Measuring the quality of staffing deployment and quality of experiences across secondary school science departments in England

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1. Executive summary

This study combines survey and administrative data to explore whether secondary school science departments that teachers feel are good places to work also have good science teacher deployment. Science teacher perceptions of the quality of interactions they have with colleagues and current staffing deployment are captured via a survey of around 800 science teachers in England. The School Workforce Census is used to create an index of science department health, based on the qualifications, experience and retention of staff in the school.

Overall, science teachers tend to be reasonably positive about their departmental working environment with 21% saying it is a highly enjoyable place to work and just 8% saying they do not find it an enjoyable and stimulating working environment. Teachers in fee-paying schools and in schools with high GCSE science value-added tend to be far more positive about their working environment.

Teachers' perceptions of departmental working practices, as measured by the quality of their working relationships and the quality of professional development, are strongly associated with their enjoyment of the department overall. By contrast, the teacher reports of staffing suitability, in terms of collegial subject knowledge, suitability of staffing and class allocation were not strongly associated with their enjoyment of working in the department.

The teachers' reports of staff suitability in their school were more strongly related to their perception of the quality of the learning environment for students and the GCSE science value-added at the school.

An additional question on teachers' perceptions of collaborative planning in their department did not have a strong association with their enjoyment of the department overall or with the other questions on departmental working practices.

The open-ended responses suggest the survey missed some factors that are important in the enjoyment of departmental life and future surveys of science departments should include questions on the quality of facilities, including lab technician support, and on levels of collegial support towards each other.

2. Introduction

In secondary schools, class teachers' main collegial interactions are often with their subject department colleagues. These colleagues may help them directly with their daily work, may support their professional development, and may generally make the department a more enjoyable place to work. This report explores the associations between a set of survey questions about the nature of colleagues in a science department and whether the teacher feels their department is a good place to work.

Several research studies have investigated the organisation of secondary school departments. A study by Alma Harris and colleagues showed that higher performing secondary school departments tended to have effective organisation of teaching, rather than merely effective individual teachers.[1] The role of Head of Department has generally been found to be an important contributor to school improvement overall.[2] A Dutch study found an association between the nature of professional communities within secondary school departments and student achievement.[3]

Science departments share many similarities to other large departments such as English and maths, but with a small number of key differences. First, they nearly always have a place for colleagues to socialise within the department because there is usually a lab room for preparation of experimental materials. Second, they always face a complexity of how to arrange the teaching of the three subjects of biology, chemistry, and physics, which means that shortages in one of these subjects tend to affect everyone within the department. This complexity has been recognised as a factor in science department leadership.[4]

Our analysis brings together data from two sources: an index of science department health based on analysis of the School Workforce Census and a survey of around 800 science teachers. We employ quantitative descriptive approaches such as regression and structural equation modelling to explore associations between teacher perceptions of their science department and measures of staffing quality. The goal is to explore whether science departments that the teachers describe as healthy in terms of the role suitability of their colleagues and the quality of their interactions are also the departments with suitably qualified teachers and low teacher turnover in the Census.[5]

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[1] Harris, A., Jamieson, I. & Russ, J. (1995). A Study of 'Effective' Departments in Secondary Schools, *School Organisation,* 15(3) 283-299.

[2] Brown, M. and Rutherford, D. (1999). A re-appraisal of the role of the head of department in UK secondary schools, *Journal of Educational Administration*, Vol. 37 No. 3, pp. 229-242. https://doi.org/10.1108/09578239910275472

[3] Lomos, C., Hofman, R.H. & Bosker, R.J. (2011). The relationship between departments as professional communities and student achievement in secondary schools, *Teaching and Teacher Education,* 27(4), 722-731.

[4] Chandler-Grevatt, A. (2023). *Science Leader Perspectives on Managing Science Departments*, Association for Science Education Report.

[5] This work contains statistical data from ONS which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the

3. Data description

3.1 The Teacher Tapp survey

The Teacher Tapp survey panel comprises teachers across the state and private sectors in England who download a mobile app, provide valid teacher and school credentials, and allow it to notify them of new questions at 3:30pm. Teachers are recruited to the panel via social and traditional media, promotion at CPD events, and via word of mouth in schools.

The target sample for this study included all those who teach science in mainstream state and private schools in England, regardless of whether science is their primary subject. We therefore selected teachers to receive the survey questions based on a filter question:

Do you currently have any of the following roles within science teaching at your school:

A. Head of the science department or faculty
B. Head of biology or chemistry or physics or KS3/4/5 science (or similar responsibility within science)
C. Teaching science for at least 3 hours a week this academic year
D. Teaching science, but for less than 3 hours a week this academic year
E. No, I have no roles within the science department [excluded from sample]

Teacher Tapp routinely collects both school and teacher demographic characteristics, which are used in the study and are summarised in the description of the sample in Table 1 below. Most of this demographic information is collected via survey questions, but school background information is matched via the school's Unique Reference Number. This includes the school's last Ofsted rating, Progress 8 and science GCSE value-added, both grouped into quartiles.

Science teachers tend to have a specialism in either biology, chemistry or physics, which might reflect any number of their own A-level subjects, their degree subject, their teacher training specialism or their teaching experiences. We ask all science teachers to choose which of the three sciences they feel their subject knowledge is strongest.

We ask the teachers in our sample the following questions about their science department, each with a 4-point response scale from of strongly agree, somewhat agree, somewhat disagree and strongly disagree:

- Thinking of those who teach science at your school, which of the following statements best aligns with your perceptions of their subject knowledge?
- Our science department is currently well-staffed with suitably qualified teachers

interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

- In our science department, a lack of suitably qualified and experienced staff means we cannot always give teachers the class allocations they would ideally want
- Science teachers at my school have a strong working relationship with each other
- Do you plan collaboratively with your colleagues in science?
- Our science department provides an environment where everyone is able to get better at teaching through professional development, observations and other collaborations
- To what extent does your school's science department provide teachers with an enjoyable and stimulating environment to work in?
- To what extent does your school's science department provide students with an enjoyable and stimulating environment to learn?

At the end of the survey, we invite them to write an open-text response to the question:

- Please tell us what makes your science department a good or less good place to work

3.2 The science department health index

The Schools Workforce Census (SWFC) is an administrative dataset owned by the Department for Education and made available to researchers on application. It provides a rich set of information on school staff, including demographic, employment, absence, qualification and curriculum data on teachers working in state schools in England.

Based on data from the 2021 SWFC, we created an index to measure science department health. The index is made up of scores in three areas that we believe embody the health of a school science department. These are:

- Qualifications: does the school have a sufficient number of specialists in each of the three main science subjects (biology, chemistry, physics)
- Experience: does the department have a broad range of teaching experience?
- Retention: does the department have a good level of stability in their staffing?

