, 2012/13 and 2013/14. Survey of primary schools.

The magnitude is equivalent to 0.03 of a point on the Key Stage 2 average points score (which ranges from 0 to 40) or 1/200 of the difference between achieving the expected level of attainment (27 points) and the level below (21 points). The precision of this estimate allows us to rule out that the impact of an additional trainee teacher is less than −0.008 and greater than 0.019 standard deviations. Again, this allows us to be confident that the impact of an additional trainee teacher is small, as 0.019 standard deviations is equivalent to 0.09 of a point on the Key Stage 2 average

points score or 1/66 of the difference between achieving the expected level of attainment and the level below.

Columns 2 to 5 present the estimates from alternative specifications to test the robustness of this main finding. Column 2 includes the one school that was dropped from the analysis sample as it reported many trainees in the (small) school and was the head of a Teaching School Alliance, meaning that the trainees were likely to be spread across schools in the alliance. Including this school, the point estimate is the same as our preferred specification, but the precision improves, such that the point estimate is now statistically significantly different from zero. As discussed above, the point estimate is small and not educationally significant.

Column 3 includes the number of trainees per Key Stage 2 class as an alternative independent variable of interest. The coefficient has the interpretation that each additional trainee per Key Stage 2 class increases pupil attainment by 0.008 standard deviations. Like our preferred estimate, this estimate is small and is not statistically significantly different from zero.

Column 4 includes a binary variable for the presence of one trainee teacher or more at the school and therefore represents the average effect of moving from zero to a positive number of trainees at the school. The coefficient is again small, positive and not statistically significantly different from zero.

Finally, column 5 presents an alternative specification with a flexible functional form for the number of trainees, which allows the impact of the number of trainees to be non-linear. For example, the second coefficient shows the impact of two trainees relative to the reference category of no trainees. Although the point estimates differ (particularly for the largest group of trainees), there is insufficient precision to conclude whether the effect of trainee teachers is non-linear.

Table 6 shows the estimated relationship between the number of trainee teachers in the English and maths departments and pupil attainment at Key Stage 4. As for attainment in high-stakes assessments at the end of primary school, shown in Table 5, we cannot reject the hypothesis that the presence of a trainee on pupil attainment in high-stakes tests at the end of secondary school is zero. Our preferred specification implies that the presence of a trainee in the department decreases pupil attainment, on average, by 0.003 standard deviations, but this is not statistically distinguishable from zero. As for the main effect for Key Stage 2, this effect is not educationally significant, equivalent to around 0.03 of a point on the range of 16–58 or 1/200 of the points required to move up one grade level.

Columns 2–5 show the robustness of this main estimate to alternative specifications. As for Key Stage 2, across specifications the results are small and not statistically significantly different from zero.

The effect of trainee teachers on pupil attainment may vary across routes, due to either the structure of training or typical characteristics of the trainee teachers on each route. Whether the trainee is an additional adult in the school (supernumerary) or is responsible for timetabled classes (not supernumerary) may have particularly important implications for pupil attainment. The expected direction is unclear, however. For example, whether supernumerary routes or non-supernumerary routes are most beneficial (or least disadvantageous) to

Table 6.   Impact of presence of secondary school trainees in the school on pupil attainment at Key Stage 4 English and maths (standardised average points score)

Independent variable of interest	(1) Main specification	(2) Including training school	(3) Number of trainees per KS4 classroom	(4) Presence of trainees	(5) Non-linearities in number of trainees
Number of trainees	−0.003 [0.007]	−0.003 [0.002]			
Number of trainees per KS4 class			0.015 [0.055]		
At least one trainee at school				−0.020 [0.027]	
Presence of 1 trainee					−0.010 [0.029]
Presence of 2 trainees					−0.031 [0.029]
Presence of 3 trainees					−0.032 [0.034]
Presence of 4 trainees					−0.050 [0.042]
Presence of 5–8 trainees					0.043 [0.071]
Year	Yes	Yes	Yes	Yes	Yes
Pupil characteristics	Yes	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes	Yes
Number of pupils	70,226	71,527	70,226	70,226	70,226
Number of schools	112	113	112	112	112

Note: The dependent variable is standardised to have a mean of 0 and a standard deviation of 1 in the population. Standard errors are presented in square brackets and are clustered at the school level. Pupil-level characteristics accounted for in the regression are: month of birth, sex, eligibility for free school meals, special educational needs status, broad ethnic group, English as an additional language status, decile of deprivation index (Income Deprivation Affecting Children Index) and prior attainment at KS2 (average points score).
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.
Source: National Pupil Database pupil-level data on attainment at KS4 and pupil characteristics from academic years 2011/12, 2012/13 and 2013/14. Survey of secondary schools.

