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Teachers' views of their primary school classrooms

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This article presents the views of 222 head teachers and classroom-based teachers about their experiences and perceptions of 193 specific classroom environments from 29 primary schools in 3 different areas in England, UK. One-to-one interviews were carried out focusing on teachers' perceptions about their classrooms throughout the year. It was found that teachers' views of their overall comfort were fairly high, despite widespread problems with overheating, stuffiness, glare and noise. Surprisingly, schools built in 1950s had the least negative feelings, while those since the 1990s to date had the highest. The teachers appear to be aware of the 'hard' aspects of the physical environment, but less conscious of the impact of 'softer' aspects, especially those with impact on the level of stimulation created.

Keywords: classrooms; comfort; design; perception; primary schools; problems; teachers; qualitative survey

1 Introduction

Change is an enduring feature of our education system, be it pedagogical, management or policy. However the built environment of that system, the school is slower and harder to adapt to these changes and so this increases the importance of understanding how their environment is working to fit their needs, in terms of both functionality and comfort. Given that in England alone in 2012 there were over three and half million primary school children (DfE 2013) – a figure that is projected to rise; this is a substantial issue.

The HEAD (Holistic Evidence and Design) project was built on a long-term endeavour to address this knotty real-world problem. It was carried out within an overarching pragmatic critical realist worldview (Johnson and Duberley 2000). An objective ontological stance was taken, that is, that there is a world to be studied separate from human experience, but that epistemologically there are many valid subjective perspectives on this reality. This developed as a 'sequential mixed methods' research programme (Cresswell and Clark 2011), moving from an exploratory, qualitative, constructivist, primarily inductive phase, including: speculations on factors and theories based on secondary sources (Barrett and Zhang 2009; Barrett and Barrett 2010), qualitative surveys of the views of school pupils (Barrett, Zhang, and Barrett 2011), and post-occupancy evaluations of a range of primary schools (Zhang and Barrett 2010). This all led into a primarily deductive, post-positivist study of the impacts of the school design on learning via the HEAD

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project itself. Here the aim was to ultimately derive statistical relationships between physical features of schools and learning impacts, but informed by the preceding work and the views of those using the school (Johnson and Duberley 2000).

Within this programme of work, a strong strand addressing the teacher's perspective was maintained, contributing further to a trend towards valuing end users views (Preiser and Vischer 2005; Mallory-Hill, Preiser, and Watson 2012). This viewpoint had been broached in earlier work (Barrett and Zhang 2012) and was pursued within the HEAD project itself to complement the hard data collected. That said, and solidly within the overarching worldview of the work, the perspective revealed by speaking to the teachers in the classrooms studied creates a valid view in its own right. This view is reported here to give a voice to this important stakeholder.

In practical terms, the opportunity was taken to speak to very many teachers actually in, and about, their own classrooms. This both informed the hypothesis-building aspect of the HEAD Project and provides a fascinating insight into the concerns of teaching practitioners on the ground. On the first front, the researchers were aware that measurements taken on one day would not necessarily highlight some interactive factors or give a wider picture of the environment through the whole of the year. On the second front, this now enables a comparison to be made between the perceptions of the teachers and the statistical evidence, focused on learning outcomes, from the HEAD Project. This has the potential to add richness to the bare statistical results, and show where there are high levels of awareness of issues amongst practitioners, or relative blind spots.

Using the Teacher Assessed results at the start and end of the preceding year, the statistical analyses of the HEAD Project linked measurements of the variations in the physical features of individual classrooms to the variations in the learning progress made by the 3766 pupils in those classrooms. The results of these analyses have been reported in Barrett et al. (2015). The headline findings are that 16% of the variation in pupils' learning progress can be explained by the physical attributes of the classrooms. The analysis was underpinned by, and confirmed the utility of, a novel neuroscience-informed framework (Barrett and Barrett 2010). Under the heading of 'naturalness', this covered the normal Internal Environment Quality (IEQ) aspects, such as heat, light, sound and air quality, but also added two other dimensions, namely: 'individualisation' and 'level of stimulation'. Of the 16% impact, broadly speaking naturalness accounted for half and the other two dimensions for another quarter each. These three factors have more memorably been styled the SIN (stimulation, individualisation and naturalness) typology.

The statistical findings will be returned to in the conclusions. The main body of this article now focuses on the views of the teachers' interviewed.

1.1 *Background to the study of teachers' views of their classrooms*

There have been many empirical studies of the individual factors effecting learning environments in schools, looking at comfort and functional performance – summarised in Barrett and Zhang (2009). A group of studies look at the design of learning environments (Nair, Fielding, and Lackney 2005; Dudek 2008; Hertzberger 2008; Lippman 2010; OECD 2011) and pupil achievement and engagement in relation to a range of design issues (Schneider 2002; Tanner and Langford 2003). Other studies examine specific issues in schools such as light and colour (Heschong Mahone Group 2003; Wei and Ng 2003, Barkmann, Wessolowski, and Schulte-Markwort 2012), acoustics (Department for Education and Skills 2003; Shield and Dockrell 2003), temperature, and air quality (Mendell and Heath 2005; Bakó-Biró 2012; Guili, Da Pos, and De Carli 2012), room size (Blatchford 2003) and classroom visual display (Almeda et al. 2014). However, there are fewer studies about teachers' views of their immediate environment (Shapiro 2001).