There are various ways of measuring each of these domains using data from the SWFC. The measures that we used are:

- Qualifications
    - % of teaching hours taught by staff who hold physics degrees
    - % of teaching hours taught by staff who hold chemistry degrees
    - % of teaching hours taught by staff who hold biology degrees
- Experience
    - % of staff with QTS
    - % of staff with >= 3 years of experience

    - % of staff with TLR
- Retention
    - % of staff who are in the same school as the previous year

We brought the experience measures together using factor analysis. The qualifications domain proved slightly more complicated and we decided that the indicators in this domain couldn't be effectively combined into one factor; they did not appear to be measuring a single underlying construct. It was not uncommon for schools to have a high proportion of teaching hours taught by staff who hold biology degrees, but to have very low proportions taught by staff with physics or chemistry degrees. To account for this, we took a different approach: we transformed the raw indicators exponentially before combining them to create a score for the domain. We weighted the indicators relating to chemistry and physics more heavily than those relating to biology; we applied weights of 1 to chemistry and physics indicators and 0.1 to biology.

We then transformed the scores for each domain into percentile ranks from 0-1, with 0 being the least healthy and 1 the most. Finally, we added the domain scores together to create a final score and ranked the eligible schools.

Unfortunately, missing and incomplete data is an issue when working with the SWFC. Missingness occurs at several stages:

- Each year, a number of eligible schools do not return the curriculum module of the SWFC; without this module, we are unable to identify which teachers in the school teach science and so can't calculate any of the measures
- A further group do not return complete data on qualifications, leaving us unable to calculate the qualifications measures
- Finally, a number of schools had failed to return data in the previous year, meaning that the retention measures cannot be calculated

We excluded any schools that did not have data available for all of the measures used in the creation of the index. For data protection reasons, we also excluded all schools with fewer than five science teachers.

3.3 Comparison of sample and population

There are no sample weights applied to the group of science teachers to responding to the survey. Table 1 summarises the demographic characteristics of the Teacher Tapp sample.

The sample is similar to the latest SWFC figures[6] on the national population of teachers in terms of age and gender. Determining whether it is representative in terms of perceived greatest subject strength is more challenging: this is not directly recorded in the SWFC. However, earlier analysis of the deployment of science teachers[7] has shown that, of those science teachers with degrees in one of the

[6] National figures show a 35%/65% male/female split for secondary school teachers, and a 20%/33%/28%/20% split for teachers in their 20s/30s/40s/50+. https://explore-education-statistics.service.gov.uk/find-statistics/school-workforce-in-england/2022, accessed 15 December 2023

[7] https://ffteducationdatalab.org.uk/2023/04/the-deployment-of-science-teachers/

three main science subjects, the breakdown by main subject is 49% / 29% / 22% for biology, chemistry and physics / engineering respectively. This compares to a split of perceived greatest subject strength of 41% / 33% / 23% in our sample.

Respondents include a high proportion of staff who have been in the same school for a relatively long period. Nearly half (48%) of respondents have been in their school for more than five years. Earlier work suggests that retention rates for science teachers in the same school are as low as 70% year on year.[8]

Table 1: Demographic characteristics of science teachers in survey

		Teacher Tapp Survey	
		All % / mean	State-funded only % / mean
Number of teachers		816	740
Age	Age in 20s	20%	21%
	Age in 30s	34%	34%
	Age in 40s	30%	29%
	Age in 50s+	15%	16%
Years of experience	Less than 5 years	24%	24%
	Between 5 and 10 years	22%	22%
	Between 10 and 20 years	36%	35%
	Over 20 years	19%	19%
Sex	Female	66%	67%
	Male	34%	33%
Tenure	Less than 2 years	26%	25%
	Over 2 and less than 5 years	26%	27%
	Over 5 and less than 10 years	27%	27%
	More than 10 years	21%	21%
Role	Head of department or faculty	20%	20%
	Minor leadership role	28%	27%
	No leadership responsibility	53%	52%
Science A-levels	Biology	60%	61%
	Chemistry	72%	72%
	Physics	42%	41%
Perception of greatest subject strength	Biology	40%	41%
	Chemistry	33%	33%
	Physics	24%	23%
	I cannot choose between the three	3%	4%

Most of the analysis in this report includes all the science teachers described above. Analysis of the relationship between survey responses and index scores is based on a subset of the data: those schools that both submitted a survey response, and for which an index score is available. Table 2 below shows the differences in characteristics between state-funded survey respondent schools and those for

[8] https://ffteducationdatalab.org.uk/2023/04/the-deployment-of-science-teachers/

survey respondent schools that have an index score available. (Note that not all schools have Ofsted ratings or GCSE performance data.)

Survey respondent schools included a relatively high number of affluent schools, and a relatively low number of deprived schools. Responses were slightly more likely to come from small than large schools. A relatively high proportion of respondent schools have an outstanding Ofsted inspection rating; for secondary schools nationally, the current proportion with an outstanding rating is 15%[9], compared to 23% of respondent schools. Attainment in respondent schools was very slightly higher than average, which stands at zero for all schools nationally.

The schools for which index scores are available are generally similar to the state survey respondents. The main difference is that there are fewer small schools with index scores available. This reflects the fact that we excluded schools with fewer than five science teachers from the index calculations for data protection reasons. Schools with index scores also had very slightly higher Progress 8 and Science VA scores, on average, than survey respondents as a whole.

Table 2: Characteristics of state schools in Teacher Tapp sample versus those with an index score

		Teacher Tapp Survey		Index scores	
		% / mean	(S.D.)	% / mean	(S.D.)
Number of schools		609		427	
Free-school meals proportion	Q1 Affluent	32%		33%	
	Q2	26%		26%	
	Q3	24%		24%	
	Q4 Deprived	18%		16%	
School size	Q1 Small	28%		20%	
	Q2	26%		31%	
	Q3	24%		26%	
	Q4 Large	22%		23%	
Ofsted inspection rating	Outstanding	23%		19%	
	Good	61%		64%	
	Requires Improvement or Inadequate	16%		13%	
School performance	Progress 8	0.04	(0.47)	0.06	(0.47)
	Science GCSE VA	0.04	(0.53)	0.05	(0.52)

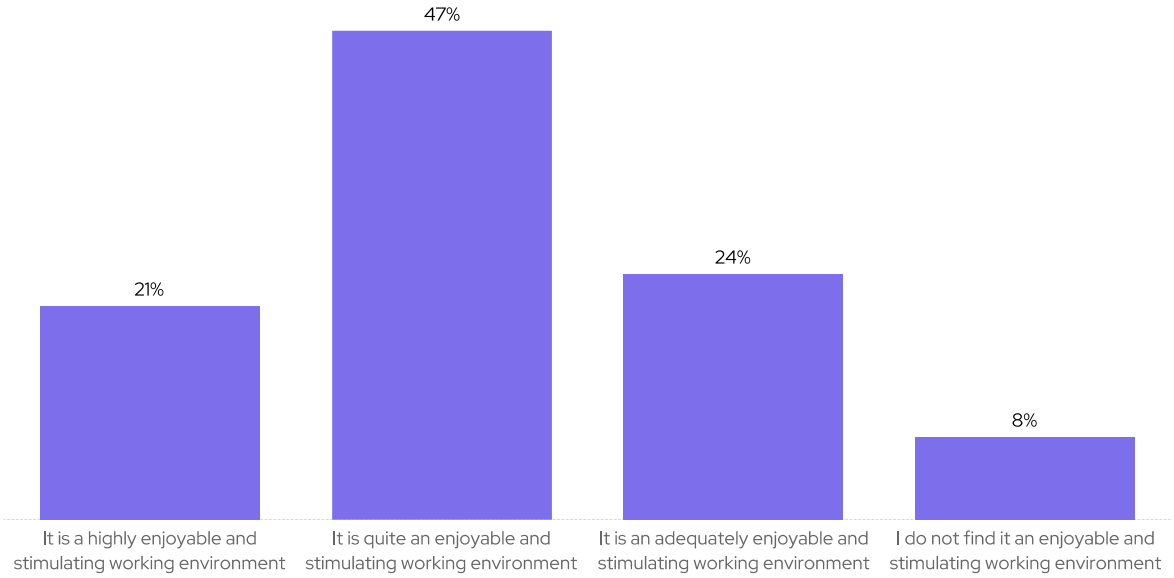
[9] Based on Ofsted management information published 12 December 2023.