pupil attainment depends on the difference between supervised and unsupervised contribution to teaching and the 'resource transfer' required from experienced teachers and the overall effect of these factors on pupil attainment. Our sample size is too small to explore heterogeneity by route, but Appendix Table A3 shows that there are no significant differences in the main estimates across supernumerary and non-supernumerary routes. The point estimate is slightly higher for non-supernumerary routes [Teach First and School Direct (salaried)] but is not significantly different from zero and is not precisely estimated due to the smaller number of schools participating in these routes. Our main results are also robust to excluding Teach First participants from the measure of number of trainee teachers, with an identical point estimate and standard error of similar magnitude. This is consistent with Allen and Allnutt

(2017), who find no positive effect of Teach First participants in their first year at the school.

In summary, pupil attainment is significantly related to multiple characteristics of pupils (e.g. ethnic group and eligibility for free school meals), but is largely unaffected by the presence of trainee teachers. These results show conclusively that for both primary and secondary schools, there is no evidence that trainee teachers harm pupil attainment.

Conclusion and discussion

The impact of trainee teachers on pupil attainment in their host schools has received little empirical attention, despite the importance of this concern to schools. The need for recent empirical evidence is heightened by the increasing demand for newly qualified teachers in England. This will affect the number of trainees present in schools, either by increasing the number of trainees in existing 'host' schools or by expanding the pool of schools involved.

Our analysis, which is the first to account comprehensively for characteristics of schools which affect both the decision to become involved with ITT (or initial teacher education) and pupil attainment, shows that we can rule out even moderately sized positive or negative effects of the presence of trainee teachers on contemporaneous pupil attainment in high-stakes assessments at the end of primary and secondary school. Our estimates for both primary and secondary schools are close to zero, precise and not statistically significantly different from zero. This suggests that having additional trainee teachers at schools that currently have some involvement with ITT is unlikely to harm pupil attainment at key milestones.

Despite the low response rate to the survey, our sample is representative for the population of schools involved with ITT. Our findings are therefore generalisable to schools that currently engage with ITT and to schools with similar characteristics. Table 7 confirms that primary schools currently engaged with ITT have significantly

Table 7. Characteristics of primary schools involved with ITT

School characteristic	All schools	BEd	HEI-led PGCE	School Direct (salaried)	School Direct (unsalaried)	SCITT
Ofsted: overall effectiveness	2.04 [0.68]	1.83 [0.63]	1.83 [0.63]	1.58 [0.71]	1.50 [0.51]	1.64 [0.70]
Ofsted: quality of teaching	2.07 [0.64]	1.90 [0.59]	1.88 [0.60]	1.65 [0.70]	1.57 [0.50]	1.73 [0.68]
Ofsted: effectiveness of leadership	1.98 [0.66]	1.77 [0.63]	1.75 [0.62]	1.52 [0.65]	1.45 [0.50]	1.62 [0.71]

Note: Standard deviations are shown in square brackets. Ofsted ratings are between 1 and 4, where 1 represents 'outstanding' and 4 represents 'unsatisfactory'; a lower mean score is therefore better.
Source: Survey of primary schools and Ofsted ratings.

better prior Ofsted grades than schools overall. In addition, schools involved with School Direct (salaried and unsalaried routes) have significantly better Ofsted grades, on average, than schools involved with BEd and HEI-led Postgraduate Certificate of Education (PGCE). This suggests that schools that chose (or were selected) to become involved with these new school-led routes had greater initial capacity. Results for secondary schools are similar, with one exception that schools currently involved with Teach First have worse prior Ofsted grades than schools overall. This reflects its status as the only ITT programme able to work with schools in special measures, but may also reflect its role as a route used to fill an existing vacancy in schools serving disadvantaged communities.

This provides evidence that schools strategically choose to become involved with ITT. The conclusion from this, in conjunction with our estimates, is that increasing the number of trainees at existing schools is unlikely to negatively affect pupil attainment, but expanding the pool of schools involved may do. This is because schools not currently involved with ITT may have less capacity to be involved and therefore may be less effective in ITT. This consideration is especially relevant in England, where the number of newly qualified teachers required is increasing in response to expanding pupil numbers and curriculum changes. ITT has been proposed as one solution to meet schools' teacher recruitment challenges, as schools can 'grow their own'. Our results provide no evidence to support the use of ITT as a potential recruitment tool for all schools in England, particularly lower-quality schools which are currently less likely to be involved with ITT. Deciding whether the new teachers required can be trained by the existing pool of schools or whether support for new schools to engage in ITT is needed should be a matter of priority for government. It would be valuable for further research to explore whether hosting a larger rather than a smaller number of trainees is beneficial for schools and whether SCITT or Teaching School Alliances provide important economies of scale in providing effective ITT. Relatedly, future research should look at whether the additional responsibilities and accountability required for teaching schools, such as coordination of ITT with professional development opportunities, positively influence pupil attainment.

