

Putting indoor climate to the test

More holistic school renovation?

Taastrup, 24 October 2017

Indoor climate conference

Professor Peter Barrett

Emeritus Professor University of Salford

Honorary Research Fellow Oxford University

Danish issues in focus

- Longer school day
- Concerns re air quality
- Broader concerns re indoor climate
- Refurbishments of bespoke primary schools
- Opportunity to address range of factors
- Opportunity to build in flexibility

Taken for granted aspects?

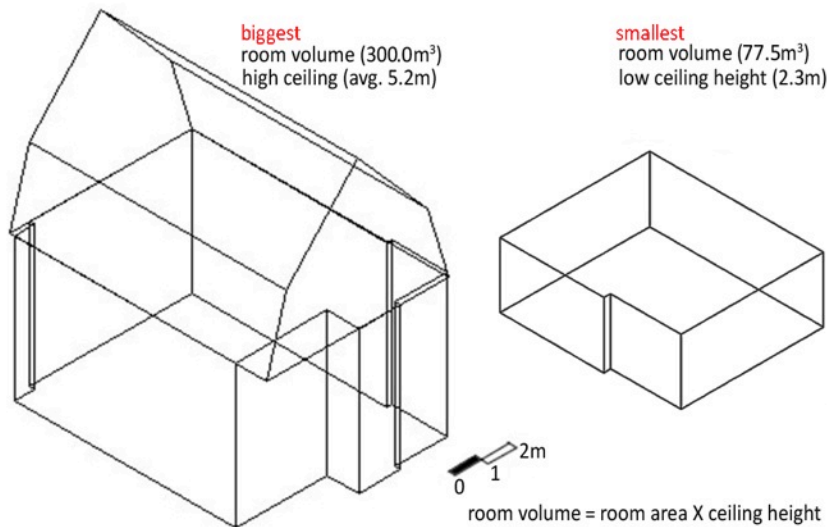
- Large parts of the world (World Bank)
 - Is there a school? Are there enough places for the pupils in the area? Has it got water, sanitation, heating? Is it wind and water-tight?
- Closer to home ...
 - Damp? Major vector for health and attendance problems

Basic requirements of
the physical school
environment

Health / Naturalness

Air quality

- Large, varied openings good, especially at high level
- Can clash with roller blinds
- Large room volume can help

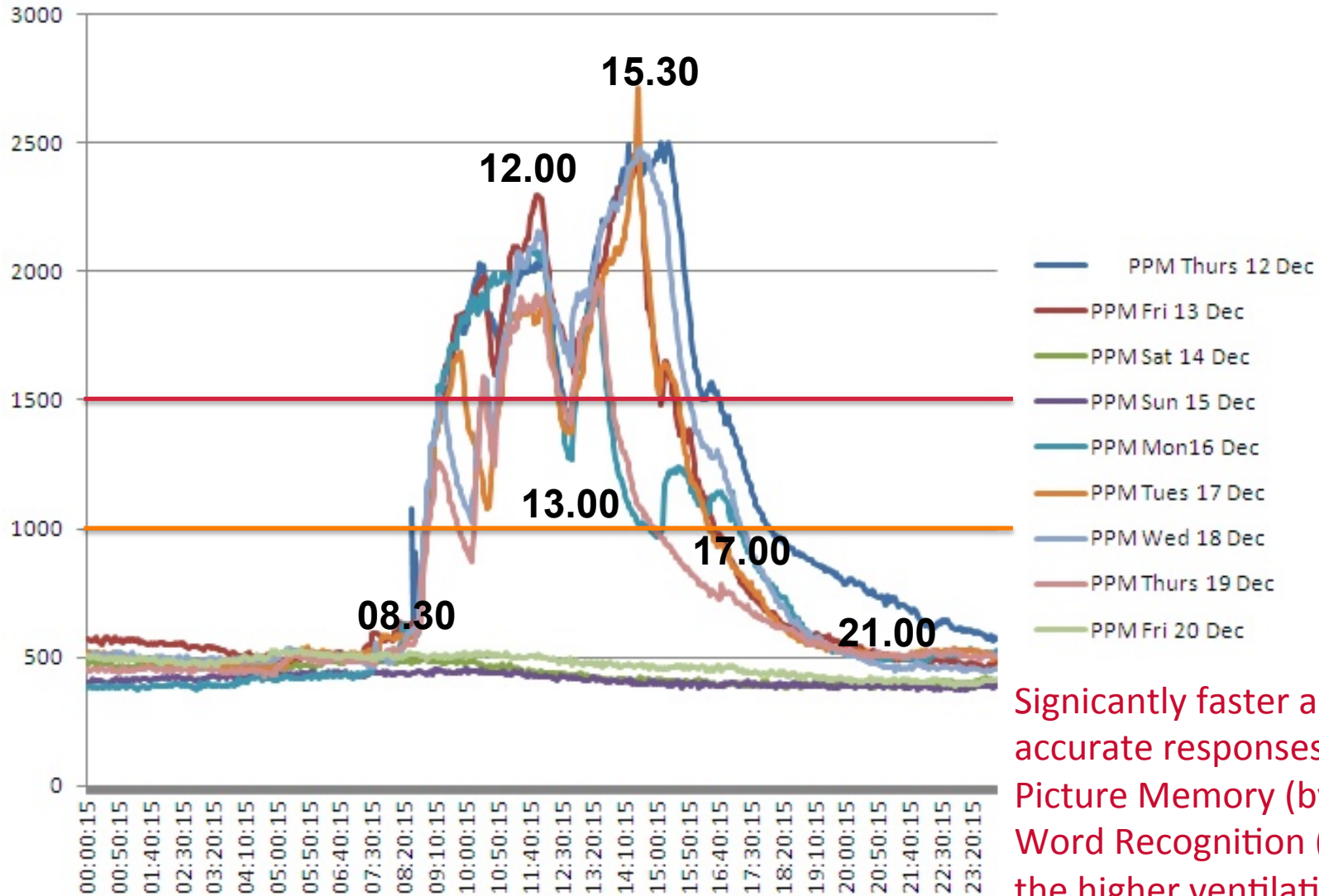


Average time for a class of pupils to “create” poor air quality ... ?

