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What are the key predictors of international teacher shortages?

Stephen Gorard [a], Mark Ledger[b], Beng Huat See [c] and Rebecca Morris[d]

aEducation and Public Policy, Durham University, Durham University Evidence Centre for Education (DECE), Durham, United Kingdom; bPDRA, Durham University Evidence Centre for Education (DECE), Durham, United Kingdom; cSchool of Education, Birmingham University, Birmingham, United Kingdom; dEducational Studies, Warwick University, Coventry, United Kingdom

ABSTRACT

Recurrent teacher shortages have been a long-standing problem for many countries. Popular strategies to attract and retain teachers, used over several decades across the world, include bursaries, scholarships, performance-related pay, professional development and reducing workload. Governments in England have invested heavily in such policy responses, but none have been shown to be particularly effective. Such policies have tended to be based on weak research evidence. Much previous research has not considered the many different factors that can explain teacher shortages, and so yields misleading results by focussing on a few factors only. In this paper, we present our ongoing research to advance understanding of teacher shortages by comparing 18 countries that reportedly have and have not experienced teacher supply issues, using a complex Qualitative Comparative Approach, and based on numerous international datasets with (initially) hundreds of possible determinants. The results suggest that wider economic issues, such as the employment rate of graduates in subjects like humanities, are key predictors of shortages, along with teacher reports of poor behaviour of students, lack of resources, and pay. This should be of interest to a wide range of stakeholders, including policymakers, wanting to develop more effective and targeted interventions to improve teacher supply.

Introduction

A lack of qualified teachers remains a major barrier to closing the attainment gap between rich and poor children according to PISA data (Schleicher 2018). Policies relating to teacher supply and teacher effectiveness would therefore play a critical role in overcoming disadvantage for children living in poverty. Eurydice (2021) showed that 35 of the 43 education systems across Europe had reported a shortage of teachers. Despite years of investment in recruiting and retaining teachers, the issue persists.

International organisations, such as the OECD, and the European Cooperation in Education and Training, have called for this issue to be addressed urgently, with a new and systemic response to the challenges (European Commission 2015). In England, the situation is particularly serious for the secondary sector because the pupil population has grown, and recruitment to initial teacher training has failed to meet its intake targets for several consecutive years. The number of subjects with under-recruitment has increased, along with class sizes, pupil-teacher ratios, and the number of teacher vacancies (Department for Education 2022; National Foundation for Educational Research 2020). Schools are especially short of high-quality teachers in key subjects such as maths and sciences.

This paper looks briefly at what a teacher shortage is, its possible causes and what can be done about it. The paper moves on to the methods used in our new study, the main findings, and the implications for research and policy.

What is a teacher shortage?

There is no universally agreed or consistent definition of what a teacher shortage is. A shortage suggests an insufficient number of individuals recruited into the profession. In fact, whether an educational system has sufficient teachers can be as much a conceptual matter as a practical one. Teacher shortages can be long- or short-term. They can also be general or specific to particular phases of education, subject areas, geographical locations or types of school. In theory, each type of shortage could be brought about and resolved by different conditions, so it is important to be explicit about the shortage that any policy is intended to deal with.

What one individual or country considers to be a shortage of teachers may also not be perceived as a shortage by others. In many developed countries, a teacher shortage is conceived as a lack of qualified teachers to teach the subject that they are trained for. According to this definition, having to deploy physics teachers to teach maths would imply that there is a teacher shortage. In some developing countries, the requirements to be a teacher are often less stringent. Unqualified and/or out-of-subject teachers might therefore be utilised without this being viewed as a cause for concern. Past research has not considered this type of difference, and this may have masked important findings. In England, professional teachers have traditionally gained Qualified Teacher Status (QTS) through training, but there has been an increase in teachers without QTS, which is reportedly widening class-based inequality in pupils' access to qualified teachers (Martindale 2019).

Generally, countries where education is reported to be significantly affected by a teacher shortage have high pupil:teacher ratios (PTRs) and larger class sizes (e.g. Brazil, Colombia and Vietnam). And countries with low PTRs and smaller class sizes may not report major issues with teacher shortages (e.g. Finland, Slovenia, Estonia and Cyprus). However, there are countries like China (Shanghai), South Korea, Singapore and Argentina (Buenos Aires) with large class sizes but low PTRs. These countries generally do not report serious teacher shortages (OECD 2019).

Teaching hours are higher in England than in many other OECD countries. This means that teachers in England can teach more classes, so classes can be smaller. Singapore, China, and South Korea are able to keep PTRs low despite larger than average

class sizes probably because they teach fewer classes (lower hours teaching). These countries also tend not to be affected significantly by a shortage of qualified teachers. This is likely because while teaching hours may be low, teachers in Japan spend the highest amount of time on other tasks (OECD 2019). All of this suggests that, in isolation, class sizes and PTRs may not be good indicators of teacher shortages.

Initial Teacher Education recruitment targets can also be used as a basis for judging whether there will be sufficient teachers in the near future. However, trainee teachers are not guaranteed to enter the profession. Also recruitment targets can vary substantially over short periods. Whether a country meets its targets can therefore have as much to do with a change in expectations as a change in the overall number of teachers being trained.

Finally, teacher vacancies are sometimes used as a measure of teacher shortages. However, since schools advertise more posts when they have greater funding, this may not reflect a 'shortage' of teachers as such.

In our analyses below, we use countries' own reports of whether they have a shortage (of any kind). And we consider this over several years of data. So, a country with a shortage here is one that has repeated reports of shortage, and using a range of indicators (see below).

Why do shortages happen?

There are two separate issues here. A country might not train enough teachers to service their schools, or too many teachers might leave service once trained.

Supply

One concern about the shortage of teachers is the relatively low status of teachers as envisaged by the public (OECD 2019). In Australia, and presumably elsewhere, there is increasing criticism of teachers, with them being blamed for failures in education (Mockler 2023). Only 25% of teachers in England think that they are valued by society and even fewer by policymakers (only 10%). The 2018 TALIS survey (OECD 2019) shows that countries in which teachers are less valued by society, policymakers and the media (e.g. England, France and Japan) report being significantly affected by a shortage of qualified teachers. Countries like Singapore, China (Shanghai), South Korea and Finland where teachers are more appreciated by the government, and the public, do not generally report persistent or high teacher shortages. In Finland and South Korea, teaching is apparently a much-coveted profession (Education GPS 2023).