Taking the SIN typology in turn: in terms of the level of *stimulation*, the use of displays is an important dimension. Almeda et al. (2014) investigated teachers' choices and ideas, through studying their choices of wall decoration. The focus was on classifying and coding the types of material used. Cluster types with particular unifying features were then identified through the analysis, for example: those that used academic-specific content to help recall and for reference, or in another cluster classrooms that used more decorative material to help motivate and engage children. Another cluster, mainly from private schools, had low amounts of wall display. The researchers speculate that this may be from a belief that the displays are distracting. The researchers conclude that this classification might be a useful tool to examine impacts on academic performance.

For the question of *individualization* Marten (2002) in her research looks at factors such as, the degree of flexibility offered to teachers to change and control their environment and analyses them in relation to both their observed behaviour and views expressed in interviews. Interestingly those teachers who felt they had control over semi-flexible features, such as larger items, cabinets and bookshelves, tended to have mixed feelings or be unsatisfied with their classroom. The researchers suggest that this may be due to them being more questioning and aware of their environment, and that this very dissatisfaction is the first step towards experimenting and change. However the semi-fixed factors, such as radiators and sinks, are investigated as physical objects only, rather than including how they can be controlled, such as with blinds or heating controls.

With an emphasis on the *naturalness* factors, Shapiro's research (2001), although extensive with over a thousand teachers interviewed across the USA, did not have access to their physical teaching spaces. The research centred on teachers' opinions about the relationship between the interior design of classroom and academic performance. It was a stratified sample in selection of the school (geographical region, age of building and school grade) and of the teachers themselves (age, gender, number of years in education and grade). Nearly every teacher saw the importance of design for learning and also for pupil attendance, with the more experienced teachers seeing the relationship most strongly. High on the list of concerns were safety (85%), comfortable furniture (85%), adequate lighting (84%) and acoustics (81%); however, the highest score at 98% was for heating and ventilation control.

The above studies help gain a contextual understanding of how various individual physical environment factors are thought to affect learning and wellbeing. This article aims to take forward the understanding of teachers' views of their classroom as a whole by collating their views on their physical spaces as experienced throughout the year, their satisfaction with their control over that environment and the relationship between these views and a statistical study of impacts on learning focused on the same classrooms.

2 Methodology

2.1 *Sample selection*

Rather than distribute questionnaires to a large sample of teachers, it was decided that in order to better understand the problems and issues faced by teachers, the responses would be best contextualised by an understanding of their specific school environment. To do this, teachers were interviewed about, and in, their own classrooms. A major choice facing the research team was how to provide *diversity* in the classrooms analysed so that the findings about the teachers' views were independent of any particular school or classroom type. A good example of this approach of using interviews and site observations is that of Marten (2002) in her study of classroom design. In this present study, the factors considered in the selection of schools/classrooms included:

- Location – urban, rural and semi-rural;
- Size – pupils numbers and numbers above or below capacity, plus single, two and three-form entry schools;
- Ofsted results – ranging from outstanding, good, satisfactory, to requires improvements;
- Date of initial construction taking in a range of eras – for example Victorian, post-war and new buildings post-1990;
- Site – constricted or open;
- Range of pupil ages.

Seeking to get a spread of schools representing all of these criteria, 30 schools were selected. This was achieved by liaising with three local authorities (Blackpool, Hampshire, and Ealing in London) that provided details of a wide range of schools willing to take part in principle. From these long lists, a profiled sample was selected, maximising coverage of the above school characteristics. Figure 1 shows how, for example, variety was achieved in the pupil roll, site space and general location of the schools. Table 3 later provides a similar view of the variety in the ages of schools involved. The selection of the exact classrooms to be studied was made on site, through initial consultation with the Head teacher, covering issues such as achieving diversity in the sample in both the pupils' ages and the physical characteristics of their classrooms. In order that a longer-term view could be gained, care was taken to use classrooms that had not been physically altered over the last year and where the same teacher was in place. In total, 193 classrooms were studied, usually typically using 6 classes from each of 29 schools, covering Year One to Year Six. Adding in the interviews of Heads, a total of 222 interviews of teachers were carried out. It can be seen that the sampling of the schools and classrooms followed the principle of 'maximum variation sampling' and within this, 'comprehensive sampling' of the teachers was achieved (Gray 2009).

2.2 *Field work procedures*

At an initial meeting, information was given to the Head on the use and storage of data and how any photographs would be taken, for example by avoiding photographing pupils and obscuring any that had unwittingly got in the frame. Following this explanation, informed consent was granted for the work. The Head then gave their strategic perspective on the general background

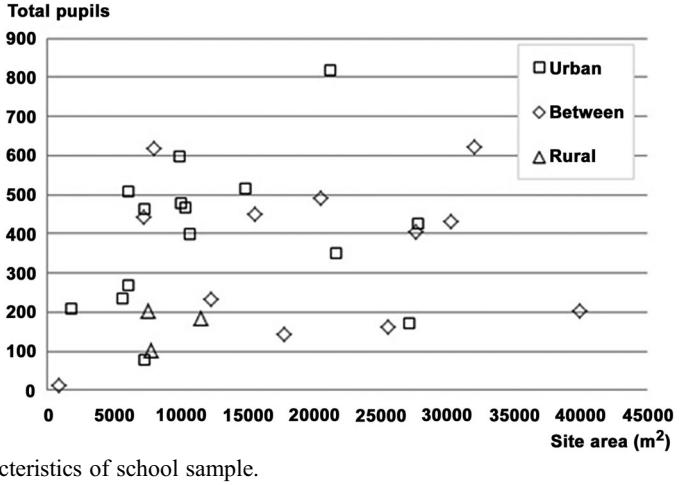

Figure 1. Characteristics of school sample.

to the school in terms of its design, construction, operation and crucial building environment features. Then the specific classrooms to be studied in detail were identified, as described above.

