

# Thermal Comfort in Schools/Institutions



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Thermal comfort is defined in ISO 7730 as:

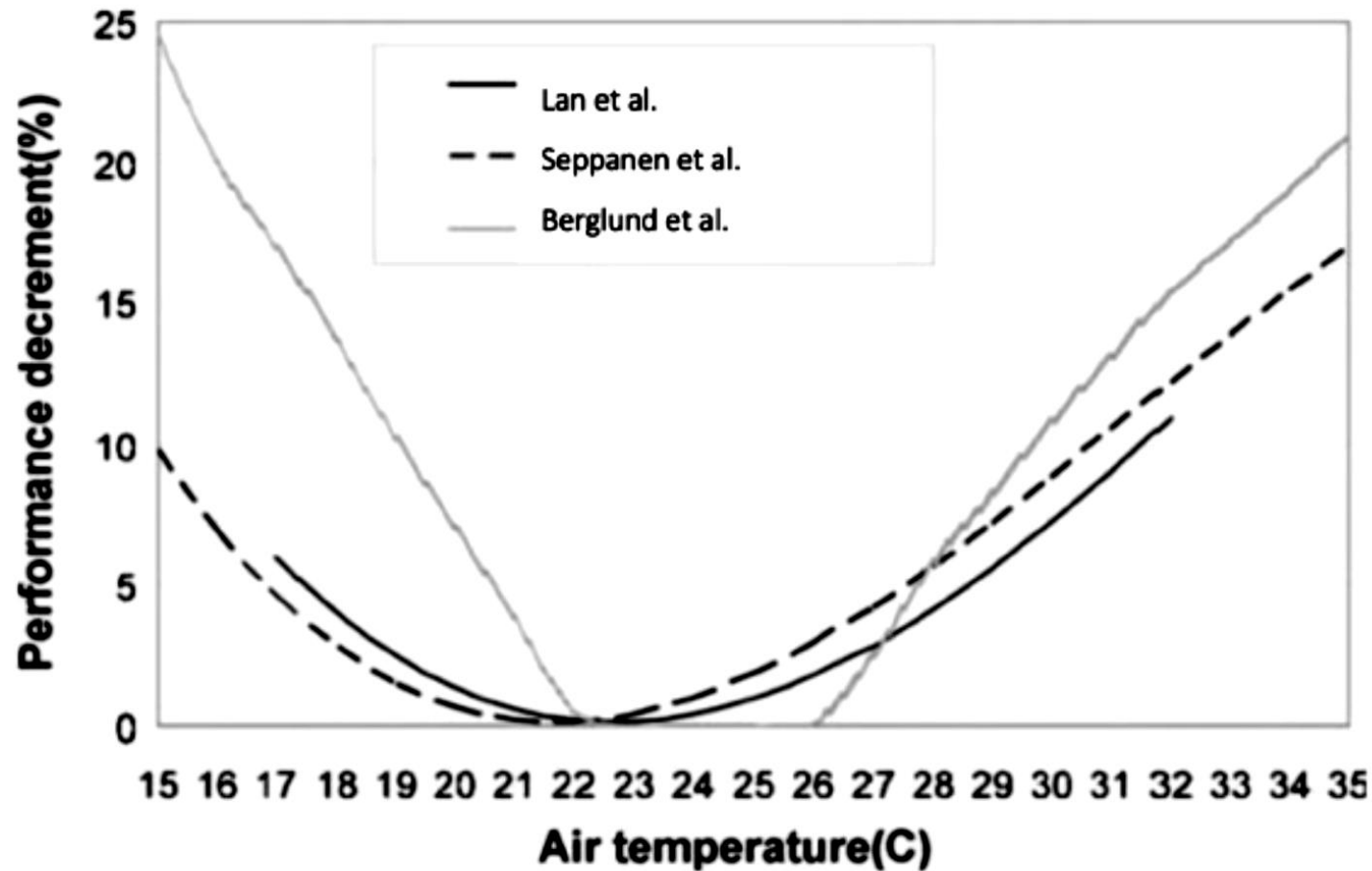
*‘that condition of mind which expresses satisfaction with the thermal environment’*