4. Findings

4.1 Overall perceptions of science department environment by teacher characteristics

In this section we explore the survey question that asks how enjoyable and stimulating their science department is to work in overall. 21% of science teachers said they felt their department was highly enjoyable and stimulating and at the other end of the scale just 8% of science teachers said they did not find it an enjoyable and stimulating environment.

Figure 1: Overall responses to whether their science department provides an enjoyable and stimulating working environment



As we interpret these survey questions it is important to remember that teacher responses are likely to reflect both the objective quality of the environment they experience and their subjective feelings about the environment. These subjective feelings mean that two teachers working in the same science department may have very different feelings about how enjoyable and stimulating it is, even if they encounter the same conversation every day. We can illustrate how consistent teachers within the same science department by looking at the instances where there are two Teacher Tapp respondents working in the same school. Whilst 564 science teachers are the only respondent from their school in the sample, there are 87 schools with two teachers, 20 schools with three teachers, two schools with four teachers and two schools with five science teacher respondents. If we look at the schools with two science teachers, 40% of the time they select the same overall response, 43% of the time they select adjacent responses, 16% of the time they select responses that are two places apart (e.g. one says it is quite enjoyable and the other says it is not enjoyable), and 1% of the time they select the opposite extremes of the scale! These differences in responses of teachers in the same department are not huge and we suspect they could be for any of the following

reasons: objectively different daily experiences; subjectively different interpretations of similar experiences; differences in perceptions of the scale (e.g. the meaning of 'quite'), or even errors or lies in their responses.

In Table 3, we show how overall perceptions of the science department vary by teacher demographics. Some differences are of substantive interest to us. For example, it is the oldest science teachers who are most likely to say that their department is not an enjoyable place to work, but there are not sex or subject specialism differences in enjoyment. Those who have been at the school less than two years are most likely to express disquiet and may indeed seek to move schools to resolve this! The Heads of Department are the most positive about whether their department is an enjoyable and stimulating place to work, with 26% saying it is highly enjoyable compared to 19% of other science teachers. This greater positivity isn't surprising, and we did consider dropping Heads of Department from the sample altogether on the basis they might find it difficult to be objective. However, given the differences in positivity are not large we decide to keep them in sample.

Table 3: Overall perception of department, by demographic characteristics

		Highly enjoyable	Quite enjoyable	Adequately enjoyable	Not enjoyable
Age	Age in 20s	24%	50%	22%	5%
	Age in 30s	17%	47%	26%	9%
	Age in 40s	22%	50%	22%	6%
	Age in 50s+	22%	40%	24%	13%
Years of experience	Less than 5 years	17%	47%	28%	8%
	Between 5 and 10 years	22%	44%	23%	11%
	Between 10 and 20 years	19%	51%	24%	7%
	Over 20 years	26%	47%	20%	6%
Sex	Female	21%	47%	24%	8%
	Male	20%	49%	23%	8%
Tenure	Less than 2 years	23%	44%	23%	10%
	Over 2 and less than 5 years	16%	49%	27%	7%
	Over 5 and less than 10 years	23%	45%	25%	8%
	More than 10 years	22%	54%	18%	6%
Role	Head of department	26%	48%	21%	4%
	Minor leadership role	19%	51%	24%	6%
	No science responsibility	19%	46%	25%	10%
Science A-levels	Biology	21%	46%	24%	9%
	Chemistry	21%	48%	24%	7%
	Physics	21%	47%	25%	7%
Perception of greatest subject strength	Biology	22%	44%	26%	8%
	Chemistry	21%	49%	21%	8%
	Physics	18%	50%	25%	8%
	I cannot choose between the three	18%	61%	18%	4%

4.2 Overall perceptions of science department environment by school characteristics

Table 4 shows how teachers' perceptions of their science department vary by school demographic characteristics. As we interpret this table, we must remember that teachers are not randomly distributed across schools. Schools serving disadvantaged communities have more difficulties in recruiting teachers and will have staff that are more inexperienced and less likely to be subject specialists. Similarly, disadvantaged schools are far more likely to have a poor Ofsted rating or school progress/value-added score.

Looking at the final column of the table, those who are most likely to say that their science department is not an enjoyable and stimulating place to work are most likely to be found in: more disadvantaged schools, small schools, schools with poor science value-added, P8 or Ofsted rating.

Table 4: Overall perception of department, by school characteristics

		Highly enjoyable	Quite enjoyable	Adequately enjoyable	Not enjoyable
Overall	Overall	21%	48%	24%	8%
Free-school meals proportion	Fee-paying	38%	43%	14%	4%
	Q1 Affluent	21%	57%	18%	4%
	Q2	18%	45%	28%	10%
	Q3	21%	42%	30%	8%
	Q4 Deprived	16%	45%	24%	14%
School size	Q1 Small	23%	41%	25%	10%
	Q2	14%	54%	23%	9%
	Q3	20%	49%	25%	6%
	Q4 Large	27%	47%	21%	5%
Ofsted inspection rating (state schools - where available)	Outstanding	25%	52%	16%	6%
	Good	19%	49%	24%	8%
	Requires Improvement or Inadequate	14%	39%	32%	15%
School Progress 8 (state)	P8 Q1 (low)	13%	42%	29%	16%
	P8 Q2	20%	44%	28%	9%
	P8 Q3	18%	55%	21%	5%
	P8 Q4 (high)	22%	53%	22%	3%
School Science VA (state)	SciVA Q1 (low)	13%	39%	34%	15%
	SciVA Q2	18%	47%	28%	8%
	SciVA Q3	20%	55%	16%	9%
	SciVA Q4 (high)	23%	54%	22%	1%