After this preliminary process, interviews of the individual class teachers, typically lasting around 10 minutes, were carried out in situ (each in the teacher's own classroom) to gather information about how, in their direct experience, the classroom performed as the context for their teaching practice *through the whole year* and about more complex interactive issues between the factors. The initial question was open-ended; so the teachers could highlight what really mattered to them in the design of the classroom. In the background, a simple questionnaire of likely issues, based on our preliminary study (see Barrett and Zhang 2012), was used by the researchers to raise prompts if needed, or to provide a place to record the responses of the teachers. The prompts used are given in Table 1 and, for the final 'overall feeling' question, included a balanced five-point Likert scale, ranging from very good through to very poor. The teachers' additional freeform comments, about their classrooms and how they performed for both them and their pupils, were carefully recorded in writing. The interactions with the teachers in each classroom could formally be described as 'focused interviews', that is explicitly about one thing: how well they found their classroom worked for them throughout the year. Because of a degree of prior knowledge on the part of the researchers, a passive 'semi-structured' set of prompts was held in the background. On top of that, owing to the practical reality of interviewing busy teachers in their workplace, at a superficial level the approach showed some features of 'informal conversational interviews' (Gray 2009).

The interviews were carried out during visits to schools made over the period November 2012 – November 2013. As mentioned above, the emphasis was, however, on the teachers' experience of their classrooms throughout the *whole year*. The expanded notes made of the discussion with the class teachers took the analysis past simple, indicative rating scores, and enabled major areas of comment to be highlighted and the more complex and interactive factors in their environment to be noted. The result was a conduit for the freely expressed views of the teachers, with some

Table 1. Prompts used in interviews.

Factors	Open questions to the teachers
Initial prompt	*Looking across your experience of this classroom over the whole year, what works really well for you and your pupils, or what do you find problematic?*
Light	Does the classroom get too bright (glare)? When is this experienced?
	Do the blinds work well to control the glare? Ease of use?
Temperature	Do you/pupils get too hot or too cold? When is this experienced in the year?
	Does the heating system work well? Do you have any control of the heating time and heating level?
Air quality	Do you/pupils get too stuffy or too draughty? When is this experienced?
	Do you have any control of the air movement? Is it easy to open the windows (or external doors) for ventilation?
	Do odours from the sink or toilet disturb your teaching and learning in the classroom?
Noise	Do noise disturbances make it hard to teach? When is this experienced? The origin of that noise?
Layout	Do you have enough space for teaching and storage?
	Do you feel there is scope to alter the configuration of the class layout?
	Do you have alternative learning opportunities for pupils, inside and outside the building within the school?
	Do you have the access to the outside and a science garden?
Anything else?	Is there anything else that you feel is important and we haven't covered?
Overall feeling	Is classroom generally comfortable for teaching and learning activities?

core areas consistently covered. The notes collected were analysed through inductive content analysis, thus freely allowing things that mattered to the interviewees to surface, although there was understandably a coalescence around some core areas (Gray 2009). It was decided to focus the analysis on 'problems', reflecting the fact that the interviews naturally tended to very much home in on what did *not* work so well. Areas that operated satisfactorily led to very little discussion. A problem area was defined as one that gained a negative rating and normally also involved issues about which notes were taken explaining what was problematic. Given the qualitative nature of this study this was by far the richer source of data compared with a simple, 'it's OK'. Analyses by the school selection factors (size, location etc.) were not used in this part of the research, as here their purpose was simply to ensure broad diversity in the sample.

Owing to the sensitivity of the data collected and the consequent existence of strict informed consent agreements, it is not possible to make the underlying data available (see Supplemental data section).

3 Results

These are set out below. After a discussion of the main problem areas identified and some consideration of how these come together at a 'school' level, a summary of the more complex, interactive issues is provided.

3.1 *Problems analysed at the classroom level*

An overall analysis of the particular factors that teachers explicitly found troublesome is given in Table 2. This provides a count (not a rating) of areas found to be problematic. The bottom row provides a total for each factor across all the schools, and the final column gives a count of all the factors together totalled for each school.

This table shows that overheated (hot) rooms were most often noted as a problem (with 77 adverse comments – that is, 40% of the classrooms sampled) along with similar figures for the related issues of stuffiness and problems with control of their heating systems. This finding resonates with Shapiro's (2001) study (see above), where heating and air conditioning control was also the most frequently noted key factor for a balanced learning environment; however their figure of 98% response indicates that it is a bigger issue in the USA.

The next most commonly noted issue, with 64 comments, was about glare. However, issues of glare were usually felt to be counteracted by blinds that were of good quality and easy to use. Glare is a complex issue, often just at certain times of day or when teachers were using the white/smart board. Satisfaction levels with blinds showed 91% of teachers reporting their blinds to be 'good', a dramatic increase from the earlier study (Barrett and Zhang 2012), where 67% of the sample felt that their blinds were difficult to use and in 'poor' or 'very poor' condition. One can speculate whether the problems were local to the first study area, but it seems more likely, given the wide geographical spread of schools in this later study, that significant refurbishment of blinds has happened generally over the last few years, particularly to cope with problems of glare when using white/smart boards.