# Why Special Focus on Schools/Institutions ?

## **Our hypothesis:**

- Activity level of students is different/higher than usual
- Most schools/institutions are unconditioned
- Many schools have formal dress code/neck-tie use in summer too
- Clothing change is usually decided by date and not temperature
- Children keep moving in and out relatively carelessly
- Academic performance may get significantly effected by comfort level
- Tolerance band for thermal conditions is different than adults (Higher risk of being unwell)

# Air temperature v/s Performance decrement



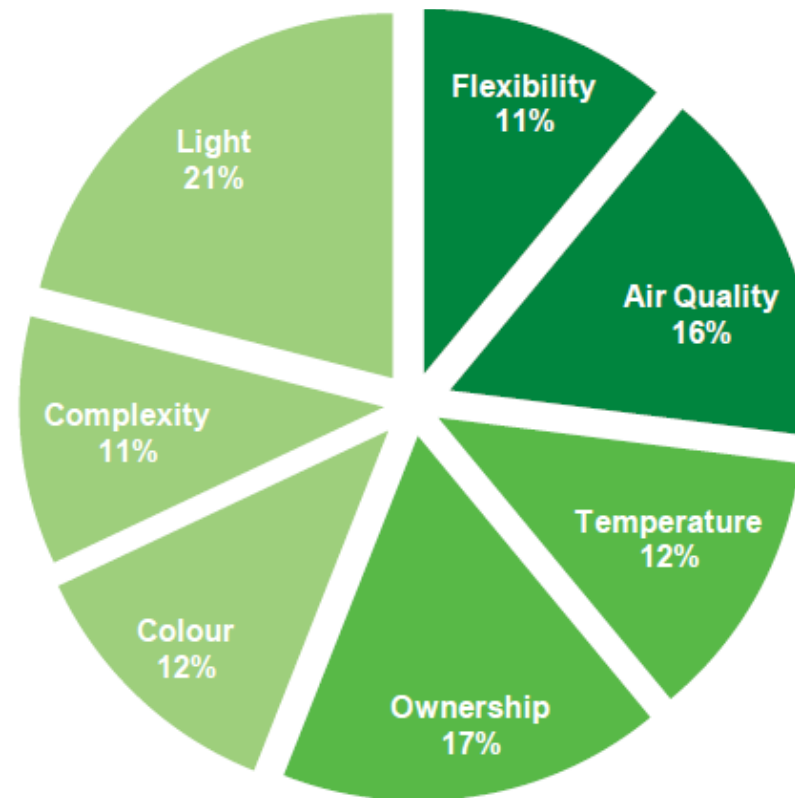
**Indicates:**

*Productivity loss can be very high if indoor conditions not kept **optimal***

*Overcooling of buildings is equally counter-productive as under-cooling*

# Thermal comfort and performance of students

Seven key design parameters that together explain 16% of the variation in students' academic progress.