**30
minutes**

CO₂ in one classroom over a week

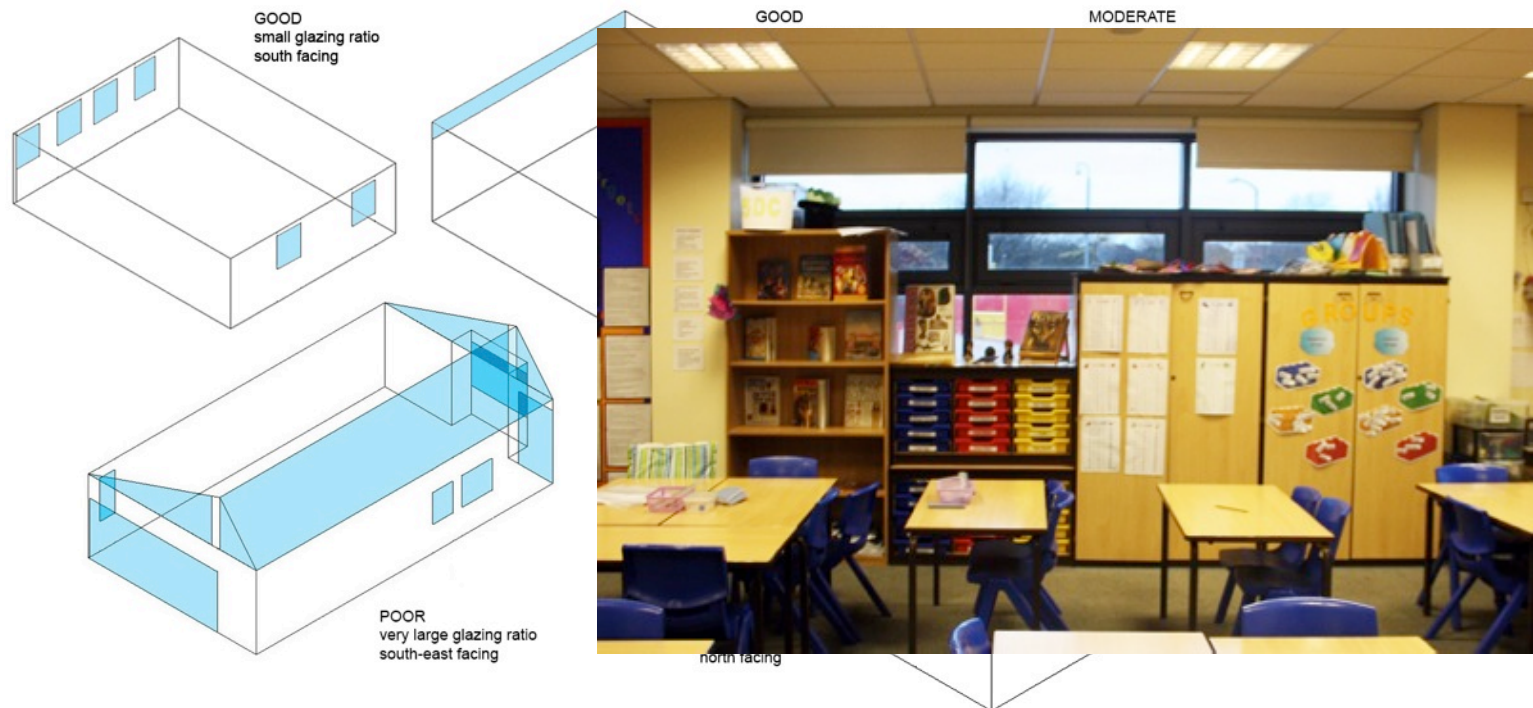
An example



Significantly faster and more accurate responses for Picture Memory (by 8%) and Word Recognition (by 15%) at the higher ventilation rates
Bako-Biro et al, 2011

Light

- High levels of natural lighting, **but** without glare: big / small windows facing North / South – not obscured with cupboards / displays
- Good quality of artificial lighting
- Good quality, easy-to-operate blinds – down and up!



Temperature

- Heating **control** in each classroom critical
- Heat gain from sun can be a problem – South facing / no external shading

Orientation and shading devices



Poor: no external or internal shading control (right)



Good: abundant sun heat but with external canopy

Sound

- Quite small rooms and carpet tiles typical on most of floor area – acoustics not problematic
- **New open designs??**



Links to nature

- Significant for **Writing** / (creativity?)