Noise disturbances, from internal sources such as heating and ventilation systems or from nearby classrooms and playgrounds, were problematic for 27% and 23% note the small size of room as being a source of difficulty for them. The least mentioned factors were about odours and lack of light.

Surprisingly, given the number of specific problems noted, when asked to give a score for their overall classroom comfort teachers were surprisingly satisfied, an improvement from the earlier study where the vast majority found it to be only 'adequate'. Again using a five-point

Table 2. Count of teachers' views of problems with their classrooms by environmental factor.

	Light			Temperature			Air quality				Noise	Layout			
School	Dark	Glare	Whiteboard	Cold	Hot	Heat control	Stuffy	Odours	Windows	Doors	Noisy	Small	Shape	Storage	Totals by school
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	0	2	0	0	2	1	2	2	0	0	1	0	0	0	10
3	2	6	0	1	3	7	5	0	1	0	1	2	0	2	30
4	0	4	0	0	6	6	5	0	1	0	1	2	0	1	26
5	0	5	0	1	5	6	7	0	1	0	1	2	0	2	30
6	2	1	1	1	6	5	7	0	0	0	0	3	0	2	28
7	1	4	4	3	2	4	4	1	3	0	3	1	0	1	31
8	2	2	0	3	5	5	6	3	4	0	2	4	1	2	39
9	0	4	1	3	1	3	4	1	0	0	1	0	0	1	19
10	0	0	0	2	2	2	1	0	0	0	0	0	0	0	7
11	1	3	1	0	3	0	2	0	0	0	1	4	2	0	17
12	0	0	0	2	2	5	1	0	5	3	2	0	0	0	20
13	1	3	2	6	3	6	2	1	1	0	3	4	0	4	36
14	1	0	1	0	0	2	0	0	0	0	2	0	3	2	11
15	1	0	1	1	4	1	5	0	4	0	1	0	2	0	20
16	0	3	3	0	2	0	1	0	1	0	4	1	1	0	16
17	0	2	0	2	3	0	2	0	0	0	1	1	0	2	13
18	1	1	0	1	1	1	0	0	0	0	2	0	0	0	7
19	0	4	2	0	1	0	3	0	3	0	4	1	0	3	21
20	0	0	0	2	1	1	0	0	0	0	1	1	0	0	6
21	0	5	3	1	4	2	2	0	0	0	0	1	0	3	21
22	2	1	3	1	2	3	2	0	0	0	1	3	2	3	23
23	0	0	1	2	2	5	4	0	3	0	4	0	0	4	25
24	1	2	3	0	2	1	0	0	1	0	0	3	1	2	16
25	2	4	0	3	4	2	3	0	1	0	3	0	0	0	22
26	0	4	0	1	7	3	5	0	6	0	2	6	0	6	40
27	0	0	0	2	1	1	0	0	0	0	4	1	0	1	10
28	0	1	1	3	2	0	0	0	3	0	4	0	0	0	14
29	0	0	0	0	0	0	0	0	0	0	0	2	0	1	3
30	3	3	4	3	1	3	1	1	2	0	3	3	6	0	33
Total by issue	20	64	31	44	77	75	74	9	40	3	52	45	18	42	

Note: School 1 was an initial pilot and so the data for this school has not been included.

scale ranging from very satisfied to very dissatisfied, of the responses to this question 62% were 'satisfied' and 13% 'very satisfied'. The latter finding is again similar to Shapiro's survey of teachers in the USA, where 18% were very satisfied with their classroom (2001). However in our study at the other extreme, taking all factors into account, 10% were 'dissatisfied' with their classroom. These findings show slightly higher satisfaction ratings than Marten's (2002) (149) earlier results on overall satisfaction with classrooms, with 41% satisfied and 20% dissatisfied.

3.2 *Problems analysed at the school level*

To see how specific factors from the teachers' views of their classrooms were spread across the whole school, the individual classroom count of problems was collected to give an overall school count (see right-hand column, Table 2) and this ranges from only 3 problems to 40 issues. Depending on the design and orientation and so on of the school, some factors were fairly common to all the rooms within a school, for example in relation to class size or storage problems. However, interestingly some classes were also found that were either exceptionally trouble free or more subject to a variety of problems compared to others in the same school. This of course may be related to the specifics of the room concerned, or its mode of use.

The average problem count across all 29 schools was 20 issues. School 26 had the most teacher mentioned problems overall; there was quite a spread of issues, with an emphasis on small, hot and stuffy classrooms often with poor storage and windows ventilation. This school also had consistent scores of 'dissatisfaction' from all teachers for their overall classroom comfort levels. School 8 also had a very high score with a similar profile of problems. Other schools with moderate to high scores showed a fairly even distribution of problems, but without an undue focus on particular issues. However, some schools had quite a low problem count but with any problems focused in particular areas. For example for Schools 27 and 28 the main concern was with noise issues, for School 21 it was problems with glare and the position of the whiteboard, and for School 15 the problems focused only on heat/stuffiness and window opening. School 12 was an interesting case where problems focused solely on the new technology controlling the windows. These opened on their own, often when the class felt cold; however this was because they were actuated by carbon dioxide sensors and this had not been explained to staff. Schools 20 and 29 had hardly any problems mentioned by teachers.