In India:  
*Humidity and sound may be additional influencing factors*

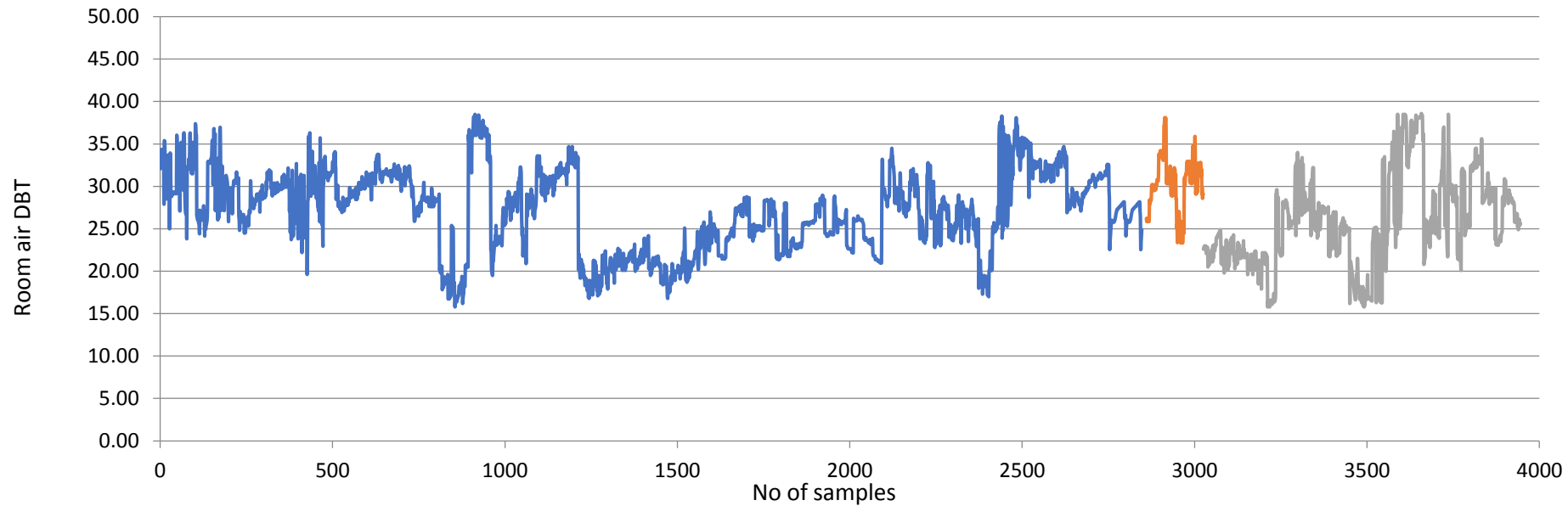
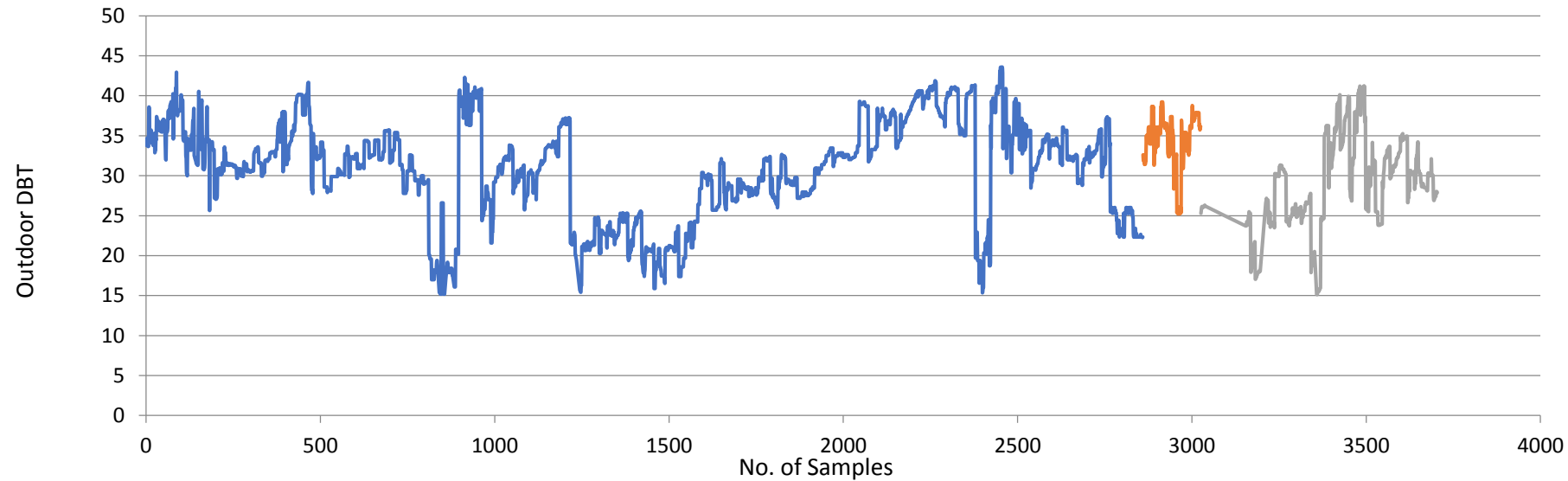
Source: Relative contribution of key classroom design parameters to academic progress (Derived from Barrett et. al, 2015).