Acknowledgements

NOTES

[1] Note that we refer to 'ITT' rather than 'initial teacher education' throughout, to be consistent with the language of government in England, but we recognise the long-standing debate on the suitability of each term, that 'education' has a stronger connotation with preparing for a professional role.

[2] These observable school characteristics are: the number of teachers per student; expenditure per pupil on learning resources; the proportions of pupils eligible for free school meals, with special educational needs and having English as an additional language; and school type (community, voluntary-aided, voluntary-controlled, foundation, grant-maintained, city technology college and training schools).

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Appendix A: Match between survey of schools and National Pupil Database

For primary schools, 240 of 291 schools in 2012 (82%) were matched to the Key Stage 2 results in the National Pupil Database (NPD). As outlined above, on investigation all the schools that were unmatched had no pupils in the relevant year group for Key Stage 2 tests (e.g. infant schools). The equivalent figures for 2013 and 2014 were 242 of 291 (83%) and 244 of 291 (84%). Again, all unmatched schools had no pupils of the correct age for Key Stage 2 tests. We restrict the final sample to be schools present across all years (240 of the 244 schools with Key Stage 2 results in 2012, 2013 and/or 2014), excluding four new schools. Of these schools, 191 provided information on the presence of trainee teachers across academic years and 162 provided full information on the presence of trainee teachers across academic years. We exclude one more school from our final sample as the large reported number of trainees is likely to be across all training schools in a partnership rather than for the school.

For English departments of secondary schools, 82 of 84 schools in the survey (98%) were linked to Key Stage 4 results in 2012. The equivalent figures were 82 of 86 (95%) in 2013 and 2014. We restrict the final sample to be schools present across all years (82 of the 86 schools with Key Stage 4 results in 2012, 2013 and/or 2014), excluding two new schools. Of these schools, 69 provided information on the presence of trainee teachers across academic years and 54 provided full information on the presence of trainee teachers across academic years.

For maths departments of secondary schools, 105 of 107 schools (98%) were linked to Key Stage 4 results in 2012, 2013 and 2014. Of these schools, 97 provided information on the presence of trainee teachers across academic years and 78 provided full information on the presence of trainee teachers across academic years. For both English and maths, we exclude one more school from our final sample as the large reported number of trainees is likely to be across all training schools rather than for the school.

As there is some crossover between schools in the maths and English final sample, there are 112 schools in our final sample for secondary school department analysis.

Table A1. Representativeness statistics for primary school sample

	BEd		HEI-led PGCE		GTP		School Direct		SCITT	
	Sampled[a]	Response	Sampled	Response	Sampled	Response	Sampled	Response	Sampled	Response
Ofsted: overall effectiveness	1.95 [0.68]	1.98 [0.61]	1.95 [0.68]	1.90 [0.60]	1.66 [0.57]	1.50 [0.67]	1.80 [0.66]	1.68* [0.64]	1.81 [0.66]	1.56* [0.69]
Ofsted: quality of teaching	1.99 [0.64]	2.02 [0.57]	1.99 [0.64]	1.92 [0.59]	1.71 [0.56]	1.59 [0.67]	1.85 [0.63]	1.73* [0.62]	1.85 [0.62]	1.66* [0.67]
Ofsted: effectiveness of leadership	1.89 [0.66]	1.98 [0.65]	1.89 [0.66]	1.80 [0.57]	1.63 [0.54]	1.45 [0.60]	1.73 [0.64]	1.61* [0.58]	1.76 [0.65]	1.58* [0.71]
Average point score at KS2	28.71 [1.55]	28.79 [1.37]	28.71 [1.55]	28.97 [1.55]	29.62 [1.80]	29.73 [1.89]	28.88 [1.60]	29.03 [1.42]	28.89 [1.39]	29.44* [1.63]
Overall value-added measure	100.13 [1.13]	100.09 [1.10]	100.13 [1.13]	100.20 [1.02]	100.16 [1.03]	100.29 [1.06]	100.32 [1.17]	100.35 [1.06]	100.06 [1.08]	100.46* [0.98]
Proportion EAL	0.17 [0.25]	0.13 [0.23]	0.17 [0.25]	0.18 [0.27]	0.16 [0.21]	0.17 [0.25]	0.20 [0.26]	0.17 [0.24]	0.17 [0.26]	0.16 [0.27]
Proportion SEN	0.10 [0.08]	0.10 [0.11]	0.10 [0.08]	0.09 [0.07]	0.10 [0.08]	0.08 [0.06]	0.10 [0.07]	0.09 [0.07]	0.10 [0.07]	0.09 [0.07]
Proportion FSM	0.18 [0.14]	0.17 [0.14]	0.18 [0.14]	0.17 [0.15]	0.11 [0.11]	0.12 [0.13]	0.19 [0.14]	0.16* [0.12]	0.15 [0.13]	0.12* [0.11]
Proportion community school	0.53 [0.50]	0.59 [0.50]	0.53 [0.50]	0.42* [0.50]	0.51 [0.51]	0.36 [0.49]	0.52 [0.50]	0.48 [0.50]	0.55 [0.50]	0.48 [0.50]
Proportion tenure less than 1 year	0.12 [0.14]	0.21* [0.28]	0.12 [0.14]	0.12 [0.15]	0.10 [0.09]	0.10 [0.12]	0.10 [0.09]	0.10 [0.12]	0.11 [0.11]	0.12 [0.15]