The incidence of problems noted by teachers at school level was investigated in relation to the building age. Table 3 puts the schools into broad chronological groups. It seems that schools built in the 1950s tend to be least problematic for teachers and those from the 1990 to 2013 period to be most troublesome. Table 4 employs Welch's *T*-test (suitable for unequal sample sizes and variances) to investigate for the statistical significance of the differences between all of the possible pairings of the groups. This shows, using the two-tail test with no assumptions regarding direction, that there is a significant difference at the 5% level between 1950s schools and those built from the 1990s onwards. If a one-tail test is used with an assumption that there is a deteriorating trend in problems from 1950s to 1960/1980s and onto 1990s+, it can be seen that this is confirmed, albeit marginally outside of the 5% threshold. Further analysis of the teachers' responses regarding problems in relation to the 1950s schools compared with the 1990+ schools indicate that the older schools were particularly *free* from complaints in the 'Usage' aspects of the size and storage provided (not, it should be stressed, because they were simply bigger). In addition, whiteboard problems were very low in the older schools, which could well be linked to having options for the optimal placement of the whiteboard. Lastly, the utility of windows for ventilation seemed to work well in the older compared with the later schools. These are *views* from a large group of teachers, who are key users of their classrooms. The point is stressed that we should *not*

Table 3. Teachers' reported problems at school level in relation to school age.

1880–1920	1950s	1960–1980	1990–2013
1903–26[a] probs	1959–19[a] probs	1970–10 probs	2006–31 probs
1902–30 probs	1950–7 probs	1970–30 probs	2008–20 probs
1900–39 probs	1950–13 probs	1975–17 probs	1990–36 probs
1880–6 probs	1950–7 probs	1963–11[a] probs	2013–23[a] probs
1906–10 probs	1950–22 probs	1970–20 probs	2003–40 probs
1920–28 probs		1978–16 probs	2004–14 probs
1921–25 probs		1986–21 probs	
1920–3 probs		1968–21 probs	
		1960–16 probs	
		1979–33 probs	
Range 3–39	Range 7–22	Range 10–33	Range 14–40
Mean 21	Mean 14	Mean 21	Mean 27

[a]Indicates some classrooms seen were later extensions.

Table 4. *T*-test results for significant differences in problems between school age groupings.

Pairs of every age band	Difference in means	*t*-stat	*df*	pval 1 tail	pval 2 tail
1880–1950	7.275	1.325	10.867	0.106	0.212
1880–1960	1.375	0.268	10.584	0.397	0.793
1880–1990	6.458	1.055	11.962	0.156	0.312
1950–1960	5.900	1.533	8.703	0.080	0.160
1950–1990	13.734	2.693	8.747	0.012	0.025
1960–1990	7.834	1.667	8.315	0.067	0.134

assume that old schools are 'bad', but rather that we need to look to the actual characteristics of the design provided.

3.3 *Complex, interactive issues raised and observed*

Moving from a simple count of problems noted, the teacher interviews and classroom observations provide rich, qualitative perspectives on a variety of interactive factors, which were seen to be at work. In summary these are:

3.3.1 *Aspects related to temperature and air quality*

- *Heating Control* was often very problematic for teachers, usually the problem related to high temperatures and stuffiness. Sometimes central thermostatic control was slow to respond or not adapting to the different situations of classrooms, especially when linked to underfloor heating. Some classrooms suffered from extremes of temperature, very cold in the winter and too hot in the summer;
- It was found that those classrooms with *external shading devices* (overhangs, canopies) experienced no serious problems arising from overheating or glare. The shading systems controlled the degree of sun heat and sunlight penetration as necessary;
- Certain features were not working to best effect. For example, teachers noted that *air conditioning* units were creating unequal temperatures across the classroom;
- It appeared that the *mechanical vents* (which were designed to increase the air movement) were not operated by the teachers in many classrooms, especially those built after 1990s in

one area (Blackpool). Teachers were not informed of the way to control the vents, to maximise the environmental benefits;
- In many schools, despite good windows, there was a problem in creating a through current of air, which requires an opening opposite or away from the windows to also be available. This issue of through draught was mentioned by almost the half of the teachers seen.

3.3.2 *Aspects related to windows and glare*

- The use of *white/smart boards* that had suffered from glare problems had been overcome by more powerful projectors and by the use of blinds of deep colour. However these blinds had the unintended consequence of a reduction in ventilation and stuffy classrooms with high carbon dioxide levels. Further they often created a rattling noise disturbance from airflow behind them. Many teachers complained about the siting of the whiteboards;
- Due to the nature of classrooms, such as the deep plan and the single-sided window, most classrooms experienced a quite varied lighting level distribution: bright near the window while gloomy away from the window. Extra *electrical lighting* installed at deep plan in one of the schools enhanced the brightness and reduced the contrast, which provided a high quality and quantity effect of visual environment;
- Further some mentioned that *blinds* were used not just against glare, but also for privacy, especially near end of the school day where those collecting children from school became a distraction at the end of lesson;
- Coverage of windows with *displays* was prevalent in some schools and worked to obliterate much natural light.