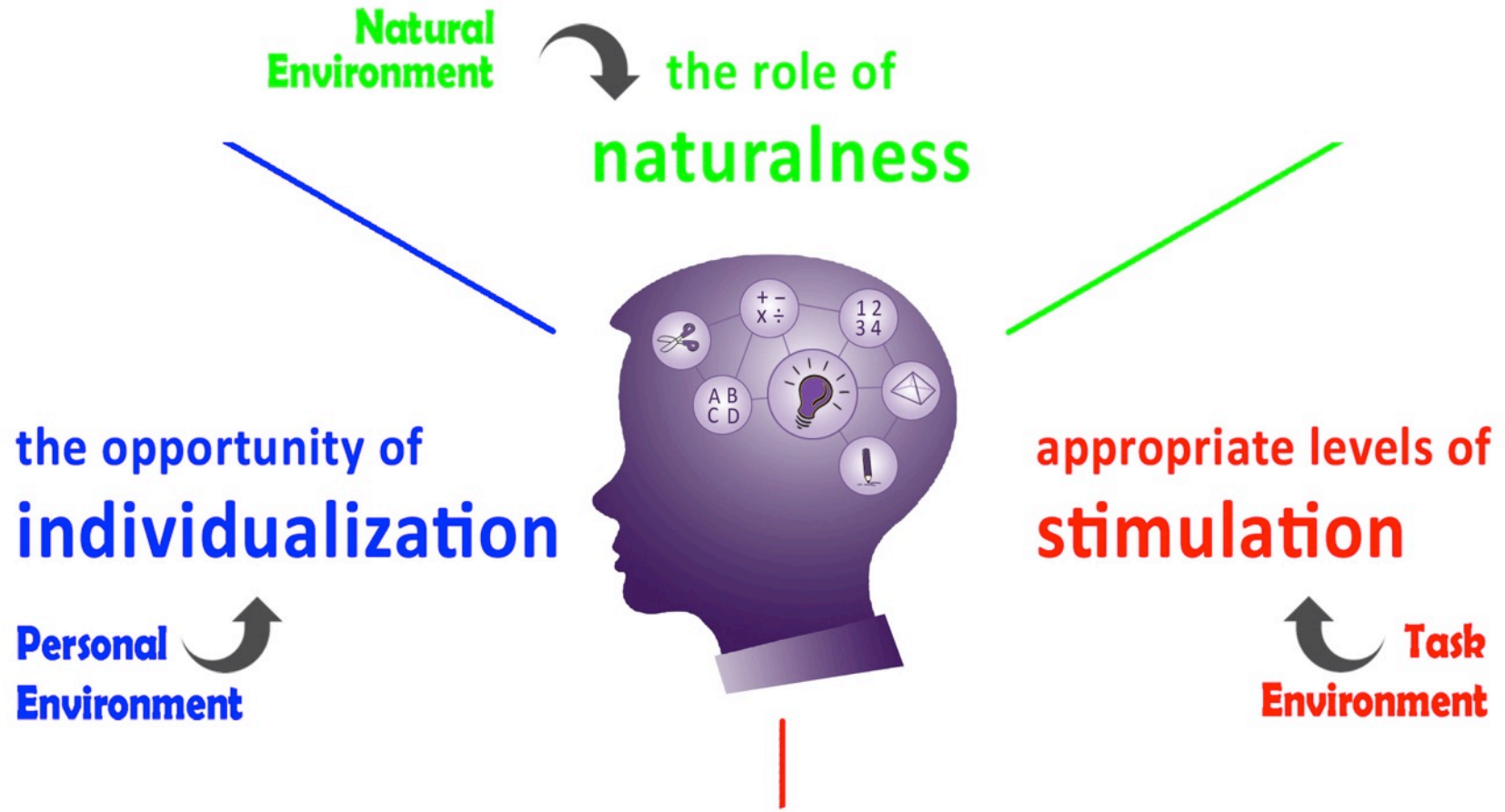


Is this enough though?

Putting the pupil at the centre



Learning is driven by the SIN design principles

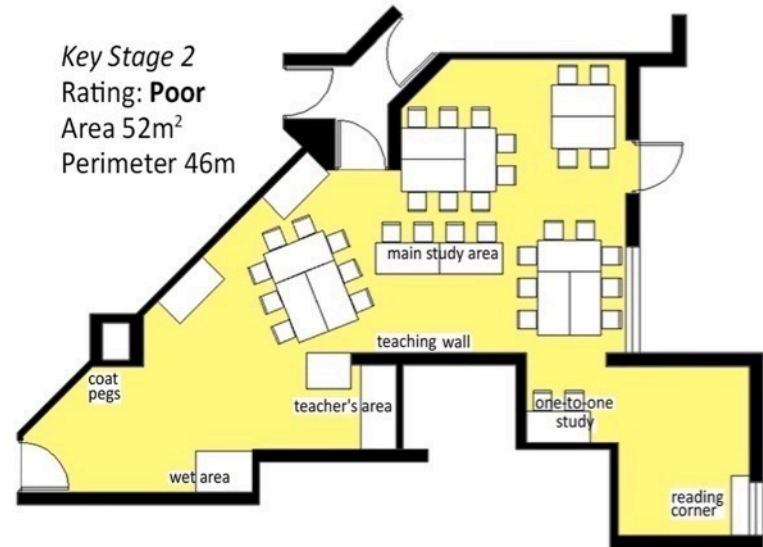


P. Barrett and L. Barrett (2010). "The Potential of Positive Places: Senses, Brain and Spaces". *Intelligent Buildings International*, 2: 218-228.

Individualisation

Flexibility / choice

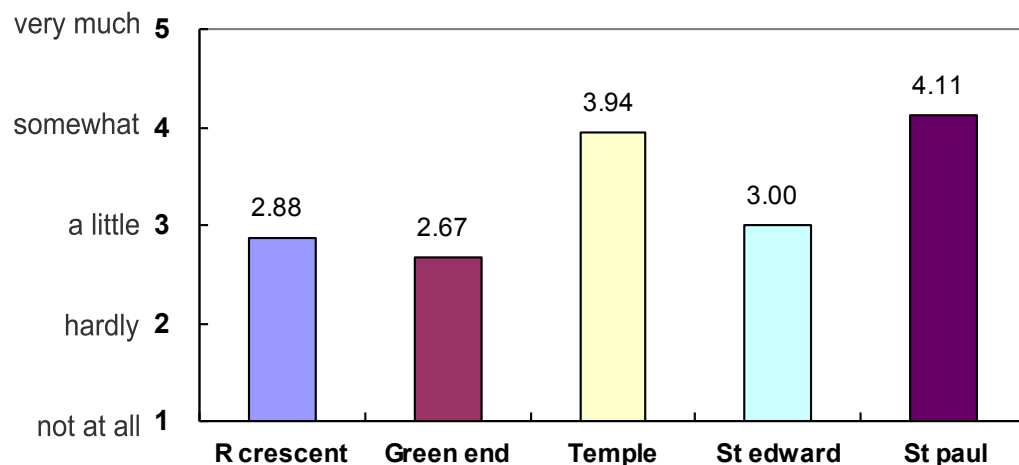
- Break out spaces / zones attached to classrooms work well (but not just camping in corridors)
- Ample wall display area is beneficial
- More complex plans with varied learning zones are appropriate for KS1 “play-based” learning
- Bigger / simpler plans for more formal learning in KS2