Table A1.   (Continued)

	BEd		HEI-led PGCE		GTP		School Direct		SCITT	
	Sampled[a]	Response	Sampled	Response	Sampled	Response	Sampled	Response	Sampled	Response
Proportion tenure between 1 and 2 years	0.15 [0.12]	0.13 [0.10]	0.15 [0.12]	0.11* [0.09]	0.15 [0.09]	0.16 [0.10]	0.15 [0.09]	0.16 [0.10]	0.14 [0.11]	0.11* [0.08]
Proportion upper pay scale	0.31 [0.19]	0.29 [0.16]	0.31 [0.19]	0.38* [0.23]	0.24 [0.16]	0.28 [0.18]	0.24 [0.16]	0.28 [0.18]	0.32 [0.18]	0.37* [0.15]

Note: [a]The samples for BEd and HEI-led PGCE routes were the same, as placements for these routes were not distinguishable in the administrative data. Standard deviations are shown in square brackets. 'Sampled' refers to all schools that were sampled to give priority for this training route. 'Response' refers to all schools that responded after being sampled to give priority for this training route or that responded about a specific trainee from this route. * Denotes that the average characteristic for the responding schools is significantly different (at the 5% level) from the average characteristic for the relevant sampled schools. Ofsted ratings are between 1 and 4, where 1 represents 'outstanding' and 4 represents 'unsatisfactory'; a lower mean score is therefore better. 'KS2' represents Key Stage 2. 'Overall value-added measure' is a measure of pupil progress during primary school, calculated so that schools where pupils make the expected level of progress, on average, have a score of 100. 'FSM' represents eligibility for free school meals. 'SEN' represents special educational needs. 'EAL' represents English as an additional language.
Source: Survey of primary schools, School Workforce Census, Edubase, School Performance Tables and Ofsted ratings.

Table A2. Representativeness statistics for secondary school sample

	HEI-led PGCE		GTP		School Direct		SCITT		Teach First	
	Sampled	Response	Sampled	Response	Sampled	Response	Sampled	Response	Sampled	Response
Ofsted: overall effectiveness	1.99 [0.81]	1.81* [0.75]	1.83 [0.77]	1.67* [0.74]	1.73 [0.79]	1.70 [0.78]	1.98 [0.81]	1.88 [0.76]	2.28 [0.83]	2.13 [0.77]
Ofsted: quality of teaching	2.09 [0.70]	1.97* [0.65]	1.97 [0.67]	1.89 [0.66]	1.92 [0.67]	1.93 [0.63]	2.07 [0.72]	1.95 [0.65]	2.31 [0.72]	2.15 [0.67]
Ofsted: effectiveness of leadership	1.82 [0.74]	1.68* [0.68]	1.69 [0.70]	1.58* [0.66]	1.66 [0.74]	1.63 [0.70]	1.82 [0.74]	1.74 [0.70]	2.02 [0.77]	1.90 [0.68]
Average point score at KS4	480.85 [74.43]	483.94 [73.29]	490.70 [73.78]	494.41 [74.34]	502.88 [83.68]	504.50 [84.82]	483.62 [74.76]	486.51 [72.23]	465.79 [73.74]	471.05 [76.61]
Overall value-added measure	1002.1 [20.53]	1003.1 [18.01]	1004.4 [19.53]	1005.9 [17.54]	1006.2 [18.46]	1005.1 [19.00]	1000.9 [19.96]	1001.7 [18.29]	1004.6 [23.14]	1003.5 [21.41]
Proportion EAL	0.14 [0.20]	0.14 [0.20]	0.12 [0.18]	0.12 [0.19]	0.13 [0.18]	0.10 [0.15]	0.09 [0.16]	0.09 [0.15]	0.32 [0.28]	0.29 [0.26]
Proportion SEN	0.09 [0.06]	0.08 [0.05]	0.08 [0.06]	0.08 [0.05]	0.08 [0.05]	0.07 [0.05]	0.08 [0.05]	0.07 [0.04]	0.11 [0.07]	0.10 [0.06]
Proportion FSM	0.17 [0.13]	0.15* [0.12]	0.15 [0.11]	0.13* [0.11]	0.13 [0.12]	0.12 [0.11]	0.13 [0.10]	0.11 [0.09]	0.33 [0.12]	0.31 [0.12]
Proportion community school	0.21 [0.40]	0.20 [0.40]	0.18 [0.38]	0.19 [0.39]	0.15 [0.36]	0.13 [0.33]	0.15 [0.36]	0.14 [0.35]	0.20 [0.40]	0.10 [0.30]
Proportion tenure less than 1 year	0.10 [0.11]	0.10 [0.11]	0.10 [0.09]	0.09 [0.08]	0.08 [0.05]	0.08 [0.04]	0.09 [0.07]	0.08 [0.06]	0.11 [0.09]	0.09 [0.08]