In Singapore, South Korea, Japan, Taiwan, China (Shanghai), over 70% of teachers indicated that teaching was their first-choice career. These are also countries where there is generally no reported national shortage. However, being valued may not be an impetus for wanting to be a teacher. Although teaching is a valued profession in Finland, only 59% of teachers indicated that it was their first-choice career.

On the other hand, there are countries, such as Vietnam, where a high percentage of schools report being severely affected by the shortage of qualified teachers, even though teachers in Vietnam are considered to be highly valued by society, the media and policymakers. Their average class sizes and PTRs are among the highest in the TALIS survey. This suggests that there are other factors at play. According to

the Vietnamese Education Minister in the Vietnam Times (2022), the recent policy to reduce class sizes, the increasing population in big cities and industrial zones, plus the government's recent rigid policy to cut the number of public employees, may explain the apparent shortage of teachers. This illustrates the influence of other policies beyond education, an issue which is rarely considered in research on teacher supply.

In England, for example, the Department for Education (DfE) incentivises schools to enter upper secondary-level students for the English Baccalaureate qualification. Since this performance measure requires students to study GCSE (age 16) qualifications in maths, English language and literature, the sciences, and another language, it increases the demand for teachers who are trained in these core subjects and reduces the demand for vocational teachers.

A shortage can occur when prospective teachers opt for what they perceive to be more favourable career options. From an individual's perspective, these decisions may be influenced by financial rewards (salary, prospect of bonuses) or their understanding of what the role entails (required tasks, working conditions, student discipline). Teacher recruitment is therefore connected to economic and employment cycles, because teaching looks more favourable during times of economic uncertainty (Aldeman 2015; Dee and Goldhaber 2017; Dolton, Tremayne, and Chung 2003; Hutchings 2011).

Although teachers' pay is often highlighted as a factor in attracting and retaining teachers, this is not often the case in reality. For example, in Portugal over 80% of teachers chose teaching as their first-choice career, even though they were most dissatisfied with their pay. Less than 50% of teachers in the TALIS survey said they were satisfied with their pay. Perhaps, this suggests that those who chose teaching as a career did not do so for the pay. In Mexico, only 40% of teachers were satisfied with their pay, but almost all teachers (97%) reported being happy with their job (OECD 2019).

On the other hand, teachers in England were somewhat happier with their pay (47% compared to the TALIS average of 39%), but they were most unhappy with their job. Only 68% said they were happy with their job compared with 87% for the TALIS average. Perhaps it is not pay alone that makes teaching unappealing. Recall that teachers in England were least likely to think that they were valued by society, policymakers and the media. Among the TALIS countries, teachers in England were also least likely to indicate that teaching was their first-choice career.

Retention

A shortage of teachers can also be brought about by teachers leaving the profession prematurely. Teaching has often been characterised as an occupation with a high level of turnover, especially among new teachers (Ingersoll and Smith 2003; Ward 2019). In England, for instance, 12.8% of teachers quit after their first year of service, and 31.3% of teachers leave the profession within the first 5 years (Department for Education 2022). This is apparently higher than in other professions (Ingersoll and Perda 2010), and greater for newly qualified teachers (NQTs), teachers of STEM subjects, and those with stronger academic backgrounds (Bowsher 2016). The latter are arguably the individuals that the Department for Education (DfE) would most like to retain.

In recent years, researchers have started to pay more attention to the factors that can influence teacher retention (Cooper-Gibson Research 2018). In their meta-analysis of 34 studies, Borman and Dowling (2008) identified 63 moderators of attrition, including the level of administrative support that teachers received, the quality of teachers' professional networks, their school's instructional spending, and whether there are opportunities for personal advancement. Teachers' stress, job satisfaction and work-life balance have been shown to correlate with teacher attrition (NFER 2023). A commonly cited factor is teacher workload Perryman and Calvert (2020). Evidence from the Teaching and Learning International Survey suggests that English teachers have an excessively high workload, especially in terms of the time that teachers must dedicate to non-teaching activities (OECD 2019).

Besides, status, pay and workload, other factors like job satisfaction, stress and working environment also need to be considered in explaining the absence/presence of a teacher shortage. These factors have been linked to teacher attrition and turnover. Teachers in England were among the top five countries to report experiencing quite a lot of stress (63% versus the TALIS average of 42%). These data suggest that perhaps the status or prestige of the profession, job satisfaction and stress associated with teaching may be a partial explanation for the shortage of teachers in England.

What can be done?

Among other factors, governments can impact upon individual career decisions by funding training places, developing alternative training routes, and marketing the profession better.

The UK government, for example, has a long history of using bursaries and scholarships to attract graduates from shortage subjects (Department for Education 2023). This is because previous studies, which often reported only the views of existing/trainee teachers, have identified these as important factors (Borman and Dowling 2008; European Commission 2017; Foster 2018; Lynch et al. 2016; Sims 2017; Sutcher, Darling-Hammond, and Carver-Thomas 2016; Walker 2015). However, a regression discontinuity design finds no evidence that the use of incentives improves retention, or student performance (Shifrer, Turley, and Heard 2017).

Unfortunately, there have been few such robust evaluations of strategies for tackling teacher supply issues. The limited number of experimental or quasi-experimental studies that have been conducted, however, suggest that monetary policies do not provide long-term solutions to teacher supply problems. While there is some evidence to suggest that financial incentives can help to recruit teachers initially (Dolan, Metcalfe, and Navarro-Martinez 2012) and encourage them to work in hard-to-fill schools temporarily (Hough and Loeb 2013), the effect of any payments does not last beyond the end of the stipulated payment/re-payment period (See, Gorard, and Gorard 2020).

Hanushek, Kain, and Rivkin (2004) concluded that really considerable salary increases (up to 50%) would be needed to induce more teachers to work in schools with high proportions of socioeconomically disadvantaged or ethnic minority students. Just because teachers themselves think that teachers' salaries should be higher does not mean that other people will go into teaching or stay in teaching if teachers were paid more. A multitude of factors can impact upon an individuals' career choice, and these

factors extend far beyond teachers' pay and working conditions (See and Gorard 2021, Gorard et al. 2023).

Another standard policy response to shortages involves reductions in teachers' workload (Education Committee 2017). The Early Career Framework (Department for Education 2019a) was implemented in England as part of the DfEs broader Teacher Recruitment and Retention Strategy (Department for Education 2019b). These guaranteed all newly qualified teachers a supervised induction programme, mentoring from a fully qualified teacher, and reduced working hours, and tried to create more supportive cultures within schools. The UK government has invested in this kind of initiative, to address unnecessary tasks that teachers undertake in the course of their duty, but has been unable to improve the situation substantially (Education Committee 2017).