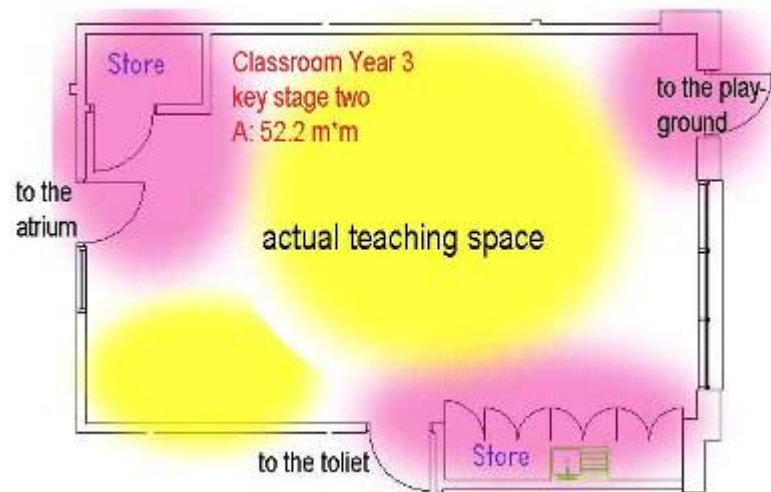
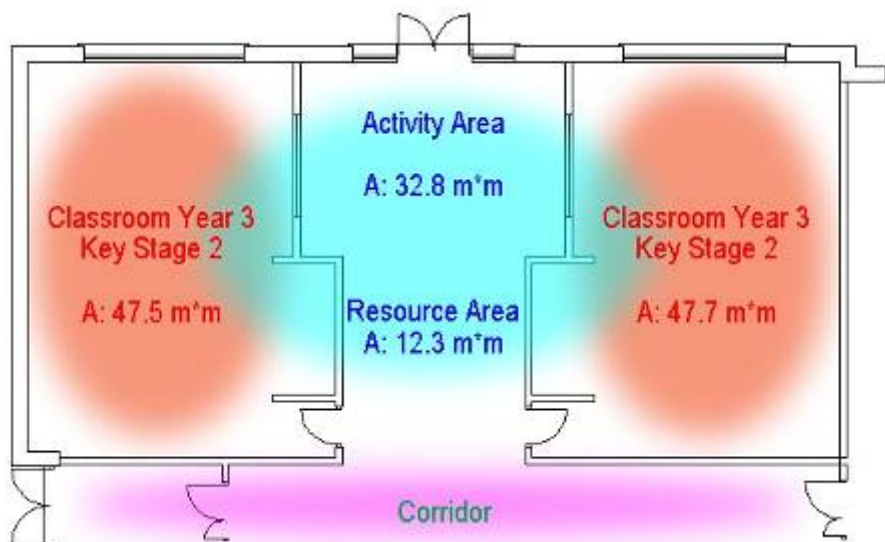
“Open and flexible”

Staff survey / POE: flexibility, Manchester

Q: Do the classrooms allow flexible use (Such as: small group work, projects, workshop, etc)? 1. Not at all 2. Hardly 3. A little 4. Somewhat 5. Very much



▼ Below Left: Temple Right: Green end



Ownership

A range of factors were found to be important in two categories: aspects that helped pupils identify with “their” classroom; and aspects that are child-sensitive.

- Distinctive room design
- Pupils’ work is displayed on the walls. Other elements such as shared display tables.
- Elements that are personalized by the pupils: such as coat pegs, lockers and / or named drawers.
- Well-designed furniture that creates a learning space that is child centred.
- Desks and chairs that are comfortable, interesting and ergonomic to the pupils’ ages and sizes.



class-made display



personal storage



lots of class-made art work on display in varied formats and sizes.

Interaction of flexibility / ownership



The “den”

The “cave”

Connection / wayfinding

- Secondary factor in HEAD study, but becomes significant in model just for **Reading**
- Thought it was about way-finding, but emerged as driven by “corridor libraries” in wider routes, especially beneficial for poorer pupils



Level of stimulation

Visual complexity

Which is best?



TOO LITTLE



ABOUT RIGHT



TOO MUCH

Appropriate level of stimulation is curvilinear for learning – not too exciting, not too boring

Colour

- Relatively calm backdrop of wall colour – curvilinear again, not all white or all bright yellow!
- Against this, points of brighter colour in the furniture etc



TOO LITTLE



ABOUT RIGHT



TOO MUCH



*How big and strong are
the effects on learning?
The evidence*

Headline results

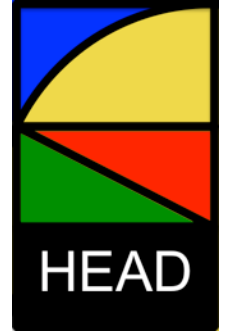
The SIN principles explain **16%** of the variation in learning achieved by the pupils over a year

(Using National Curriculum sublevels in Reading, Writing and Maths at the start and end of the year, and fixing all except built environment factors to their means)

Multilevel
modelling
factored out
other
influences

The HEAD Project

Holistic Evidence and Design – sensory impacts,
practical outcomes



To explore if there is any evidence for demonstrable impacts of school building design on the learning rates of children in **primary** schools

Primary schools present a real opportunity as pupils mainly in one space and there are annual measures of academic progress – relatively **simple**

*Pilot phase funded by Nightingales now IBI
HEAD Project funded by EPSRC 2012-15*

www.cleverclassroomsdesign.co.uk

Big / diverse UK study sample

Looked at 153
classrooms in 27
schools, with
3766 pupils

- **Observation** – layout, display, lightings, floor covering, colour, view out, window (opening) size and position etc.
- **Measurement** – lighting level, temperature, noise level and CO₂ level, room height, window height, furniture and fixture size
- **Interview** – sensory comfort, e.g. temperature, glare, noise, smell, size and usage etc.