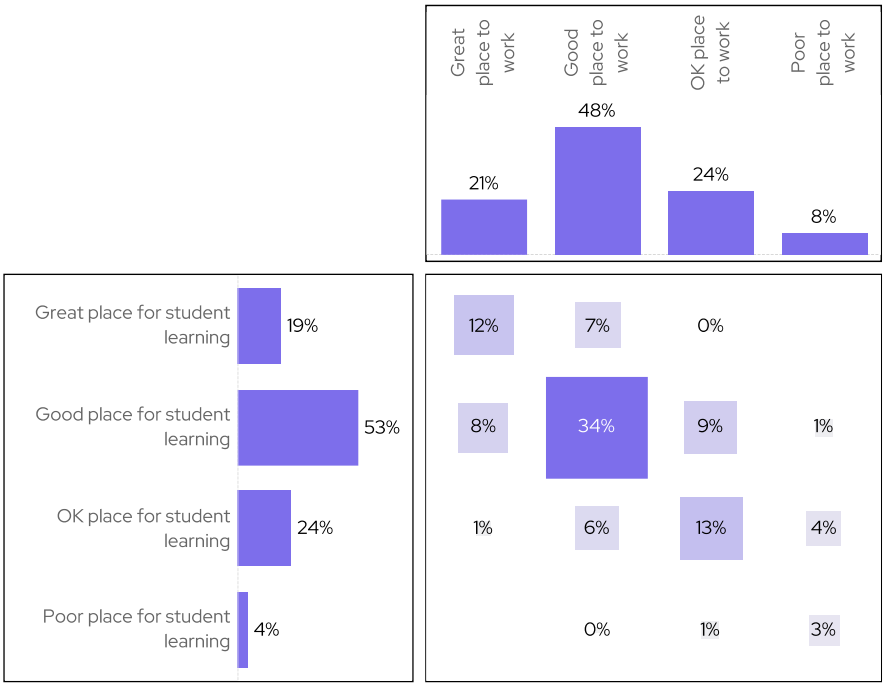
Whilst we cannot place any sort of causal interpretation on these differences, an ordinal regression (not shown here) does indicate that the smaller schools are still seen as less enjoyable environments, even when we condition on school free school meals quartile. The differences in responses by Ofsted rating still hold, conditional on free school meals and school size quartile. The Progress 8 and science value-added variables are highly correlated (0.89) so when included separately, both are strongly related to overall perceptions of the department. Furthermore, when

included in an ordinal regression for state schools only, no other relationships hold (i.e. FSM and size are insignificant).

We can use these ordinal regressions to confirm that our finding that short tenure teachers are least positive holds, even conditional on school characteristics. Similarly, our teachers in their 50s are still the least positive, even conditional on school characteristics.

Whilst it is beyond the scope of this project to analyse what makes science departments an effective and enjoyable place to learn, we did ask the teachers for their views of whether the department was a good place for students to learn. Teachers were generally positive, with just 4% feeling their department was a poor place for student learning and 24% feeling it was an adequate place to learn. Figure 2 shows that there is a strong relationship between teacher's perception of their department as a place to learn and as a place to work.

Figure 2: Relationship between teachers' perceptions of working environment versus learning environment for students.



4.3 Describing elements of departmental environment

We want to explore what elements of departmental staffing characteristics are associated with teachers feeling it is a good place to work overall. We use six survey questions to measure elements of staffing.

The first three questions largely relate to the suitability of staff in the science department, with the hypothesis being that it is more enjoyable to work in an environment where science teachers can be deployed to teach classes they are

best suited for and where rich professional conversations can take place. These three questions are:

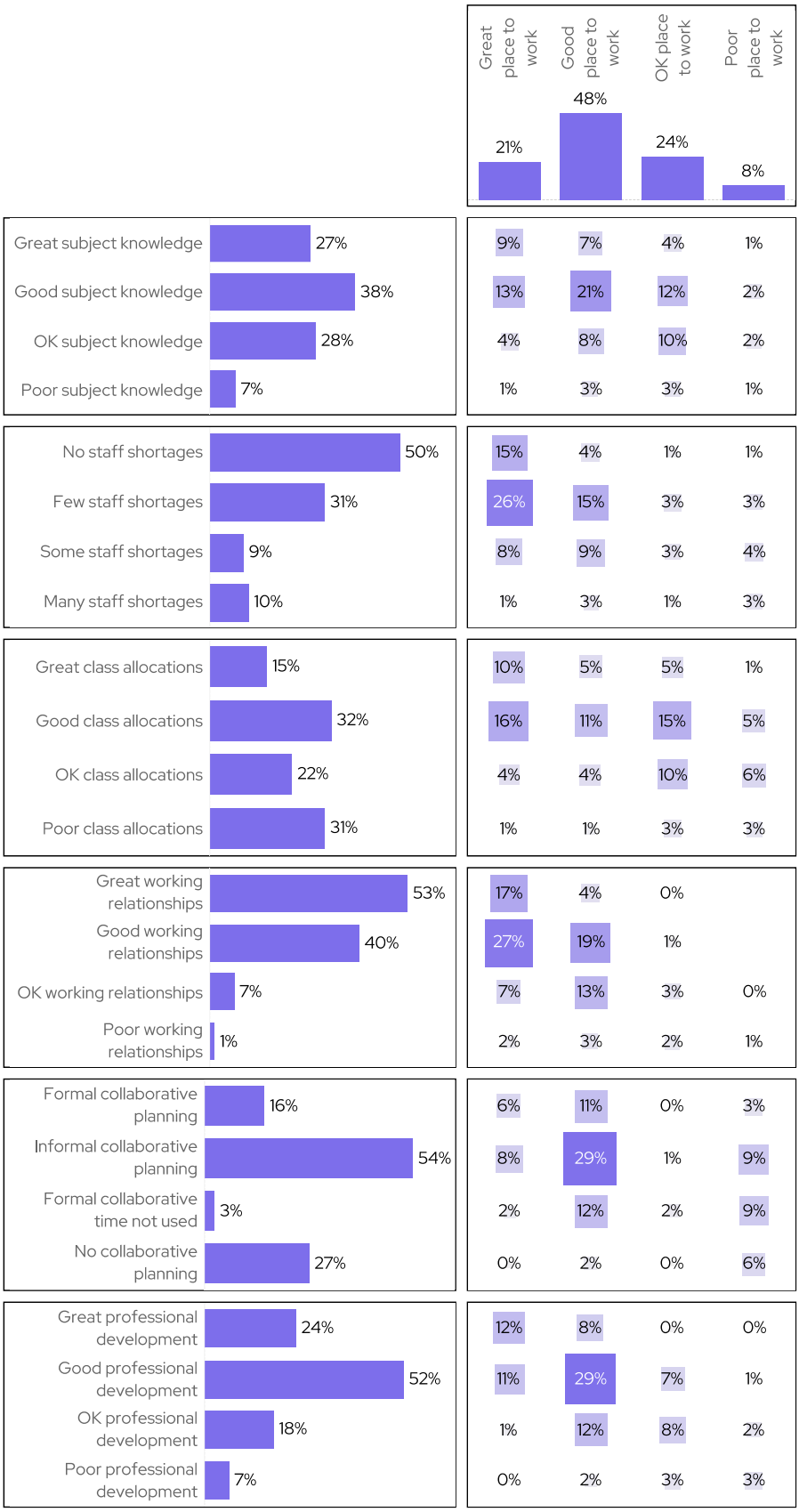
- **Subject knowledge:** Thinking of those who teach science at your school, which of the following statements best aligns with your perceptions of their subject knowledge?
- **Staff shortages:** Our science department is currently well-staffed with suitably qualified teachers
- **Class allocations:** In our science department, a lack of suitably qualified and experienced staff means we cannot always give teachers the class allocations they would ideally want

The next three questions relate to the nature of how teachers work together and support each other within the science department:

- **Working relationships:** Science teachers at my school have a strong working relationship with each other
- **Collaborative planning:** Do you plan collaboratively with your colleagues in science?
- **Professional development:** Our science department provides an environment where everyone is able to get better at teaching through professional development, observations and other collaborations

Figure 3 shows how these responses to these survey questions are related to the question about the overall perceptions of working in the science department. Two survey questions have a clear and strong relationship with the overall perceptions of the department: working relationships and professional development. Overall, the three questions about the suitability of staff are less strong related to the overall perception of the department. It is clear that the question about collaborative planning is measuring quite a different construct.