The evidence surrounding strategies for improving teachers working conditions is only slightly more promising. Teacher induction and continuing professional development have both been connected with teachers' intention to remain in the profession (Allen and Sims 2017; De Angelis, Wall, and Che 2013). Teacher's accountability, stress, workload and support from administrators/leaders have been shown to correlate to teacher retention (Marinell and Coca 2013). The studies with the strongest research designs, however, have failed to detect any benefits (De Jong and Campoli 2018; Department for Education 2019b; Helms-Lorenz, van de Grift, and Maulana 2016).

To develop more effective policies, it is necessary to improve our understanding of teacher supply issues and the conditions that impact upon them. There is much more that could be discussed here, and for a fuller treatment see See et al. (2023).

Methods

Most previous work employing cross-sectional analysis has not included other potential influencing factors happening at the time of the data collection, such as teacher education reforms (e.g. teacher recruitment practices, changes in qualification criteria for teacher recruitment), changes in class sizes and the health of the economy. These external factors can have an effect on teacher supply, but are rarely, if ever considered in the analytical procedures employed. Comparing education practices, political and economic contexts across nations can help to assess the relative contributions of these factors.

Our study is therefore looking at a much wider range of these factors, to identify a fuller set of determinants of teacher shortages. The search will include other educational policies. Our past research, for example, suggests that shortfalls in government planning may be one of the primary causes of teacher supply problems in England (See et al. 2020). The analysis will therefore include factors such as how far countries plan in advance. We will also assess background variables that describe the geographical, political, sociological, and economic context in which the education systems operate.

Datasets

Whilst a number of large-scale research projects have reported upon this area (e.g. TALIS 2018, Eurydice 2021, Education at a Glance 2022), no single pre-existing resource has included all of the background factors mentioned in the previous section (Ledger et al. 2024).

Our analysis is based on a combination of data sources, including international studies of teacher supply (TALIS 2013, 2018, Eurydice 2018; 2021, Education and Training Monitor 2019, EFEE/ETUCE 2012), and policy documents (Education International 2015, Education at a Glance 2013-2020; European Commission 2013, 2015, 2017). Where possible, we have used the most recent information available for any indicator.

Each source provides overlapping but somewhat different information. TALIS collects data on teachers and school leaders from OECD and partner countries, including data on teacher demographics, professional development opportunities, teacher appraisal, working conditions and job satisfaction. Their survey of principals also asked about principals' background, their school, management activities, leadership style, staff training opportunities, and school climate.

The Eurydice Report of Teaching Careers in Europe covers 43 education systems including the European Union Member States. It identifies education systems with different types of shortages (e.g. subject-specific or regional) and those with oversupply. The survey data is collected from national experts and representatives of the Eurydice Network and contains information on regulations/legislation pertaining to education policies in each country/jurisdiction. This includes information about how each jurisdiction plans for teacher supply and demand, the qualifications needed to be a teacher, routes into teaching and recruitment methods, employment conditions and career structure of teachers.

The Education and Training Monitor (European Commission 2019) compiles a country-by-country analysis of 28 country reports. It focuses on teachers and the challenges of the teaching profession. The report therefore offers information that is not available from the other sources.

ETUCE/EFEE is a survey of trade unions of teachers and employer organisations, including Ministries of Education, and regional/local governments of school governing bodies. The survey collected information on national policies and practices on teacher recruitment and retention as well as the characteristics of teacher shortages. It also collected information about teachers' legal status and workforce planning (who is responsible for planning, and which stakeholders are involved in it).

Our analysis will therefore include data on teachers' pay, working conditions, school climate, preparation, development, teaching and evaluation practice (and other possible job attractors and stressors). And perhaps for the first time, these will be considered in relation to wider educational policy, cultural factors and economic conditions – including how countries plan for teacher supply, the location of schools, the distribution of the national population, the legal status of teachers, how valued teachers are within society, the national employment rate, and the salaries of similarly educated adults. The study will predominately focus upon state-funded secondary education because most information is available for this.

There are some methodological differences between datasets. These discrepancies include the geographical regions that are described. In Belgium, for example, different educational policies apply to the French, Dutch and German-speaking regions. TALIS 2018 therefore sampled the three municipalities separately. Other sources either presented country-level data, or drew upon partial samples (reports from teachers working within the two largest regions). Some of these issues were overcome by accessing the raw data.

Selecting countries

From the outset, it was apparent that it would be easier to assess the teacher supply situation within some countries and sectors than others. This is because more data is available on developed countries with centrally regulated education systems. There are also more datasets related to state-funded, mainstream, and lower-secondary education. Reasonably complete information was only available for countries that took part in all studies. This is a significant barrier that has implications for all cross-national research. In our case, it reduced both the scope of our investigation and the number of countries that could be included in our analyses.

The first step was to identify 20 countries with reasonably complete data, of which 10 clearly had teacher shortages and 10 clearly did not. This decision was based on questions about teacher shortages from the datasets described above, including shortages in certain phases, regions or subjects. Countries where all indicators suggested a shortage, over time, were compared to countries where all indicators suggested no shortage, and these are listed in Table 1. Note that we reduced the 20 to 18 (nine of each) because, on closer inspection, two of the countries did not have enough comparable data.

These countries were initially coded as 0 (no shortage) and 1 (shortage) in the dataset. In addition, we used principal component analysis to create a combined shortage score for each country based on a shortage indicator for each year it was available (therefore emphasising the permanence of shortages), a reported lack of pedagogical personnel (ISCED2 data for 2018), and a shortage of ITE applicants. Table 1 shows the values used (the loadings for each country on the shortage factor). The correlation between the simple 0/1 shortage indicator and the combined shortage score was +0.94. The shortage score was used as the outcome for the correlation and regression analyses below, and the shortage indicator was used for the QCA.

The possible predictors of teacher shortage were grouped loosely into a number of categories, such as geography, economy, expenditure, employment rates, salaries for teachers, the structure of the school system, class sizes, nature of ITE, workload, stress, CPD, and the characteristics of the teacher workforce. Because the number of possible predictors was so much larger than the number of countries, the strongest predictor (in terms of correlations with teacher shortage scores) was chosen to represent each group. These are described in more detail in the results sections.