# Thermal comfort studies on subjects from Indian Educational Institutions

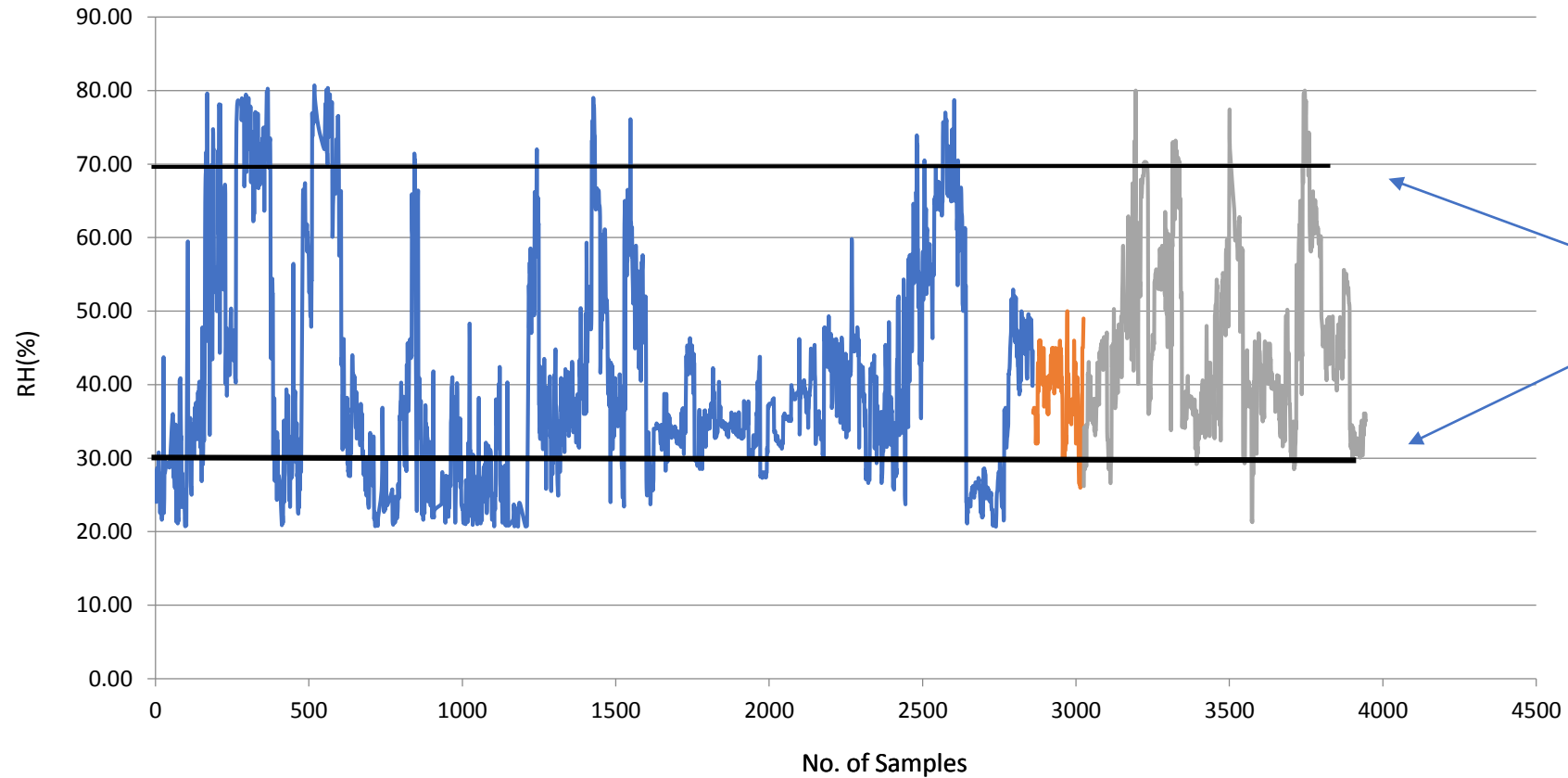
- MNIT: Major focus on college, some data from schools
- IIT Kharagpur: College
- IIT Madras: College
- CEPT Ahmedabad: College
- Salesian College, Darjeeling: School and college both
- Gyan Vihar Univ., Jaipur: College