1900s



1920s



1950s



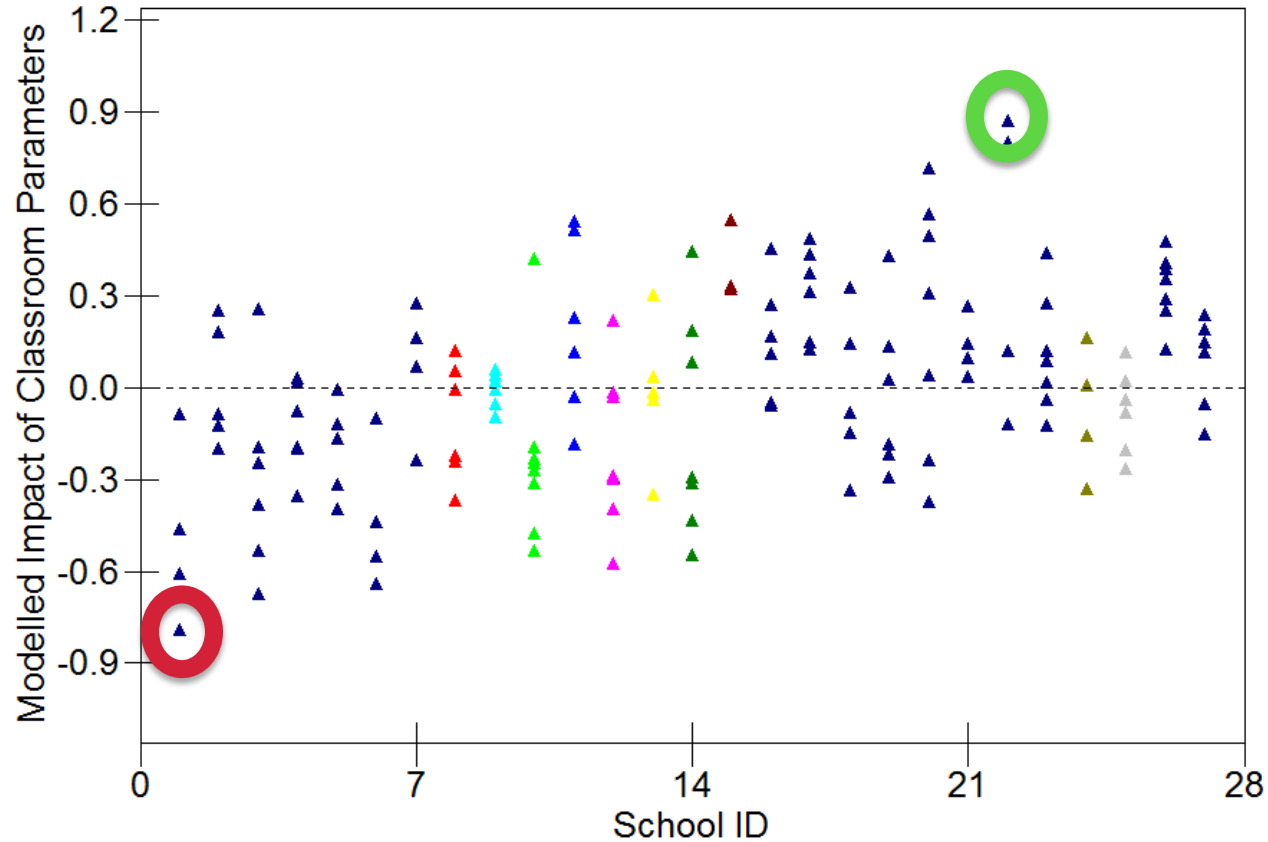
1970s



2000s

In nested situations (pupils in classroom) **multilevel modeling** presents the opportunity to separate out impacts from various levels