3.3.3 *Classroom layout: Size, furnishings and storage issues*

- A notable feature was the *cramped classroom* conditions in some of the rooms. Although it was really problematic in about a quarter of the sample, it was also a feature consistently mentioned by staff;
- The number, positioning, size and use of *learning zones* showed great variety and choices made had a variety of consequences to remaining class space. However, in some classes, the scope to position these zones was limited by the placement of whiteboards, doors, through access, windows and radiators. Some schools in London had no space to create learning zones. Flexibility of space was problematic for many;
- As the pupils aged and grew larger their class *furniture size* rightly increased. However despite these increases in size of both children and their desks/chairs, the classroom size did not reflect this. Although it is argued that at this age much of their work is of a more static nature, this ignores the fact that they are moving around the class to use technology and equipment. Further, teachers in these classes found it very difficult to get across their class to assist pupils individually. This was a common problem. Some had gone to the lengths of removing their own chair from the class simply to create more space;
- Teachers in some of the very small classrooms had experimented with *desk layout*. They had found a pattern of short rows rather than the more usual table format more space efficient and better for preventing distraction. However this layout was not one encouraged by their schools;
- There was variability in the provision of *personal storage*; in some schools all the children had their own drawer storage within class, whilst other schools did not provide them. Variability was seen also in the placement of coat hanging space, with some allowing for this within classes and others outside of it. Again there was diversity across schools in provision

in this, but uniformity within them. When coats were hung within rooms, it usually meant the loss of wall display space. Further the hanging space was often squeezed causing coats to fall off pegs;
- Many teachers like the spaces designed specifically for storage, coat pegs and/or break-out space. It caused fewer problems than those that had to occupy a corner (side) of the classroom. The *dedicated spaces* attached to the classroom led to easy usage and management and improved the flexibility of the classroom very much because it usually had a clear boundary and was more freely accessible.

4 Discussion

Returning now to the HEAD findings based on the statistical analysis of links between classroom design and pupils' learning rates (Barrett et al. 2015), Table 5 provides a comparison of these findings and the views of the teachers reported in this article. These perspectives are connected by a focus on a common set of classrooms. The statistical analysis is very much focused on pupils' learning progression; however, this is also a major preoccupation of most if not all teachers. The similarities and differences are thus interesting to note.

In the area of 'naturalness', there is generally good alignment between the quantitative statistical evidence and the teachers' qualitative views. In the case of light, it would seem that the value of daylight *per se* is under-appreciated by teachers, which could easily be seen to lead, at times, to an unnecessary reliance on artificial lighting. In the area of air quality, the teachers raise the issue of cross-ventilation and the use of automatic actuators clearly needs to be linked to the training of the teachers to get the most out of the technology provided. Within the statistical analysis, acoustics do not emerge as a significant factor in the multilevel modelling. Despite this, quite a high level of 'noise' problems is noted by teachers, typically stemming from nearby classrooms or playgrounds. This does not appear to impact on learning, but noise is known to be hard to ignore (Huang et al. 2012) and so it is not surprising that it is noted here. Overall it would seem that these basic naturalness or 'comfort' factors are aspects of the learning environment provided by the classroom of which teachers are well aware at a general level, if not their relative importance for learning.

In the area of 'individualisation', the picture is more mixed. In relation to aspects that would make the classroom feel like it is distinctive and 'owned' by the pupils, the teachers' view is muted and relatively utilitarian. That said, in quite a lot of classrooms, a real effort had clearly been made by teachers. Overall, however, it seems likely that this is not *generally* an area where the classroom is seen as an active resource by teachers. This is in contrast to their awareness of the size and layout of the classroom and the practical implications for their teaching practice. Here teachers add interesting detail on the fine detail of the impacts of the relative positions of room elements and the optimal ways in which competing demands can be addressed. On the question of 'individualisation' then the 'hard' aspect of space/layout is high in teachers' consciousness, but the 'softer' aspects of ownership seem less explicit.

According to the statistical analysis, the area of the 'appropriate level of stimulation' is driven by the visual complexity of the building and the displays used, together with the colour scheme of the classroom. These aspects were almost totally absent in the teachers' observations about their classrooms. It would seem that managing the design of the space to create an appropriate level of stimulation for learning is not something they would normally consciously address. In addition, until the HEAD results, there was no clear evidence that, in fact, a mid-level of stimulation is appropriate. Interestingly, in interactions with teachers since these results have been released, there is an immediate intention to utilise this dimension of the characteristics of the classroom space; now it has been highlighted.

Table 5. The main classroom characteristics that support the improvement of pupils' learning v teachers' views.

Design principle	Design parameter	Good classroom features statistically linked to higher learning rates[a]	Teachers' views[b]
Naturalness	Light	Classrooms towards the east and west can receive abundant daylight and have a low risk of glare. Oversize glazing has to be avoided especially when the room is towards the sun's path for most of year. Also, more electrical lighting with higher quality can provide a better visual environment.	Problems with glare are noted by a high number of teachers. The main reaction involves the extensive use of blinds, in part driven by the, largely successful, accommodation of the use of white/smart boards, but sometimes for privacy. However, there are complications in practice, such as: noise nuisance from rattling blinds, leaving blinds closed longer than necessary and difficulties in opening windows behind blinds for ventilation. A lack of sensitivity to daylight levels is evident in a fairly common practice of obscuring the windows with display material, however, some teachers are aware that good quality artificial lighting is needed, especially in deep plan rooms. *Part aligns with statistical analysis, but value of daylight per se seems under-appreciated*
	Temperature	The classroom receives little sun heat or has adequate external shading devices. Also, radiators with a thermostat in each room provides more opportunities to control the thermal environment within comfortable bounds.	Classrooms being too hot is *the* most often noted problem of all from the teachers' perspective, but sometimes both extremes of hot and cold are involved. Unsurprisingly, concerns about heating control are often noted too. Problems with heat gain from the sun were not a problem where external shading was provided. *Aligns with statistical analysis*
	Air quality	Big window opening sizes at different heights can provide good ventilation options for varying conditions. Having a large room volume can contribute to diluting poor air. Air conditioning where necessary can help.	Stuffiness is *one of the* most often noted problems. Teachers also stress the value of cross-ventilation to enhance air movement. Views around mechanical ventilation varied. In several cases the teachers did not know how to operate vents, etc and where there was air conditioning the creation of unequal temperatures within the classroom is noted. *Aligns with and expands on statistical analysis*

(*Continued*)

Table 5. Continued.