# Dry Bulb Temperature variation

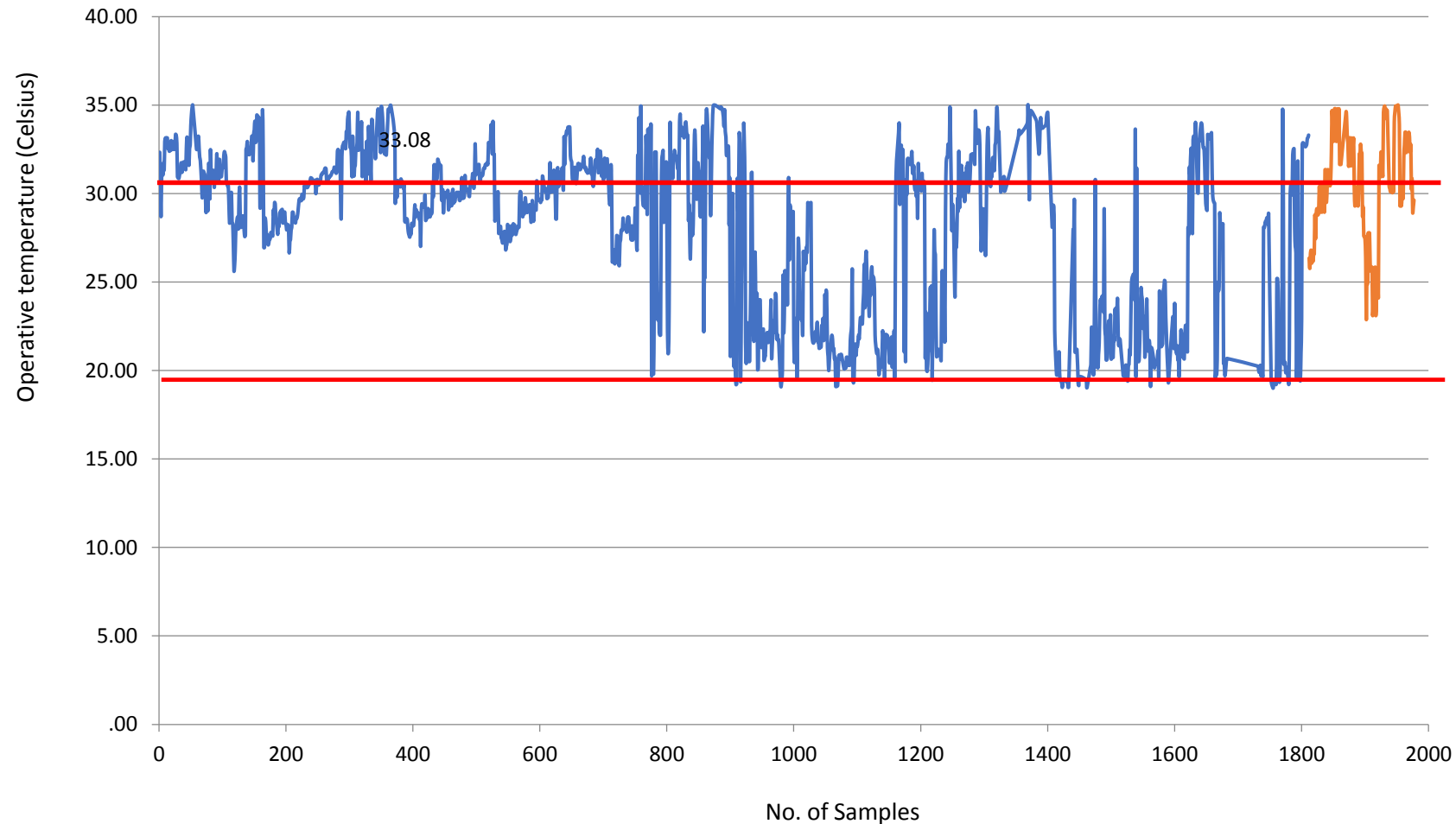


# Relative Humidity variation



Horizontal lines showing