Extreme case - potential impact



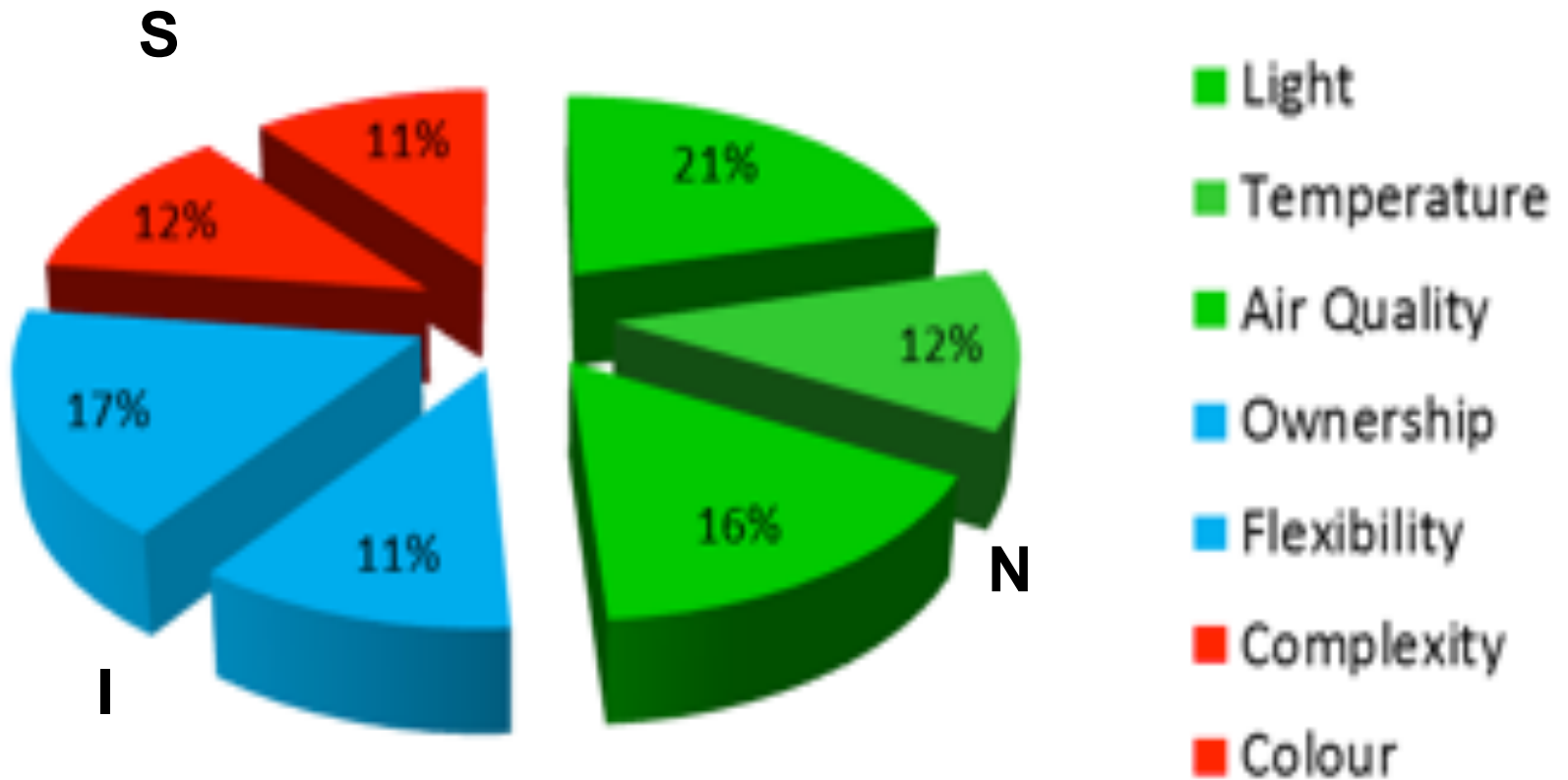
Least
effective
classroom



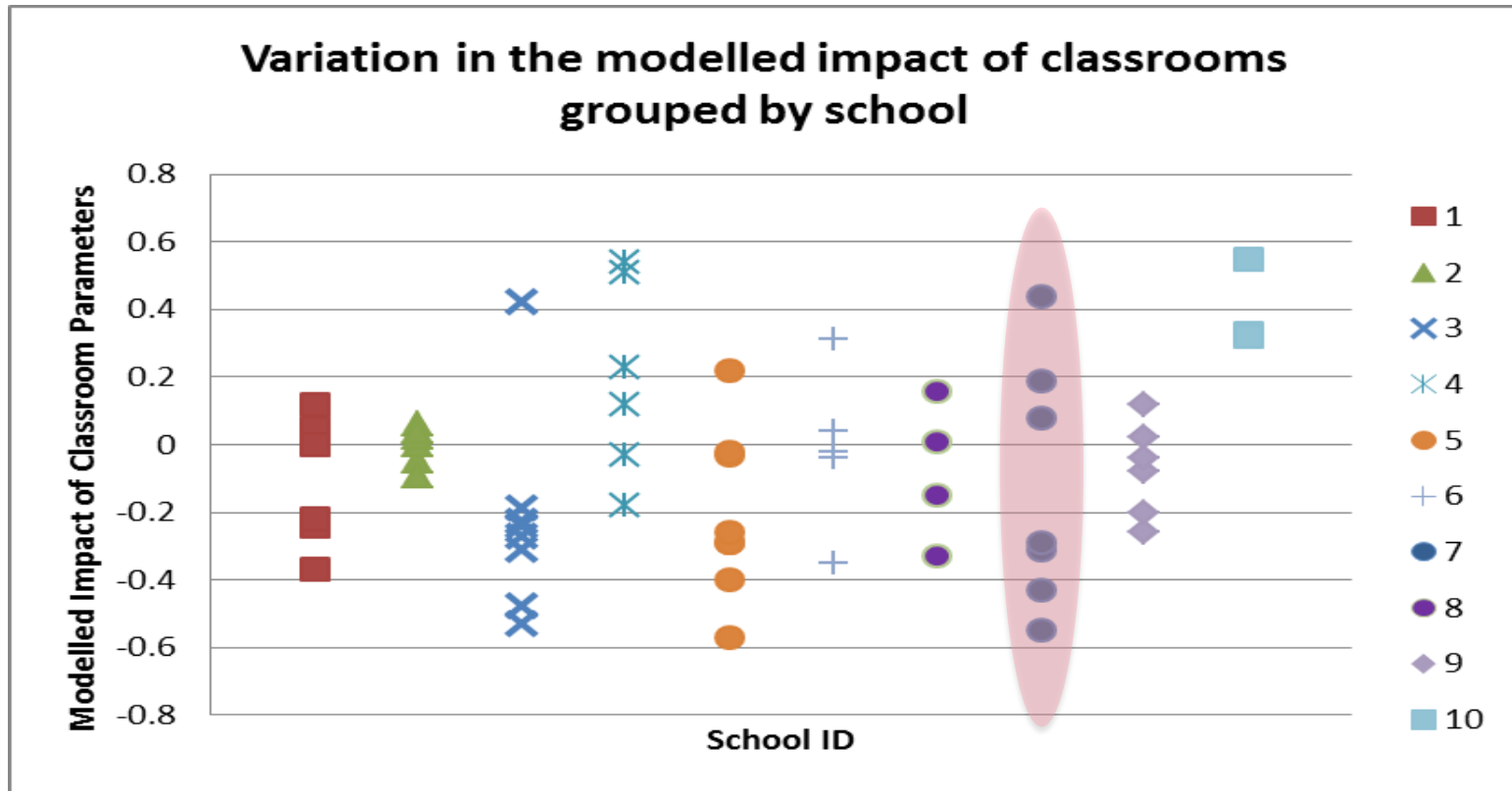
Most
effective
classroom

+ 1.3 sublevels for
“average pupil”

Contribution from each classroom measure



Danger! Big variations within schools



First and foremost the individual classrooms must each be well designed – **argument for “inside-out design”**

*Dynamic links to
pedagogies / the future*

Performance criteria

- Sustainability
- Flexibility and adaptability
 - Inc community
- Value for money