Across all 18 countries, each possible predictor was correlated with the shortage factor. In this way, a subset of promising predictors was selected, and used in a multiple regression model to help predict/explain the teacher shortage scores. The variables

Table 1. List of countries deemed to have teacher shortages.

Shortage countries	Shortage score	Non-shortage countries	Shortage score
Czech Republic	0.07	Australia	−0.45
England	1.56	Cyprus	−0.97
Estonia	0.75	Finland	−1.15
France	1.25	Lithuania	−0.19
Latvia	0.87	Singapore	−1.10
Malta	1.40	Slovak Republic	−0.88
Netherlands	0.98	Slovenia	−1.08
Norway	0.62	Spain	−1.05
Sweden	0.62	Taiwan	−1.11

were entered in three blocks – of generic factors, educational factors, and those that might also be the outcome of a shortage.

No one factor will account for all of the variation in teacher supply that we observe, and some factors will be more important under some circumstances than others. Teacher salary, for instance, may have a greater influence on teacher recruitment and retention when teachers' job satisfaction and/or autonomy is lower, when the profession is less respected, or when graduates have a large range of career options. To acknowledge this complexity, we are using Qualitative Comparative Analysis, which allow different configurations of conditions to be analysed collectively as 'cases'. And so, we will assess how successful each configuration is in avoiding (or eliciting) teacher shortages.

We created a truth table of the factors linked or not linked to shortage countries, and created from a Boolean expression. This expression was simplified as far as possible.

The strongest predictors of teacher shortages

The correlation results are dealt with in an order going from general and structural factors to teaching or school-specific factors.

Geography

A total of eight indicators are used to represent the general population density of each country, and the geographical distribution of schools within it. These could be related to shortages in terms of access difficulties, recruitment to isolated schools, and the ability of teachers' families to find jobs and services in the local area (Tables 2 and 3).

There is no clear relationship between shortages and high levels of rural population (villages of up to 3,000 people). So, for national measures of shortage, geographical isolation does not seem to matter. Countries with high levels of their population in cities (more than 100,000 residents) are less likely to report shortages, whereas shortages are strongly linked to having residents in towns of between 3,000 and 100,000 residents (Table 2).

A similar pattern appears for where the majority of schools are in each country (Table 3). The percentage of schools in villages is not really relevant to teacher shortages. Shortages are less likely in countries where more schools are in larger conurbations, and more likely where schools are in towns or small towns. The results are clearly dependent on each other, so that countries with more schools or residents in cities will have fewer in

Table 2. Correlations between shortage scores and population distribution in each country, 2018.

Correlation	% population rural	% population in towns	% population in cities
Shortage factor	−0.01	+0.46	−0.37

Table 3. Correlations between shortage scores and school location, 2018.

Correlation	% schools in villages	% schools in small towns	% schools in towns	% schools in cities	% schools in large cities
Shortage factor	−0.01	+0.35	+0.40	−0.14	−0.29

towns and villages and so on. Of course, all of these indicators could be proxies for other factors, such as the level of economic development of the country. This will be considered further when looking at GDP and other possible predictors below.

The best single predictor here is the percentage of the general population living in towns, and this is used in the analyses later in the paper.

Retirement age

Many countries still have a different retirement age for men and women, so these are dealt with separately here. There is not much variation in retirement ages, but one country (the Netherlands) has retirement at 70 and one (Finland) at 62. Most are around 65. In general, shortages are more likely in countries with a higher retirement age (Table 4). This is notable, because it means that the extra years of service due from each teacher before retirement is not helping.

For further analysis, the retirement age of men is used because it has a slightly higher correlation with shortages. Anyway, the ages for men and women are strongly related in most countries

Unemployment among degree holders

In most countries teaching is a graduate profession, and so shortages could be related to the employment rates of graduates in general. In countries with higher inactivity and unemployment rates for graduates generally there is a lower shortage of teachers (Table 5). This is perhaps because teaching is partly a backup career for some (Gorard etal. 2020). Conversely, where employment rates are high there is, understandably, a greater risk of shortage.

The rate of inactivity of graduates is the best single predictor of teacher shortages, and is used in later analyses.

Employment rates by degree discipline

Related to this issue is the employment rate of graduates from a broad range of subject disciplines. The figures suggest that teaching is not in competition with Science, Engineering and Health (Gorard etal. 2023). These may be degree subjects with their own clear career trajectories (such as law, accountancy or dentistry). But lower employment for humanities, services and social sciences is linked to lower teacher shortages (Table 6). These are the subject areas where most teachers come from.

Table 4. Correlations between shortage scores and retirement ages.

Correlation	Retirement age women	Retirement age men
Shortage factor	0.33	0.35

Table 5. Correlations between shortage scores and unemployment rates among graduates.

Correlation	Rate of inactivity, graduates	Rate of unemployment, graduates	Population of graduates
Shortage factor	−0.23	−0.20	0.17

Table 6. Correlations between shortage scores and employment rate with tertiary education, by subject.

Correlation	Humanities	Social sciences	Science	Engineering	Agriculture	Health	Services
Shortage factor	0.38	0.25	0.01	0.06	0.16	−0.01	0.39

The employment rate for humanities graduates is used below, having the highest correlation for a mainstream subject area.

Salary rates by degree discipline

The absolute level of earnings in each degree subject area is not strongly related to teacher shortages (Table 7). As might be expected, higher pay for teachers is slightly related to less shortage. And higher pay in other competing sectors is marginally related to teacher shortages. However, none of these possible predictors is used in the analysis below. The relationship is too weak compared to other factors.

Flexibility of choice of job

The extent to which adults in all occuptions feel that they could take a different job to their current one is not strongly linked to shortages, even before taking prior predictors into account (Table 8). Again, due to this lack of ability to predict shortages, none of these indicators is used in subsequent analyses.

Expenditure on education

Job flexibility was the last of the generic factors, not overtly related to schools or education. The next factor is how much each country spends on education. The figures here are for ISCED2 (lower secondary) schooling in 2020. Expenditure on education is positively linked to shortages. More money means more shortage, and *vice versa* (Table 9). This is perhaps because the largest proportion of funding in schools is spent

Table 7. Correlations between shortage scores and salaries by subject area.

Correlation	Full-time earnings Education	Full-time earnings Humanities	Full-time earnings Social sciences	Full-time earnings Sciences	Full-time earnings Engineering	Full-time earnings Health
Shortage factor	−0.05	0.03	0.07	0.08	0.08	0.09

Table 8. Correlations between shortage scores and flexibility in job.