Design principle	Design parameter	Good classroom features statistically linked to higher learning rates[a]	Teachers' views[b]
Individualization	Ownership[c]	Classroom that has distinct design characteristics; personalised display and high quality chairs and desks are more likely to provide a sense of ownership.	Personal storage for pupils' possessions and hanging space for their coats are aspects that touch on the pupils' ownership of the classroom and are areas about which teachers quite often had views. These mainly concern mess and the loss of wall space for display. *Weak relationship to statistical findings*
	Flexibility[c]	Larger, simpler areas for older children, but more varied plan shapes for younger pupils. Easy access to attached break-out space and widened corridor for pupils' storage. Well-defined learning zones that facilitate age-appropriate learning options, plus a big wall area for display.	Many teachers had strong views on the issues of cramped classroom size and the arrangement of associated spaces, including storage. Cramped spaces had serious implications for flexibility, often compounded by poor choices in the relative positions of whiteboards, doors, radiators, etc. This impacted on choices about learning zones. Further, older children and their furniture are much bigger, but the space for them is not always increased and, in the extreme, this could result in problems for the teacher being able to simply get around the class. Having storage/coats and break-out space outside of the main room relieved the pressure on the main space in several cases. *Aligns with and expands on statistical analysis*
Stimulation	Complexity[c]	The room layout, ceiling and display can catch the pupils' attention but in balance with a degree of order without cluttered and noisy feelings.	Teachers do not comment much at all about the visual complexity of the classroom as a factor. There is some mention about higher ceilings inducing a calmer feel if plain, but again sometimes causing acoustic complications. *Absent relationship to statistical findings*
	Colour[c]	Light walls with a feature wall (highlighting with vivid and or light colour) produces a good level of stimulation. Bright colour on furniture and display are introduced as accents to the overall environment.	Teachers do not comment at all about the colour of the classroom as a factor. *Absent relationship to statistical findings*

[a]Based mainly on Table 13 in Barrett et al. (2015).
[b]Based on Section 3 of this article.
[c]Strongly usage-related classroom features.

5 Conclusions

This study on teachers' perceptions of their classroom environment shows that they find overheated classrooms, stuffiness and a lack of control over this to be the most widespread problem. However, although glare is a factor, problems with it seem to be mitigated by widespread use of good blinds, alongside powerful projectors for white/smart board use. This, as a problem, does seem to have receded over the last few years. There does seem to be some differences in the volume of problems perceived in schools built in different periods. Although they have all been maintained and altered over the years, the original design will have an impact on the characteristics of the schools, and schools from 1950s had lowest 'problem' scores, maybe due to the layout and the physical mass of construction. Surprisingly the newer schools from the 1990s to date had the highest problem count.

When compared with the HEAD statistical analysis of impacts on learning, the teachers' perceptions tended to resonate with the 'hard' aspects of the classroom design, such as air quality and size. However, on the 'softer' aspects, such as level of stimulation and pupils' ownership of the spaces, teachers do not seem to be as aware of their importance. It would seem that these aspects of the physical environment could be seen more clearly as dynamic elements that can be actively utilised to engender learning.

Given the problems that they experienced, teachers' perceptions of their overall comfort were surprisingly high. That said, it is hoped that these findings and their implications will inform educational practice in the 'softer' areas of space use and allow a more sensitive accommodation by designers of teachers' design requirements for their classrooms.

The results of the HEAD project, including the teachers' perspective reported here, have implications beyond school design, most particularly in the general area of IEQ. The underpinning 'SIN' typology takes in a broader than normal scope of factors, but within a clear neuro-informed, sensory framework. But, just like teachers, it would seem, IEQ researchers typically stress the naturalness (or comfort) factors of heat, light, sound and air quality. That said commercial assessment systems such as BUS extend to issues of layout and environmental control. However, the evidence-based operationalisation of aspects, such as the optimum level of stimulation and issues of individualisation in the HEAD project, extend and deepen these approaches.

It is notable that the evidence of the HEAD project shows that these last two areas in fact have as much impact on pupils' performance as the comfort factors. Thus, as Clements-Croome and others argue (Clements-Croome 2014; World Green Buiding Council 2015), it is necessary to think beyond just comfort and to include the impacts of spaces on health, wellbeing and productivity, all within the challenging context of energy constraints. The SIN model helps move consideration onto a broader, user-centric trajectory. It has enabled measurable performance impacts to be more comprehensively captured and in so doing fleshes out and gives credence to the importance of some of the softer aspects of the built environment.

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Supplemental data

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References

Almeda, M., M. Weber, P. Scupelli, A. Fisher, and R. Baker. 2014. "Clustering of Design Decisions in Classroom Visual Displays." International Conference on Learning Analytics and Knowledge, Idianapolis, USA, March 24–28.