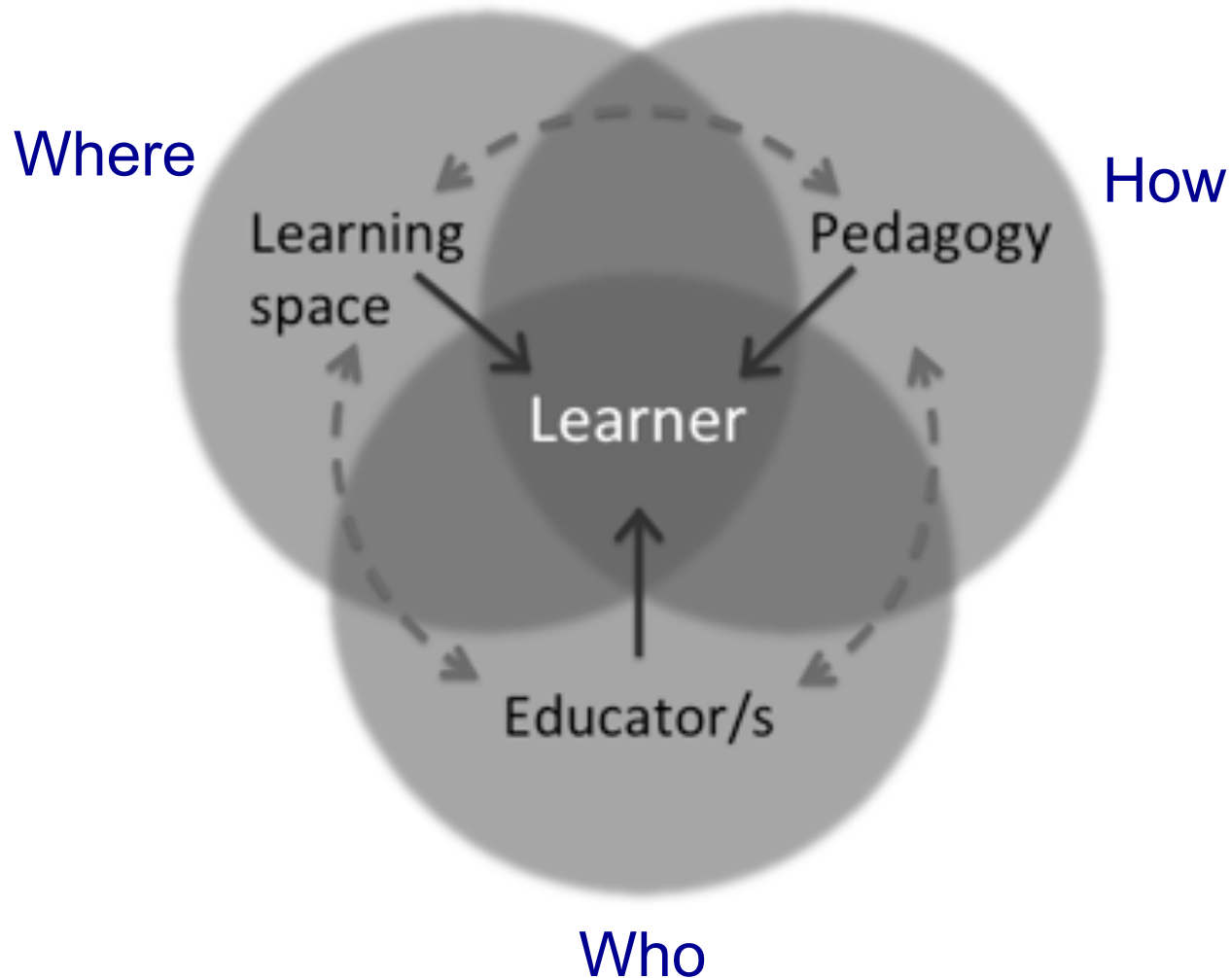
DfES Building Bulletin 95

- Flexibility
- Community needs
- Sustainability
- Safety and security
- Alternative financing

OECD PEB Compendium of Exemplary Educational Facilities

A high emphasis on efficiency and future proofing ...
but a low emphasis on schools as **learning** spaces ... a
low emphasis on spaces for **people** ... a rebalancing of
criteria is needed

The full learning environment



Norwegian flexible classroom design

– via SIN lens

- **Inadvertent low stimulation**
 - Lack of wall space for displays, glass and white for walls, choices of black, white and grey for furniture
- **Problem of ownership**
 - “If everyone “owns” everywhere, then no-one owns anywhere”
- **Mismatch with pedagogy**
 - Notions of team working, cooperation and transparency – for whom?
 - Acoustics
 - Can a space be **too** big?



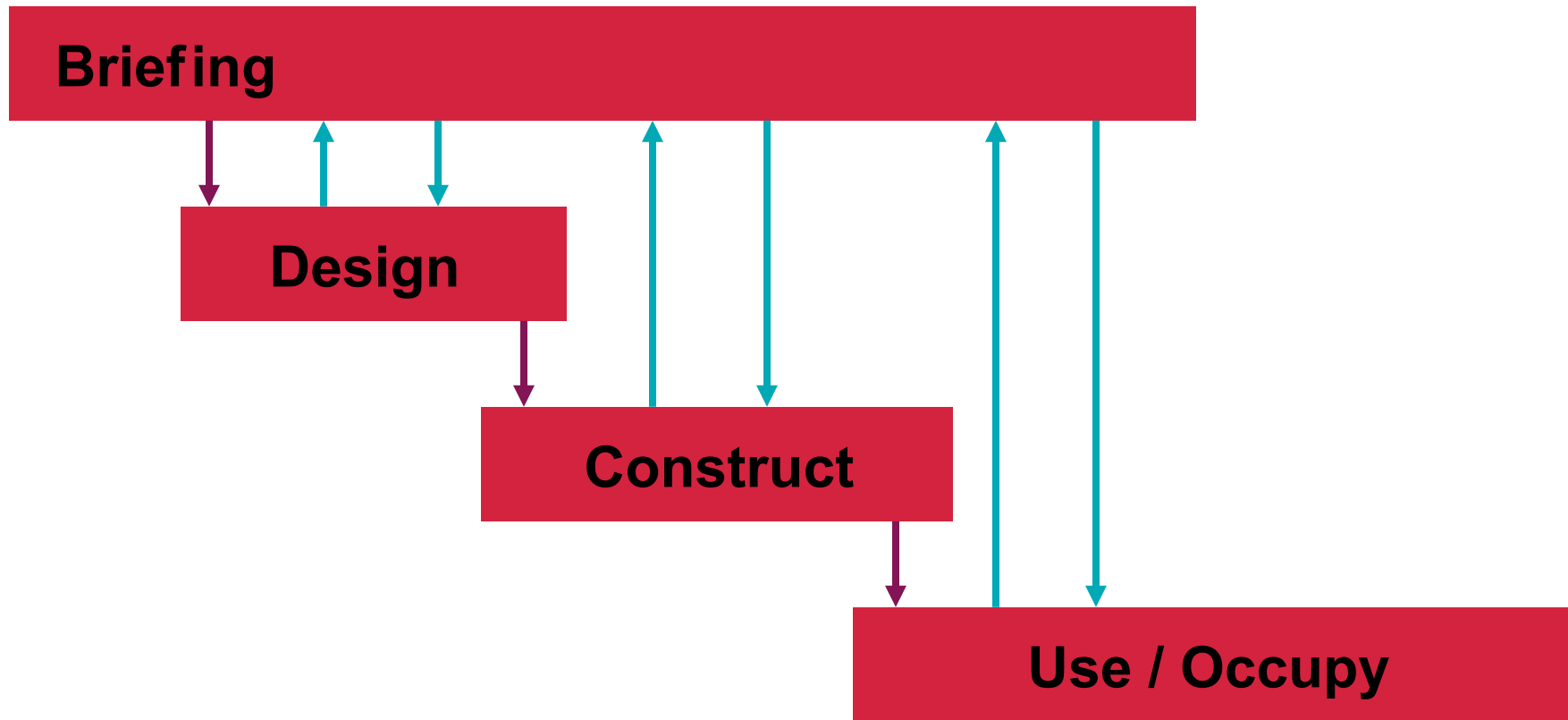
The role of technology ...