Figure 3: Relationship between overall and individual dimensions of environment



We use an ordinal logistic regression to provide insights in how each survey question's responses correlate with the overall measure, conditional on the other responses. For each variable, the most positive response (i.e. 'great') is the reference category. The first column shows the change in outcome associated with moving from 'great' to 'good', holding other variables constant. The second and third columns show the changes associated with moving from 'good' to 'ok' and from 'ok' to 'poor', respectively.

Table 5 below shows the coefficients and their corresponding standard errors for each predictor variable across the different categories of the outcome variable measuring the teachers' overall perception of their departmental working environment. The size of the coefficients in relation to the standard errors confirm that both professional development and working relationships are strongly predictive of the teacher's overall rating of their working environment, conditional on all other factors.

Table 5: Ordinal logistic regression of overall perception of working environment

	Great to good		Good to OK		OK to poor	
Constant	-0.6553	(0.2421)	-3.9240	(0.3892)	-7.8822	(0.7435)
Subject knowledge	0.1176	(0.1400)	0.2036	(0.1799)	-0.5103	(0.2874)
Staff shortages	0.1748	(0.1761)	0.4120	(0.2064)	0.9528	(0.2623)
Class allocations	0.1881	(0.1309)	0.4707	(0.1680)	0.6486	(0.2419)
Working relationships	0.6582	(0.2572)	1.4689	(0.2979)	2.0057	(0.3609)
Collaborative planning	0.0361	(0.1287)	0.2130	(0.1550)	0.6173	(0.2168)
Professional development	1.3586	(0.2137)	2.1696	(0.2617)	3.0087	(0.3355)

Note: Log-likelihood: -597.07; AIC: 1236.13

4.4 Identifying common factors to describe departmental environment

We now look at the extent to which these individual factors describing departmental environment are related to each other. Figure 4 illustrates the relationship between the three survey questions measuring the suitability of staff in the science department. Whilst the direction of the relationships is as expected, the strength of the correlations is perhaps not as high as one might think.

Figure 4: Relationship between questions measuring staff suitability

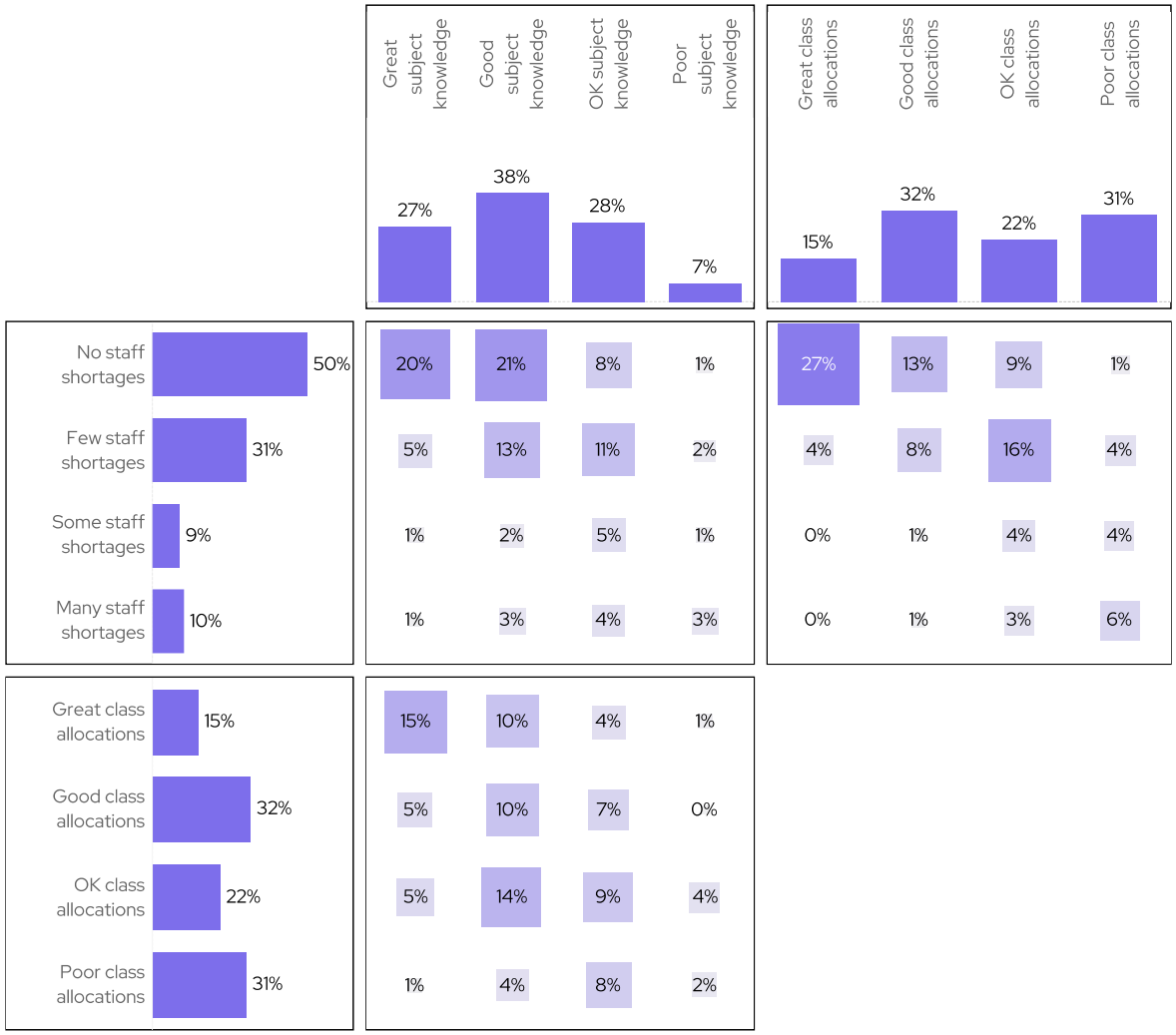
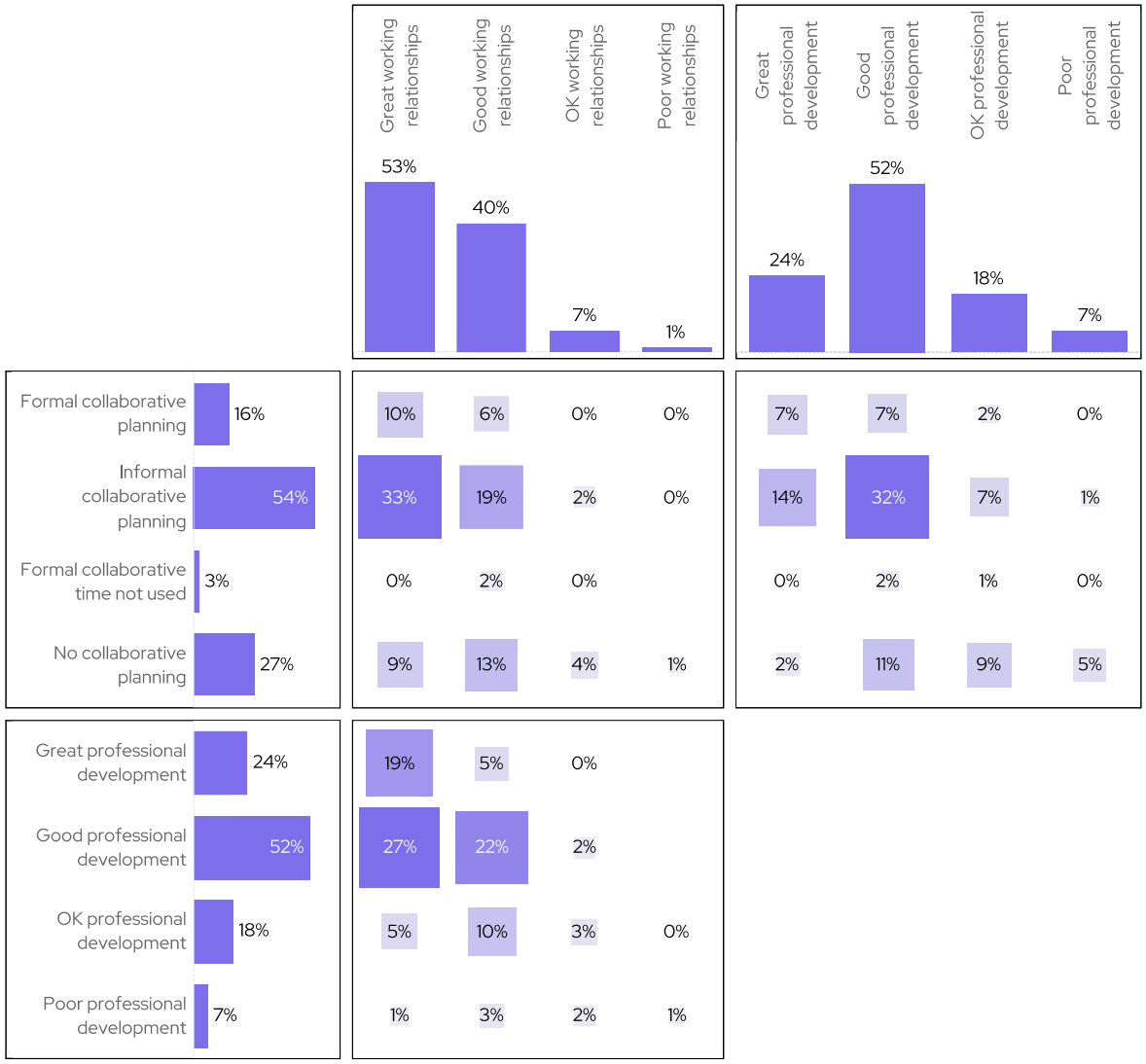