Correlation	Adults with tertiary education	All levels of education	All adults
Shortage factor	0.05	0.06	0.06

Table 9. Correlations between shortage scores and expenditure on education.

Correlation	%GDP expenditure	All education expenditure	Expenditure staff	% Expenditure staff
Shortage factor	0.03	0.37	0.37	0.13

on staff, and so the more money schools have, the more they can spend on staff. This increases the demand for staff, in terms of advertised vacancies, which is then interpreted as a 'shortage' (See and Gorard 2020). Other factors might include the need to offer more money or incentices in countries where there is a shortage.

Expenditure on staff is used in the analyses below as the most relevant indicator with a high correlation.

Employment with an education background

The unemployment rate for adults with a tertiary qualification in education is highly correlated with teacher shortages (Table 10). Lower unemployment is linked to greater teacher shortage. This is perhaps because graduates who could find employment easily elsewhere are less likely to go into teaching, again suggesting that teaching is not always a first choice career for graduates.

The unemployment rate for those with at least a degree in education is used in the model below.

Salaries for teachers

Ignoring variables such as teacher pay for men relative to women, and for teachers at different ages, which have no clear link, shortages are linked to how teacher pay compares to pay for the highest paid professions (other than teaching) in each country, and to how long it takes to reach the top of the teacher salary scale (Table 11). As above, it is not clear whether higher pay somehow leads to shortage, or is a consequence of it.

Teacher pay, relative to best salaries in other fields, is the most relevant and thereby important of the more strongly correlated indicators.

Initial teacher training

Although alternative pathways to teacher qualification are common, their availability shows no strong link to shortages (Table 12). There is slightly more shortage in countries with more formal requirements for becoming a teacher. None of these measures is strong enough to be used below.

Table 10. Correlations between shortage scores and employment rates in education.

Correlation	Employment rate, tertiary teacher training	Unemployment rate, tertiary qualification in Education	Inactivity rate, tertiary qualification in Education
Shortage factor	0.30	−0.41	−0.17

Table 11. Correlations between shortage scores and relative salaries for teachers.

Correlation	Teacher pay relative to best pay	Teacher salaries 2020	Salary of top of starting scale	Years from start to top salary
Shortage factor	−0.32	0.14	0.36	−0.28

Table 12. Correlations between shortage scores and having alternative pathways to teaching.

Correlation	Alternative pathway to secondary teaching	Alternative pathway to teaching	Official requirement for becoming teacher
Shortage factor	−0.01	0.07	0.12

Table 13. Correlations between shortage scores and forward planning.

Correlation	Geographical-based needs	Subject based needs	Pupil growth projection	Adequate recruitment policies 2012
Shortage factor	0.08	0.12	0.12	−0.19

None of these variables is included in the later analysis.

Forward planning

Countries with forward planning for teacher supply have somewhat more chance of shortages (Table 13). This is as likely to be an effect as a cause. Therefore, none of these predictors is used in the analysis below. Ideally, forward planning is carried out on a medium- to long-term basis. Finland's long-term forward planning may explain why they have been successful in balancing teacher demand and supply while keeping class sizes small. But this is not straightforward as not all countries with long-term forward planning are able to effectively manage their workforce. England, for example, has long-term forward planning of 6–10 years, but is still unable to provide sufficient teachers to meet demand. This is because while England may have a long-term plan for teacher supply, decisions about the actual number of teachers to be trained are generally made on a year-by-year basis.

Teacher recruitment targets in England tend to shift dramatically from year to year. Such short-term adjustments will almost certainly herald what is seen as a shortage. Recent DfE figures in England show that recruitment to the target for modern foreign languages fell from 88% to 62%, but this was only due to a large increase in the target from 1,600 in 2018/19 to 2,241 teachers in 2019/20. The number of teachers recruited remained largely unchanged. On the other hand, there are countries like the Slovak Republic and Slovenia with no forward planning at all, and Northern Ireland, which plans one year ahead, yet do not report a shortage of teachers. Some countries such as Poland, Slovenia, the former Yugoslav Republic of Macedonia, and Serbia, where there is no forward planning, face a rather different challenge – an oversupply of teachers.

Structure of the school system

School size

Average school size is not strongly linked to shortages, but shortages are less likely in countries with larger ISCED2 schools (Table 14). This may be linked to the geographic factor (above) of countries with more schools in large cities. Perhaps larger schools are more efficient in the deployment of staff because of economies of scale (See, Gorard, and Gorard 2020). Small schools will still need a full complement of staff, especially at secondary stage with specialist subjects, despite the smaller pupil population. Having a greater percentage of students in state-funded schools is linked to shortages.

Table 14. Correlations between shortage scores and school size.

Correlation	Schools <250	Schools 250–499	Schools 500–749	Schools 750–999	Schools 1000+	% students in public schools
Shortage factor	0.00	−0.05	0.19	0.13	−0.07	0.16

Table 15. Correlations between shortage scores and class size.

Correlation	Student:teacher ratio ISCED2	Class size 2019
Shortage factor	−0.12	0.32

Table 16. Correlations between shortage scores and use of special schools.

Correlation	Widespread use of special schools
Shortage factor	−0.21

None of these measures is strong enough to use below (but general population density is).

Class size

Overall, the student-to-teacher ratio is not strongly linked to shortages, perhaps surprisingly, but average class size is (Table 15). A problem with class size is that it could be an outcome of teacher shortages rather than a potential determinant. The situation is confusing. In countries like Taiwan, China and Singapore, class sizes are often larger than in England, for example, yet these countries do not report shortages.

Therefore, class sizes are not used below as they are not clearly a predictor of shortage.

Special schools

Countries that have a policy of using special schools, rather than inclusion of most children with disabilities or learning challenges in mainstream settings, tend to have less shortages, perhaps because of fewer classroom challenges in mainstream schools (Table 16).

Teaching assistants (TAs)

Teaching Assistants who are not qualified teachers but act as classroom support may be a result or a cause of lack of teacher shortage, but are clearly strongly related to it either way (Table 17). An R of −0.71 is the largest (absolute) correlation found so far, but this indicator is not used below because of doubts about the direction of any causal link. The more teachers there are compared to TAs the less shortage there is. Of course, it could be that people selecting a role as assistants are potential teachers so reducing the potential

Table 17. Correlations between shortage scores and use of assistants.