Table A2.   (Continued)

	HEI-led PGCE		GTP		School Direct		SCITT		Teach First	
	Sampled	Response	Sampled	Response	Sampled	Response	Sampled	Response	Sampled	Response
Proportion tenure between 1 and 2 years	0.14 [0.09]	0.13 [0.08]	0.14 [0.08]	0.13 [0.10]	0.12 [0.05]	0.12 [0.05]	0.14 [0.10]	0.15 [0.14]	0.17 [0.09]	0.15 [0.07]
Proportion upper pay scale	0.35 [0.21]	0.39* [0.21]	0.34 [0.21]	0.36 [0.22]	0.31 [0.23]	0.33 [0.22]	0.37 [0.20]	0.36 [0.22]	0.23 [0.18]	0.28 [0.19]

Note: Standard deviations are shown in square brackets. 'Sampled' refers to all schools that were sampled to give priority for this training route. 'Response' refers to all schools (or individual departments within schools) that responded after being sampled to give priority for this training route or that responded about a specific trainee from this route. * Denotes that the average characteristic for the responding schools is significantly different (at the 5% level) from the average characteristic for the relevant sampled schools. Ofsted ratings are between 1 and 4, where 1 represents 'outstanding' and 4 represents 'unsatisfactory'; a lower mean score is therefore better. 'KS4' represents Key Stage 4. 'Overall value-added measure' is a measure of pupil progress during secondary school, calculated so that schools where pupils make the expected level of progress, on average, have a score of 1,000. 'EAL' represents English as an additional language. 'SEN' represents special educational needs. 'FSM' represents eligibility for free school meals.

Source: Survey of secondary schools, School Workforce Census, Edubase, School Performance Tables and Ofsted ratings.

Table A3. Impact of presence of secondary school trainees in the school on pupil attainment at KS4 English and maths (standardised average points score)

Independent variable of interest	(1) Main specification	(2) Excluding Teach First	(3) Supernumerary	(4) Non-supernumerary
Number of trainees	−0.003	−0.003	−0.005	0.013
	[0.007]	[0.002]	[0.008]	[0.035]
Year	Yes	Yes	Yes	Yes
Pupil characteristics	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes
Number of pupils	70,226	70,226	70,226	70,226
Number of schools	112	112	112	112

Note: The dependent variable is standardised to have a mean of 0 and a standard deviation of 1 in the population. Standard errors are presented in square brackets and are clustered at the school level. Pupil-level characteristics accounted for in the regression are: month of birth, sex, eligibility for free school meals, special educational needs status, broad ethnic group, English as an additional language status, decile of deprivation index (Income Deprivation Affecting Children Index) and prior attainment at KS2 (average points score). Supernumerary routes are HEI-led PGCE, Graduate Teacher Programme, School Direct (unsalaried) and School-Centred Initial Teacher Training. Non-supernumerary routes are Teach First and School Direct (salaried).
$*p < 0.1; **p < 0.05; ***p < 0.01$.
Source: National Pupil Database pupil-level data on attainment at KS4 and pupil characteristics from academic years 2011/12, 2012/13 and 2013/14. Survey of secondary schools.