Figure 5 shows the relationships between the questions measuring working practices within the department. Here the relationship between the strength of working relationships and professional development look relatively strong, but the collaborative planning question is not consistent with other measures of working practices.

Figure 5: Relationships between questions measuring working practices



We use a polychoric correlation to measure the strength and direction of the association between these ordinal variables, taking into account the underlying latent continuous variables that are assumed to be related. Table 6 shows stronger relationships between the three questions measuring staffing suitability. In addition, the professional development and working relationships questions are relatively strongly correlated, but collaborative planning practices are less strongly related to everything else.

Table 6: Polychloric correlation between underlying departmental characteristics

	Subject knowledge	Sufficient staffing	Class allocations	Working relationships	Plan collaboratively	Professional development
Subject knowledge						
Sufficient staffing	0.50					
Class allocations	0.40	0.67				
Working relationships	0.32	0.36	0.23			
Plan collaboratively	0.11	0.21	0.10	0.32		
Professional development	0.24	0.30	0.20	0.55	0.45	

The correlation between the different responses suggests that there are two latent variables being described. The responses to the first three questions are describing how well-staffed you feel your department is, and the second whether you enjoy working with your colleagues.

Therefore, to adequately capture these in an analysis, we should instead look at using a structural equation model instead of the regression, building these two latent variables as indicators of a teacher's view of their department.

The model is specified as follows:

Latent variables:

- **Staff suitability =** subject knowledge + sufficient staffing + class allocations
- **Working practices** = working relationships + plan collaboratively + professional development

Outcome responses:

- Perceptions of working environment = staff suitability + working practices
- Perceptions of learning environment = staff suitability + working practices
- Science value-added = staff suitability + working practices + FSM Quartile

With the following output:

Table 7: Structural equation model

Latent variables:	Estimate	Standard error	z-value	P(>|z|)
Staff suitability =~				
Subject knowledge	1.000			
Sufficient staffing	1.960	0.205	9.577	0.000
Class allocations	1.707	0.178	9.612	0.000
Working practices =~				
Working relationships	1.000			
Plan collaboratively	1.129	0.121	9.318	0.000
Professional development	1.410	0.108	13.099	0.000
Latent variables:	**Estimate**	**Standard error**	**z-value**	**P(>|z|)**
Working environment =~				
Staff suitability	0.155	0.102	1.529	0.126
Working practices	1.384	0.129	10.766	0.000
Learning environment =~				
Staff suitability	0.285	0.095	3.015	0.003
Working practices	0.967	0.108	8.998	0.000
Science value-added =~				
Staff suitability	21.072	7.519	2.802	0.005
Working practices	7.784	7.363	1.057	0.290
Free school meals quartile	11.043	1.982	5.572	0.000

So, the feeling of whether or not you think you have an enjoyable and stimulating workplace is mainly driven through the relationship and working practices that teachers have with their colleagues. In fact, whether or not you feel that your workforce is sufficiently well-staffed has little bearing on the subject.

However, the reverse is true when looking at the value-added score from science. Here, the best predictors of science GCSE performance are the quality of the staffed workforce and the FSM quartile of the school. This reflects a clear distinction between the quality of the learning environment for students, where suitably qualified staff are important, and the quality of the learning environment for teachers, where quality of interactions with colleagues matters most.

4.5 Relation between index score and survey responses

In this section we look at how the index scores calculated based on data in the School Workforce Census (SWFC) compare to survey responses. As well as overall index scores, we will also look at sub-scores in each of the three areas that make up the index: experience, qualification and retention.

The analysis in this section is necessarily limited to those schools that both completed the survey and for which an index score exists. This excludes private schools, which are not included in the SWFC, and state-funded schools with incomplete records in the SWFC. For data protection reasons, we also excluded schools with fewer than five science teachers when calculating index scores. This leaves a sample of 427 schools, considerably fewer than used elsewhere in this report.

We start by looking at the correlation between teachers' overall perception of how enjoyable and stimulating their science department is to work in and their school's

index score. As shown in Table 8, there is a small positive correlation between index score and teachers' perception. The correlation between teachers' perception and the sub-scores for qualifications and for retention are similar, while the correlation for the sub-score for experience is relatively low.