Correlation	Teaching assistant ratio 2018	Teacher: admin ratio 2018
Shortage factor	−0.71	0.10

size of the teacher workforce. The ratio of administrators is less important, but proportionately fewer administrators is linked to more shortage, perhaps via workload.

Again, the TA ratio is not used because it may be an outcome as much as a predictor.

Appraisal

Awarding teachers a bonus after appraisal is linked to lower shortages, but making actual salary increases dependent on appraisal is linked to more shortages (Table 18). Perhaps bonuses are one-off so there is always a chance that more teachers can get a bonus, making such payments more generally attractive and acceptable, whereas salary increases can be seen as a penalty if withheld.

Both indicators are used below.

Characteristics of teachers

Shortages are not strongly linked to having a generally ageing or more experienced teacher workforce (Tables 19 and 20). Having more female teachers and teachers with higher levels of formal qualification are linked to less shortages. This is perhaps to do with the professionalism of the job. Having disproportionately younger (<30) or older (>60) teachers is linked to shortage, perhaps partly because older teachers may have dropped out.

As the strongest predictors, the highest level of education, and the percentage of teachers aged less than 30, are used in later analyses.

Teacher workload

Hours worked

The number of hours teachers work is often cited as a reason for teachers leaving the profession, which might partly explain any teacher shortage. Working hours

Table 18. Correlations between shortage scores and appraisal, 2020.

Correlation	No top level appraisal	Appraisal bonus	Appraisal salary increase	Appraisal promotion	No paid study leave
Shortage factor	0.07	−0.42	0.42	0.26	0.39

Table 19. Correlations between shortage scores and teacher characteristics.

Correlation	% teachers female 2018	% teachers female 2019	Highest level of education	Years experience 2020	How long remain teacher
Shortage factor	−0.12	−0.10	−0.29	0.01	−0.02

Table 20. Correlations between shortage scores and teacher characteristics.

Correlation	Ageing teachers	% teachers < age 30, 2019	% teachers > age 50, 2018	% teachers > age 60, 2018	% teachers > age 60, 2019
Shortage factor	−0.01	0.28	−0.05	0.19	0.27

can be measured in a number of ways, such as the number of hours teachers report they spent teaching, the number of days teaching, the statutory teaching hours, or statutory working hours. Not all are related to shortages. Tables 21 and 22 show those measures with the strongest link to shortages. The results are somewhat confusing. Longer working hours are linked to lower likelihood of teacher shortages, while longer teaching hours are linked to more shortage. Both statutory figures are used in the later analyses. It may be that it is classroom contact that is the most exhausting element of teaching.

The pupil-to-teacher ratio is a measure of the level of teaching resources available and does not take into account teachers' working hours or hours spent teaching. Countries, like Singapore, China and South Korea have larger class sizes than England, but lower PTRs. This can be explained by the fact that teaching hours are higher in England than in the other countries. This means that teachers in England can teach more classes, so classes can be smaller. Singapore, China, and South Korea are able to keep PTRs low despite larger than average class sizes probably because they teach fewer classes (fewer hours teaching).

Types of workload

Teacher shortages are linked to headteachers or teachers reporting too much work in certain tasks, including classroom teaching. The strongest links are to reporting too much marking, and too much lesson preparation (Table 23).

Both are used below.

Pressures

Lack of resources for schools is strongly linked to teacher shortages (Table 24). Accountability for student results also adds pressure. The former is used below.

Table 21. Correlations between shortage scores and workload hours.

Correlation	Instruction time per year 2021	Number of days teaching	Statutory teaching hours	Statutory working hours
Shortage factor	0.24	0.33	0.36	−0.48

Table 22. Correlations between shortage scores and workload hours.

Correlation	Hours this week 2018	% Teaching time	% full-time working hours 2018	Hours availability at school
Shortage factor	0.17	−0.13	−0.35	0.28

Table 23. Correlations between shortage scores and too much work, 2020.

Correlation	Too much lesson preparation	Too much teaching	Too much marking	Too much admin	Covering for absence
Shortage factor	0.48	0.43	0.49	0.25	0.24

Table 24. Correlations between shortage scores and sources of pressure, 2018.

Correlation	Academic pressure	Lack of resources	Lack of material	Held responsible for student achievement
Shortage factor	0.16	0.45	0.30	0.20

Table 25. Correlations between shortage scores and sources of stress.

Correlation	Workplace stress	Workload stress	Experience stress	No time for personal life	Impact on mental health	Impact on physical health
Shortage factor	0.43	0.36	0.38	0.19	0.25	0.12

Table 26. Correlations between shortage scores and inclusion, 2018.

Correlation	Cope with multicultural classes	Diversity beliefs	Modify lessons for SEN
Shortage factor	0.41	−0.01	0.26

Table 27. Correlations between shortage scores and abuse, 2018.

Correlation	Abuse among students	Abuse to staff
Shortage factor	0.39	0.31

Stress

It is not surprising that all indicators of reported stress and workplace wellbeing also show strong links to teacher shortages (Table 25). The strongest predictor is workplace stress, and this is used below.

Having multicultural classrooms, and having to adjust teaching where students with disabilites and learning challenges (SEND) are included in mainstream settings, are both linked to shortages (Table 26). This might reflect the issue of whether a country has a policy of special schools or mainstream inclusion, as above. It may be harder to teach in mixed settings, especially where class sizes are high (Gorard and Smith 2010). The diversity beliefs of students (such as religion) are not an issue here.

Coping with multicultural classes is used in the later model.

There was a wide range of student discipline and behaviour indicators in the datasets – such as the frequency of vandalism, and the possession of drugs and alcohol by students. But the sense of these can be summarised in two – abuse taking place among students, and abuse from students to staff (Table 27). Both are linked to a shortage of teachers, suggesting the negative influence of having a poor school 'climate'.

Job satisfaction

In general, the more satisfied teachers are, and the more valued they feel, the less there is a shortage (Table 28). This is most apparent with the indicator 'I would choose teaching as a career again'.

Table 28. Correlations between shortage scores and satisfaction, 2018.

Correlation	Job satisfaction	Satisfied salary	Satisfied contract	Choose teaching again	Feel valued
Shortage factor	0.19	−0.33	−0.24	−0.57	−0.32

Summary

Of the indicators considered so far, many were judged not relevant, or are covered by other variables with stronger links to shortages. These are not used in the model below.

- Alternative pathways to teaching
- Salary rates by degree
- Flexibility of job choices
- Forward planning
- School size

Also, the following indicators are at least as likely to be outcomes of shortages as predctors. They are used in the regression below but only in the last step.