Bakó-Biró, Z., D. J. Clements-Croome, N. Kochhar, H. B. Awbi, and M. J. Williams. 2012. "Ventilation Rates in Schools and Pupils' Performance." *Building and Environment* 48: 215–223.

Barkmann, C., N. Wessolowski, and M. Schulte-Markwort. 2012. "Applicability and Efficacy of Variable Light in Schools." *Physiology and Behavior* 105: 621–627.

Barrett, P., and L. Barrett. 2010. "The Potential of Positive Places: Senses, Brain and Spaces." *Intelligent Buildings International* 2: 218–228.

Barrett, P. S., F. Davies, Y. Zhang, and L. Barrett. 2015. "The Impact of Classroom Design on Pupils' Learning: Final Results of a Holistic, Multi-level Analysis." *Building and Environment* 89: 118–133.

Barrett, P. S., and Y. Zhang. 2009. *Optimal Learning Spaces: Design Implications for Primary Schools*. SCRI Reports 2. Salford, UK: University of Salford.

Barrett, P., and Y. Zhang. 2012. "Teachers' Views on the Designs of their Primary Schools." *Intelligent Buildings International* 4 (2): 89–110.

Barrett, P. S., Y. Zhang, and L. C. Barrett. 2011. "A Child's Eye View of Primary School Built Environments." *Intelligent Buildings International* 3: 1–17.

Blatchford, P., P. Bassett, H. Goldstein, and C. Martin. 2003. "Are Class Size Differences Related to Pupils Educational and Classroom Processes." *British Educational Research Journal* 29 (5): 709–730.

Clements-Croome, D. 2014. "Sustainable Intelligent Buildings for Better Health." Comfort and Well-Being EC Denzero Project.

Cresswell, J. W., and V. L. P. Clark. 2011. *Designing and Conducting Mixed Methods Research*. London: Sage.

Department for Education and Skills, ed. 2003. *Acoustic Design of Schools. Building Bulletin*. London: TSO.

DfE. 2013. *National Pupil Projections: Future Trends in Pupil Numbers. Statistical Release*. London: DfE.

Dudek, M. 2008. *Schools and Kindergartens: A Design Manual*. Basel: Birkhauser.

Gray, D. E. 2009. *Doing Research in the Real World*. London: Sage.

Guili, V., O. Da Pos, and M. De Carli. 2012. "Indoor Environmental Quality and Pupil perception in Italian Schools." *Building and Environment* 56: 335–345.

Hertzberger, H., ed. 2008. *Space and Learning*. Rotterdam: 010 Publishers.

Heschong Mahone Group. 2003. *Windows and Classrooms: A Study of Student Performance and the Indoor Environment*. Fair Oaks, CA: Californian Energy Commission.

Huang, L., Y. Zhu, Q. Ouyang, and B. Cao. 2012. "A Study on the Effects of Thermal, Luminous and Acoustic Environments on Indoor Environmental Comfort in Offices." *Building and Environment* 49: 304–309.

Johnson, P., and J. Duberley. 2000. *Understanding Management Research*. London: Sage Publications.
Lippman, P. C. 2010. *Evidence-based Design of Elementary and Secondary Schools: A Responsive Approach to Creating Learning Environments*. Hoboken, NJ: John Wiley.
Mallory-Hill, S., W. Preiser, and C. Watson, eds. 2012. *Enhancing Building Perfomance*. Chichester: Wiley-Blackwell.
Marten, S. 2002. "The Classroom Environment and its Effects on the Practice of Teachers." *Journal of Environmental Psychology* 22: 139–156.
Mendell, M., and G. Heath. 2005. "Do Indoor Pollutants and Thermal Conditions in Schools Influence Student Performance? A Critical Review of the Literature." *Indoor Air* 15: 27–52.
Nair, P., R. Fielding, and J. Lackney, eds. 2005. *The Language of School Design*. Minneapolis: Design share. com.
OECD. 2011. *Designing for Education: Compendium of Exemplary Educational Facilities*. Paris: OECD CELE.
Preiser, W., and J. C. Vischer. 2005. *Assessing Building Performance*. Oxford: Elsevier-Butterworth-Heinemann.
Schneider, M. 2002. *Do School Facilities Affect Academic Outcomes?* Washington, DC: Educational Resources Information Centre.
Shapiro, B. 2001. *Teachers' Opinions about Interior Design and Learning*. San Mateo, CA: Schoolfacilities.com.
Shield, B., and J. Dockrell. 2003. "The Effects of Noise on Children at School: A Review." *Building Acoustics* 10 (2): 97–116. doi:10.1260/135101003768965960.
Tanner, C., and A. Langford. 2003. *The Importance of Interior Design Elements as they Relate to Student Outcomes*. Athens, GA: University of Georgia.
Wei, W., and E. Ng. 2003. "A Review of the Development of Daylighting in Schools." *Lighting Research Technol* 35 (2): 111–125. doi:10.1191/1477153503li072oa.
World Green Buiding Council. 2015. *Health, Wellbeing & Productivity in Offices: The Next Chapter for Green Building*. Toronto: World Green Buiding Council.
Zhang, Y., and P. S. Barrett. 2010. "Findings from a Post-occupancy Evaluation in the UK Primary Schools Sector." *Facilities* 28 (13/14): 641–656. doi:10.1108/02632771011083685.