Table 8: Kendall's Tau correlation between index score and overall perception of department, by school characteristics

		Overall index score	Experience	Qualifications	Retention
Overall	Overall	0.12	0.03	0.11	0.11
Free-school meals proportion	Q1 Affluent	0.10	0.03	0.13	0.06
	Q2	0.13	0.07	0.13	0.05
	Q3	0.10	-0.05	0.10	0.12
	Q4 Deprived	0.09	-0.01	-0.03	0.22
School size	Q1 Small	0.21	0.17	0.09	0.13
	Q2	-0.11	-0.17	-0.09	0.02
	Q3	0.17	0.03	0.22	-0.01
	Q4 Large	0.13	0.03	0.15	0.12
Ofsted inspection rating (where available)	Outstanding	0.14	0.06	0.10	0.10
	Good	0.11	0.02	0.12	0.09
	Requires Improvement or Inadequate	0.05	-0.10	0.06	0.11
School Progress 8	P8 Q1 (low)	-0.05	-0.03	-0.06	-0.02
	P8 Q2	0.20	0.06	0.13	0.20
	P8 Q3	0.10	-0.03	0.10	0.13
	P8 Q4 (high)	0.13	0.05	0.13	0.04
School Science VA	SciVA Q1 (low)	0.04	0.02	-0.08	0.11
	SciVA Q2	0.12	0.08	0.11	0.07
	SciVA Q3	0.13	0.01	0.09	0.13
	SciVA Q4 (high)	0.04	-0.06	0.12	0.00

When we look at the correlation broken down by school characteristics, we can see that the overall index score is less closely correlated with teachers' perception in more challenging schools; that is, those with poor Ofsted ratings, and in the lowest quartile for Progress 8. It is more closely correlated in small schools, those with top Ofsted ratings, and those with high Progress 8 scores.

Next, we consider the relationship of the index sub-scores to some of the individual survey questions. Table 9 shows that the first three questions, those focused on the suitability of staff in the science department, are most closely related to index scores, as we might expect given that the index had a similar focus. The correlation between the qualifications sub-score and the subject knowledge survey question is slightly higher than for the other sub-scores, again as we might expect, as is the correlation between the retention sub-score and the sufficient staffing survey question.

Table 9: Kendall's Tau correlation between index score and underlying departmental characteristics

	Overall index score	Experience	Qualifications	Retention
Subject knowledge	0.19	0.12	0.15	0.14
Sufficient staffing	0.18	0.11	0.11	0.15
Class allocations	0.18	0.13	0.13	0.13
Working relationships	0.08	0.03	0.06	0.06
Plan collaboratively	0.00	-0.07	0.01	0.04
Professional development	0.01	-0.04	0.00	0.06

Next, we used ordinal regression models to model the relationship between overall perception of working environment and the six survey questions, with and without index score. We found a small improvement in the fit of the model when adding in index scores, as shown in table 10.

Table 10: Ordinal logistic regression of overall perception of working environment, with and without index scores

Model	AIC
Perception =~	
Survey questions	822.96
Perception =~	
Survey questions + Overall index score	820.34

Finally, we refit the structural equation model, this time including index score as an additional latent variable, producing the following output:

Table 11: Structural equation model, with index score

Latent variables:	Estimate	Standard error	z-value	P(>|z|)
Staff suitability =~				
Subject knowledge	1.00			
Sufficient staffing	1.73	0.18	9.46	0.00
Class allocations	1.62	0.18	9.27	0.00
Working practices =~				
Working relationships	1.00			
Plan collaboratively	1.20	0.14	8.68	0.00
Professional development	1.50	0.13	11.95	0.00
Index score	1.00			
Latent variables:	**Estimate**	**Standard error**	**z-value**	**P(>|z|)**
Working environment =~				
Staff suitability	0.17	0.11	1.57	0.12
Working practices	1.29	0.14	9.48	0.00
Index score	0.12	0.06	2.10	0.04
Learning environment =~				
Staff suitability	0.27	0.11	2.59	0.01
Working practices	0.97	0.12	8.08	0.00
Index score	0.09	0.05	1.74	0.08
Science value-added =~				
Staff suitability	0.17	0.07	2.30	0.02
Working practices	0.09	0.07	1.23	0.22
Index score	0.02	0.04	0.43	0.67
Free school meals quartile	0.19	0.02	9.63	0.00

Adding the index score to the model contributes little additional insight: the latent variable on working practices still contributes most to the outcomes on working and learning environment, while the latent variable on staff suitability is still most closely related to science VA.

Overall, then, the index scores do bear some relation to whether teachers think their department is a good place to work, but that relationship is fairly weak. It tends to be weaker for challenging schools, particularly those with a low Ofsted rating. The weakness of the relationship may partly reflect the fact that the index is based entirely on measures of the suitability of staff in the department. As we have seen, teachers' overall perception of their department is much more closely related to the survey questions on working practice than those on staff suitability. However, the correlation of the index with the questions on staff suitability is also fairly weak.

4.6 Improving surveys of departmental environment

There are teachers who report relatively poor perceptions of overall working environment, even though their responses to these individual questions are positive, and vice versa. This suggests there may be factors that determine how teachers feel about their working environment that were not captured within these survey questions. So, in this section we use their open-ended responses to a question that simply asks why they gave the response they did to the question about working environment to establish whether there are new survey questions we should develop for the future.

First, we identify the teachers who responses to all the questions were not consistent with the ordinal logistic regression estimates presented in Table 5, i.e. they had a large residual (unexplained) value in the regression. For teachers who are negative on sub-dimensions but positive overall, they seem to be people that, despite objectively difficult situation enjoy the day-to-day experience of work in their science department.

Why? They say they have appreciation for the people around them with comments such as:

- *"Supportive colleagues who will always step in if you need help"*
- *"Cohesion and banter"*
- *"We love each other and the students, are aware of our flaws but strive to improve"*
- *"A good place as we actually like each other and there are no competing egos! There is a strong team ethic and we all support and look out for each other, professionally and personally. This is also noticed by students and other colleagues. I feel very fortunate."*

Teachers who are positive on the sub-dimensions but negative overall, they report a wider variety of issues that lead them to not enjoy their working environment. Some are related to interpersonal relations, but others are related to workload and resources. Quotes include:

- *"Lots of cliques, a lack of communication, unprepared technicians"*
- *"Facilities are really lacking. Labs are old-fashioned. We are a small school but only one lab has a working gas supply. Too many lessons take place in classrooms rather than labs"*
- *"Not enough time to meet expectations, constant meetings and deadlines. No work/ life balance with stronger teachers taking the brunt to support weaker ones. Not a sustainable working environment"*

In addition to informally exploring these responses that are inconsistent with our model, we categorise the topic that each teacher mentions in the open-response questions using Latent Dirichlet Allocation (LDA). LDA works through the responses and assigns various words in them to a particular topic based on probability and context. We set the model to create seven topics, which are set out in Table 8 as a list of topics and associated list of words. It has some assumptions and drawbacks, namely that teachers using similar words are writing about similar topics and that topics can be drawn from individual words mentioned. Nevertheless, the analysis is good enough to give us some high level ideas about what types of topics might be missing from our original survey.