- Class size
- Ratio of TAs
- Would choose teaching again

The remaining 24 variables in Table 29 are those in each category with the strongest link(s) to teacher shortages. These are used in the ensuing regression analysis, to try and reduce them further for QCA.

Table 29. Correlations between indicators and country shortage factor.

Proportion of teaching assistants	-0.71
Would choose teaching again	−0.57
Statutory working hours	−0.48
Appraisal bonus	−0.42
Teacher pay relative to best pay	−0.32
Highest level of education	−0.29
% of teachers aged < 30	−0.28
Rate of inactivity – degree holders	−0.23
Widespread use of special schools	−0.21
Abuse to staff	+0.31
Class size	+0.32
Retirement age (male)	+0.35
Salary at top of starting scale	+0.36
Statutory teaching hours	+0.36
National expenditure on education staff	+0.37
Employment rate – humanities degree	+0.38
Abuse among students	+0.39
Unemployment rate with "education" degree	+0.41
Cope with multicultural classes	+0.41
Appraisal linked to salary	+0.42
Workplace stress	+0.43
Lack of resources for school	+0.45
% population in towns	+0.46
Too much lesson preparation	+0.48
Too much marking	+0.49

Regression analysis

Of the 24 variables in Table 29, the three that could be the cause or effect of shortage, and entered in Block 3 of the regression model, are not needed. The model explains teacher shortages with 100% accuracy without any of Block 3. Therefore, the following three variables are not considered any further:

- Class size
- Proportion of Teacher Assistants
- I would choose teaching again

Of the remaining 21 variables four are not needed to create the model of 100% accuracy, using forward entry of variables. These are:

- % unemployment for those with degree in education
- Highest level of formal education required for teachers
- Having too much marking
- Intimidation or abuse among students

These are presumably heavily correlated with other predictors – such as intimidation of students by students and of teachers by students.

We ran a regression model using the shortage score for each country as the outcome, and with the remaining 17 key predictors identified above. The predictors were entered in three blocks. The first included generic geographic and economic factors, the second had educational factors, and the third had items that could be the result of teacher shortages or a predictor, such as the proportion of teaching assistants. This third block was not needed. The first block led to an R of 0.804, using the first five indicators in Table 30. The second block led to an R of 1.000 using the remaining indicators in Table 30. These factors can explain all of the variation in this relatively small number of cases. Note that the percentage of unemployment for those with tertiary qualifications in education, and the highest level of formal education required to be a teacher, were also not relevant to this prediction.

The number of remaining predictors, even for the simplest regression model here, is still nearly as large as the number of countries. This is not recommended (Gorard 2021). We used correlation/regression to identify a set of candidate predictors from the much larger set of 100s of variables in our original dataset. We then used this smaller set in a qualitative comparative analysis (QCA) to identify the minimum 'requirements' for a country to have a teacher shortage or not. Using the regression coefficient values, the most important contributors to teacher shortage (or not) are the percentage of the population living in towns, the employment rate of humanities graduates, abuse of teachers, teacher pay relative to other fields, level of lesson preparation, lack of resources, workplace stress, and high statutory working hours. These are the key predictors used in the QCA that follows.

Table 30. Coefficients in model predicting shortage factors.

Block		Unstandardised	Standardised
1 Generic	% of population in towns up to 100,000	2.43	0.46
	Employment rate for humanities, languages, arts	0.08	0.36
	Retirement age, men	0.14	0.23
	Rate of inactivity, with a degree	−0.03	0.12
2 Education	Intimidation of teachers	2.57	0.73
	Teacher pay relative to best pay	7.66	0.62
	Too much lesson preparation	2.32	0.59
	Lack of resources	−9.34	−0.54
	Workplace stress	10.86	0.50
	Statutory working hours	0	−0.50
	Salary at top of starting scale	−1.12	−0.27
	Appraisal used to assign bonuses	0.58	0.25
	Cope with multicultural classroom	−1.08	−0.18
	Percentage of teacher workforce aged < 30	−0.05	−0.17
	Statutory teaching hours	0	0.12
	Special schools	0.22	0.11
	Expenditure on staff	0	−0.10

'Qualitative' comparative analysis

Some variables, such as whether a country has widespread use of special schools, and whether teacher appraisal is used to assign a bonus, are binary in format. All other figures are converted to z-scores and then into binary form representing whether a score is at/above or below the mean. Based on the analyses above, the unemployment rate of those with a degree in education is not used (the inactivity rate is a better predictor); nor is the highest level of formal education required to be a teacher. The patterns appear in Table 31.

Most countries without shortages have teachers who report low workplace stress, and less abuse or intimidation, although Lithuania reports both. More than half have a high retirement age (including Australia and Spain). The counties without shortages are very mixed in terms of still using special schools – Slovakia, Finland, Taiwan and Singapore – or not. Most countries with shortages also have a high retirement age (7 out of 9 cases), and a greater population in towns (7 out of 9), as opposed to cities. Some have high expenditure on staff – Malta, Netherlands, France and England – while others do not.

These complexities of similarities and differences between shortage and non-shortage countries create a challenge to find the simplest expression of the combinations of indicators linked precisely to shortages. Latvia has apparent shortages but does not fit well with other shortage countries. Cyprus had no apparent shortage but otherwise shared many similarities with shortage countries. This makes the resulting logical expression to define a country with shortage more complex.

The simplest discriminating expression that we have found so far is that a country has a teacher shortage if:

- A high proportion of the population lives in towns (not big cities like in Singapore)

AND

   o There is a reported lack of resources in schools
   OR

Table 31. Charactistics of systems with or without shortage.