OECD (2015) Students, Computers and Learning: Making the connection

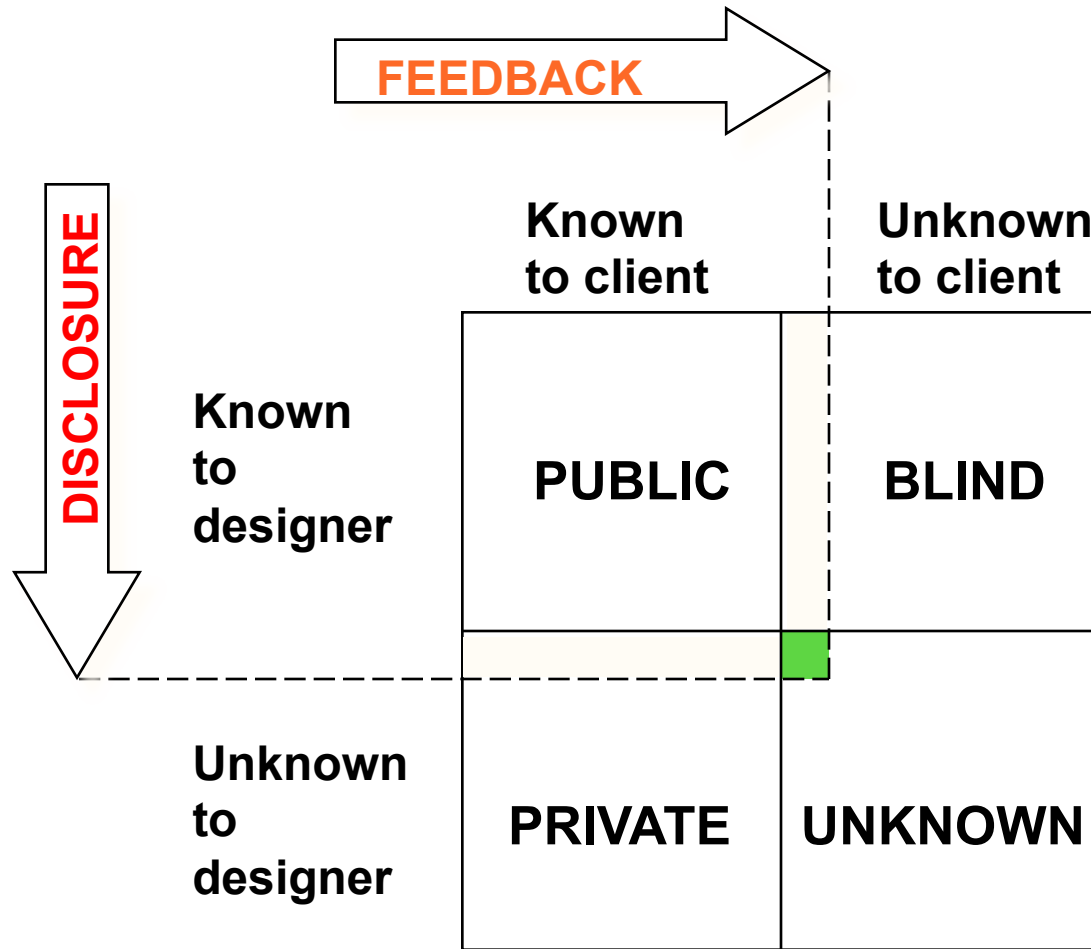
- Students who use computers very frequently at school do a lot **worse** in most learning outcomes, even after accounting for social background and student demographics.
- The results also show **no appreciable improvements** in student achievement in reading, mathematics or science in the countries that **had** invested heavily in ICT for education.
- One interpretation of all this is that building deep, conceptual understanding and **higher-order thinking requires intensive teacher-student interactions**, and technology sometimes **distracts** from this valuable human engagement.

Design process and use

Managing project dynamics



The Johari Window



Opportunities and tensions

- Lot teachers can do, but ...
 - **Understanding** – light, visual complexity, building management systems
 - **Competing priorities** – energy and air!
 - **Focus on teaching** – third teacher?

Practical implications for optimising the classroom



Advice for Teachers	Advice for Designers
<ul style="list-style-type: none"> • Keeping glazing clear, by minimizing occlusion of the windows can maximise environmental benefits from natural light. • Access and active use of the blinds/curtains is needed to address problems with glare. • Careful siting of high power projector to minimise need to close blinds. • Shrubs or planters placed outside south-facing windows can reduce glare. 	<p>Advice here is given for UK latitudes but similar considerations will be needed for other locations. Sun glare is more of a problem now because of the use of computer projectors.</p> <ul style="list-style-type: none"> • Large glazing is welcomed when it is towards the North, East or <u>West</u> which receives abundant daylight and has a low risk of glare during the normal hours of occupation. • Oversize glazing should be avoided when the room is orientated towards the sun's path and in this situation external shading should be provided. • High quality electrical lighting is essential to provide a natural light alternative.
<ul style="list-style-type: none"> • A typical classroom with thirty pupils will normally need active ventilation within a 1 hour lesson. Avoiding obstructing access the window openings is important. • Excess CO₂ can cause drowsiness and inattention and a CO₂ meter in the classroom can give teachers an indication of an air quality problem. 	<ul style="list-style-type: none"> • Big window opening sizes and at different levels, provide varying ventilation options. Controls should be easy to access and use. • Where possible, increasing the ceiling height can mitigate air quality issues because of a larger classroom volume, but effective ventilation is still needed. • Mechanical ventilation may sometimes

Summary

Need for consistency – despite differences!

- Fundamentally **healthy** places, that ...
- Inherently support SIN-ful **learning!**
 - Provision of requisite naturalness
 - Opportunity for individualisation
 - Appropriate level of stimulation

Long-term need for flexibility

- Evolution / fashion in pedagogy - **fit**
- Demographic changes over coming **decades**

Retail parallel



Utilitarian experience



Hedonic experience

The background is a vibrant blue gradient with a dynamic water splash effect. Numerous water droplets are captured in mid-air, creating a sense of movement and freshness. The splash is centered, with ripples emanating from the point of impact. The overall aesthetic is clean, modern, and refreshing.

AQ

Health
Learning

Availability in USA