Table 8: Topics of open-responses used in Latent Dirichlet Allocation

Topic	Keywords	Description	Number of mentions	%
Resources and facilities	Resources, practicals, labs, equipment, technicians	Resources and facilities available, including labs, equipment, and the role of technicians	28	6%
Leadership dynamics	Leadership, team, science, lead, head, strong	Leadership roles, team dynamics, and the overall structure of the science department	31	6%
Supportive colleagues	Support, team, staff, colleagues	Supportive environment, camaraderie among staff, and positive work dynamics	189	39%
Teaching students	School, students, science, lessons, teaching	Teaching experiences, the nature of lessons, and student interactions within the school	27	6%
Workload	Work, time, workload, pressure, lot, marking	Challenges related to workload, time constraints, and the pressures of marking	32	7%
Staff shortages	Staff, shortage, teachers, recruitment, turnover	Challenges related to staff recruitment, shortages, and turnover rates	31	6%
Teaching curriculum	Science, curriculum, subject, level, knowledge	Teaching the science curriculum, teaching methodologies, and the depth of subject knowledge	151	31%

We can make a few overall observations about the types of topics that teachers mention in relation to their working environment. One is that there are very few mentions of staff shortages, although some other topics such as depth of subject knowledge are indicative of staffing quality issues.

Our questions seem to be missing something specific about the resources and facilities of the science department. Many science teachers provide unprompted comments on how fantastic their technicians are to work with. It's easy to see the role of technicians as merely delivering equipment for practicals, but perhaps they also tie together the coherence of the department as members of staff who might have supported the school for a long period of time.

Our survey questions also miss something important about leadership dynamics. These qualitative responses about leadership include mentions of issues with both the school's leadership team *and* the science department's leadership and future questions would have to take care to disentangle these issues.

Our survey questions also do not directly invite them to explain how they feel about their colleagues, and in particular whether they feel sufficiently supported and whether they enjoy the company of their departmental colleagues.

Whilst the question on collaborative planning was not successful within our original set of questions, it should be possible to craft a question on whether departmental planning and marking approaches lead to a sustainable workload for them.

Asking survey questions about students and the curriculum seems less straightforward. In the case of students, they are only mentioned within the open-responses in a positive sense. The nature of the responses about teaching and the curriculum are extremely diverse.

4.7 Do explanations for departmental qualities vary by school demographics?

We now provide some supplementary analysis of whether the predictors of working environments differ for different types of school demographics. Table 9 and Table 10 show the output from ordinal logistic regression models of working environment fitted separately to for state schools serving the most affluent 50% and the most deprived 50% of schools, respectively. We can compare the coefficients and standard errors to see if the relationships between the predictors and the outcome variable differ between the two groups. Within each of these two models, it is clear that only two variables are important contributors to variation in perceptions of working environment. These variables measure whether there is a culture of professional development and whether there are good working relationships between colleagues. In general, other relationships are less strong compared to the overall model shown in Table 5, suggesting that associations may have been confounded with other factors associated with school demographics.

Table 9: Ordinal logistic regression of working environment, most affluent 50% state schools

	Great to good		Good to OK		OK to poor	
Constant	-0.3034	0.2887	-3.3304	0.4626	-7.0090	0.9474
Subject knowledge	0.1111	0.1862	0.2318	0.2301	-0.7683	0.4324
Staff shortages	0.2572	0.2638	0.4801	0.3031	1.4564	0.3931
Class allocations	-0.0610	0.1753	0.2975	0.2210	0.2539	0.3333
Working relationships	0.6983	0.3455	1.7349	0.3983	2.5346	0.5233
Collaborative planning	-0.0719	0.1671	-0.1181	0.2035	0.1537	0.2922
Professional development	1.5210	0.2758	2.2126	0.3331	2.8227	0.4657

Note: Log-likelihood: -361.80; AIC: 765.60

Table 10: Ordinal logistic regression of working environment, most deprived 50% state schools

	Great to good		Good to OK		OK to poor	
Constant	-0.8285	0.4192	-3.7634	0.6141	-7.2268	1.0388
Subject knowledge	0.0799	0.2144	0.1320	0.2694	-0.4842	0.4081
Staff shortages	0.1472	0.2197	0.3140	0.2583	0.5523	0.3664
Class allocations	0.3712	0.1838	0.4674	0.2249	0.3895	0.3355
Working relationships	1.1103	0.4271	1.4291	0.4649	2.1435	0.5423
Collaborative planning	0.1065	0.2039	0.6488	0.2280	0.8003	0.3070
Professional development	0.9050	0.3220	1.8596	0.3753	3.1270	0.4887

Note: Log-likelihood: -281.67; AIC: 605.35

Table 11 explores whether the types of comments made by teachers in the open response question varies by type of school. Overall, it is hard to see any clear relationships. Issues of workload and staff shortages are generally more likely to be made by teachers do not rate their overall environment highly, but this is true across all types of schools.

Table 11: Mentions in open-responses, by school demographic and performance

	Enjoyable				Not enjoyable			
	High FSM		Low FSM		High FSM		Low FSM	
	+ve sci VA	-ve sci VA	+ve sci VA	-ve sci VA	+ve sci VA	-ve sci VA	+ve sci VA	-ve sci VA
Resources and facilities	3%	5%	5%	5%	15%	7%	2%	7%
Leadership dynamics	13%	7%	9%	5%	8%	5%	2%	3%
Supportive colleagues	16%	34%	42%	58%	31%	51%	39%	27%
Teaching students	3%	5%	8%	2%	0%	2%	7%	3%
Workload	3%	2%	6%	2%	8%	9%	12%	10%
Staff shortages	8%	3%	6%	2%	8%	5%	10%	10%
Teaching curriculum	55%	44%	25%	26%	31%	21%	27%	40%

5. Conclusion

Overall, science teachers tend to be reasonably positive about their departmental working environment with 21% saying it is a highly enjoyable place to work and just 8% saying they do not find it an enjoyable and stimulating working environment. Teachers in fee-paying schools and in schools with high GCSE science value-added tend to be far more positive about their working environment.

Teachers' perceptions of departmental working practices, as measured by the quality of their working relationships and the quality of professional development, are strongly associated with their enjoyment of the department overall. By contrast, the teacher reports of staffing suitability, in terms of collegial subject knowledge, suitability of staffing and class allocation were not strongly associated with their enjoyment of working in the department.

An additional question on teachers' perceptions of collaborative planning in their department did not have a strong association with their enjoyment of the department overall or with the other questions on departmental working practices.

The teachers' reports of staff suitability in their school were more strongly related to their perception of the quality of the learning environment for students and the GCSE science value-added at the school.

Data from the School Workforce Survey on staffing suitability in science departments is correlated with the teacher reports of staffing suitability, but the association is perhaps not as strong as expected. Unfortunately, it is hard to explore why this correlation is not stronger in these datasets. A better approach would be to use a clustered sample with multiple reports of staffing suitability from each school.

The open-ended responses suggest the survey missed some factors that are important in the enjoyment of departmental life. Future surveys of departmental life should consider capturing:

(1) The quality of resources and facilities, including the support of lab technicians
(2) Perceptions of the science department leadership
(3) If teachers find their departmental colleagues are supportive towards them
(4) Whether teachers enjoy student interactions during lessons
(5) How manageable teacher workload is
(6) Whether teachers like the science curriculum they were asked to teach