	Teacher shortage	Humanities employment rate	Teacher pay relative to best	Statutory working hours	Too much lesson preparation	Workplace stress	Lack of resources	Intimidation or abuse	Population in towns
Australia	0	0	1	1	0	1	0	1	0
Cyprus	0	0	0	1	1	0	0	0	1
Finland	0	0	1	1	0	0	0	1	1
Lithuania	0	1	0	0	1	1	1	0	0
Singapore	0	1	1	1	1	0	1	0	0
Slovakia	0	0	0	0	0	0	1	0	0
Slovenia	0	1	1	1	0	0	0	0	0
Spain	0	0	1	0	0	0	0	0	1
Taiwan	0	0	0	1	0	0	0	0	0
Czechia	1	1	1	0	0	0	0	0	1
England	1	1	0	0	1	1	0	1	1
Estonia	1	1	0	0	0	0	1	1	0
France	1	0	1	0	1	1	1	1	1
Latvia	1	0	0	0	1	0	1	0	0
Malta	1	0	0	1	1	0	1	0	1
Netherlands	1	1	1	0	0	1	0	1	1
Norway	1	1	0	0	1	1	0	1	1
Sweden	1	1	0	1	0	0	0	1	1

o There is a high level of reports of intimidation or abuse of teachers by students

AND

o There is high employment for graduates with no clear vocational route (i.e. not medicine, accountancy, engineering and so on) OR statutory working hours for teachers are low

OR

- Statutory working hours for teachers are low

AND

o There is a high level of reports of intimidation or abuse of teachers by students
OR
o there is a reported lack of resources in schools
AND
o teacher pay is low relative to the best pay in other fields

These are the conditions that identify a country with a teacher shortage, as opposed to one with no reported shortage. Note that the reported level of workplace stress for teachers, and the level of lesson preparation, are not needed in this logical statement of teacher shortages.

The implications are discussed in the final section. The results do not mean that other possible predictors are completely irrelevant. But the results do mean that the other predictors are not necessary to explain the differences between these countries.

Limitations of the study

The secondary analysis in this paper is necessarily correlational, which limits the kind of causal claims that can be made. Where there is no noticeable correlation it is reasonably safe to infer no causal link between that indicator and teacher shortages. A robust correlation might represent a situation where the indicator was a determinant of a teacher shortage, but this cannot be proven. Here, we rely on two other elements of a causal model (other than correlation and intervention) – time sequence and theoretical explanation (Gorard 2013). We use these two to help decide how to employ indicators in our model, as described throughout the text.

The countries involved are those for which there is the most complete data. Even so, some data was missing and we occasionally had to use a different year, or substitute a value with the overall mean (Gorard 2021). As with any study, there could be important indicators that were simply not available, despite this being the study that uses the most indicators, among all studies we have encountered in reviews (e.g. See, Gorard, and Gorard 2020). We used the data from the most recent and most complete year for all countries involved, and this usually meant ISCED2, so strictly the results in this paper are more concerned with secondary education than other phases.

Although many indicators are based on official data, some are based on aggregated self-reports. There is no real alternative to this when considering factors such as teacher stress.

Discussion

Some of the factors emerging from QCA are understandable but not really malleable, at least in education. These include whether much of the population lives in towns (about the level of development of the country and the ease of access to opportunities), and the level of employment for graduates from degrees with no clear occupational outcome (whether there is a ready pool of graduates seeking employment). One would not wish for high unemployment in other sectors in order to solve a teacher shortage. However, perhaps the message is that teaching needs to be made more attractive to a wider pool of graduates than currently. At least part of this would involve addressing the remaining four factors (See et al. 2023).

The simplest, but not necessarily the easiest, factor to address is the level of pay for teachers (relative to similar graduate occupations). This would not be a quick solution (assuming that any pay rises were commensurate rather than astonishing in scale), and so would need to be given time to work. The implication though is that any funding available for teacher pay is better given as salary increases rather than temporary incentives or bonuses (a supposed 'quick fix'). These do not seem to work long-term (See, Gorard, and Gorard 2020). Perhaps the issue is as much about the status of the teaching profession as it is about pay itself.

There is less likelihood of shortage where statutory (paid) working hours are higher, but teaching contact hours are lower. Teacher statutory working hours are negatively correlated with actual teaching hours (−0.28). More teaching is linked to shortages but total hours are not. This is something that can be addressed by policy (larger class sizes, or shorter, better-prepared lessons).

Finance is also related to the reported lack of resources in schools. This is actually a more important element of the logic above than relative pay is (appearing in more terms of the Boolean solution). 'Resources' could include staff, such as assistants and administrators as well as teachers themselves, therefore making this as much an outcome of shortages as a cause. However, it is most simply understood as referring to teaching and classroom resources. This could be remedied, probably more cheaply than increasing pay, and certainly more cheaply than providing incentives or bonuses for some staff/recruits.

A high level of reported abuse and intimidation of teachers by students would seem to be an obvious place for policy-makers to start addressing teacher shortages in the medium term, as it can apparently be addressed by policy and changes in practice, and would not need a major and enduring financial commitment. The approaches used to reduce such abuse and to increase respect for teachers would have to evidence-informed rather than led by dogma or intuition.

In fact, all of these suggestions would need to engineered or translated from evidence into a more usable form than it is possible to do here.

Many of the factors commonly attributed to teacher recruitment and retention relate to job status and working conditions, or what Herzberg called 'hygiene factors'. No one factor alone can explain teacher shortages. For example, teachers' pay may not be associated with teacher job satisfaction, and teachers' status, in turn, may not influence people's choice of teaching as a career. But most research does not look at these factors in combination. Research to understand individuals' choice of teaching as a career also

usually considers only those who are already in teaching or intending to teach, ignoring those who could potentially be teachers but chose not to be. Such research is not helpful in informing policy and practice.

To attract more people into teaching a much greater emphasis must be put into the attractors for those with the potential to be teachers but who are not currently interested (as opposed to merely offering those in teaching more of what they want). As above, steps could be taken to raise the profile and prestige of the profession, and any extra funding used to raise basic salaries, and provide schools with better resources, rather than temporary incentives or similar.

Incentives to deploy teachers to hard-to-staff schools are only a stop-gap measure. A longer-term benefit would come from reducing the diversity of schools, and reconsidering the ways in which school places are allocated to pupils. This would help eliminate schools with high levels of disadvantage, which are currently the hardest to staff. More creative approaches to retention, such as offering sabbaticals for professional development, could be tested.

These findings have been based on 18 countries with the most comparable data. Meantime our project has been conducting detailed case studies in other countries to improve the data known about them, or to plug gaps in our knowledge. The next step will be to repeat our analyses with a larger number of countries to assess the stability of the factors identified here.

Disclosure statement

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Notes on contributors

Stephen Gorard in Professor of Education and Public Policy at Durham University, and Director of the Durham Universiy Evidence Centre for Education (DECE).

Mark Ledger is a postdoctoral research fellow with the Durham University Evidence Centre for Education.

Beng Huat See is Professor of Education Research at Birmingham University.

Rebecca Morris is Associate Professor at the Department for Educational Studies, University of Warwick.

ORCID

Stephen Gorard http://orcid.org/0000-0002-9381-5991
Beng Huat See http://orcid.org/0000-0001-7500-379X

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