limits as per ISHRAE IEQ Std. 10001-2016

# Operative Temperature (adjusted) variation



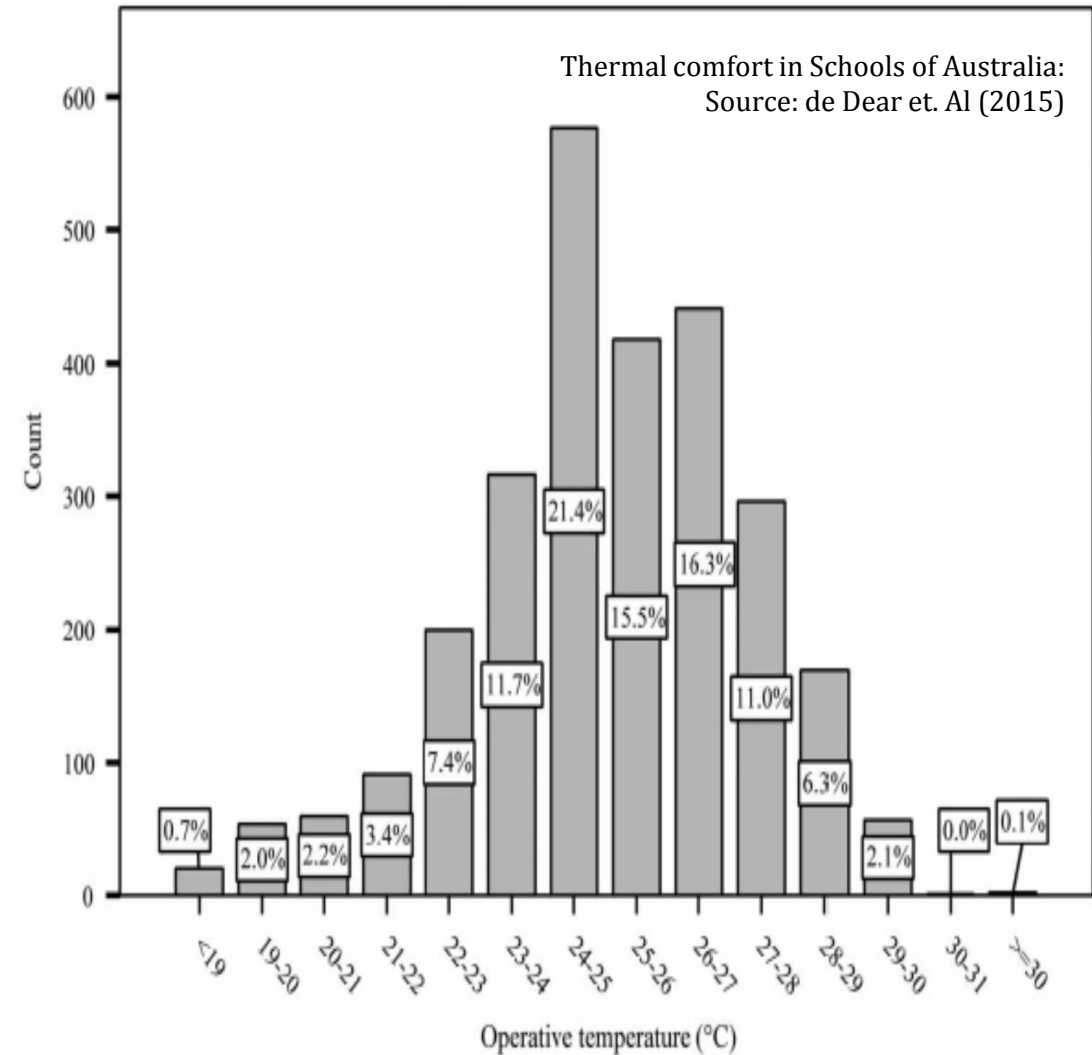
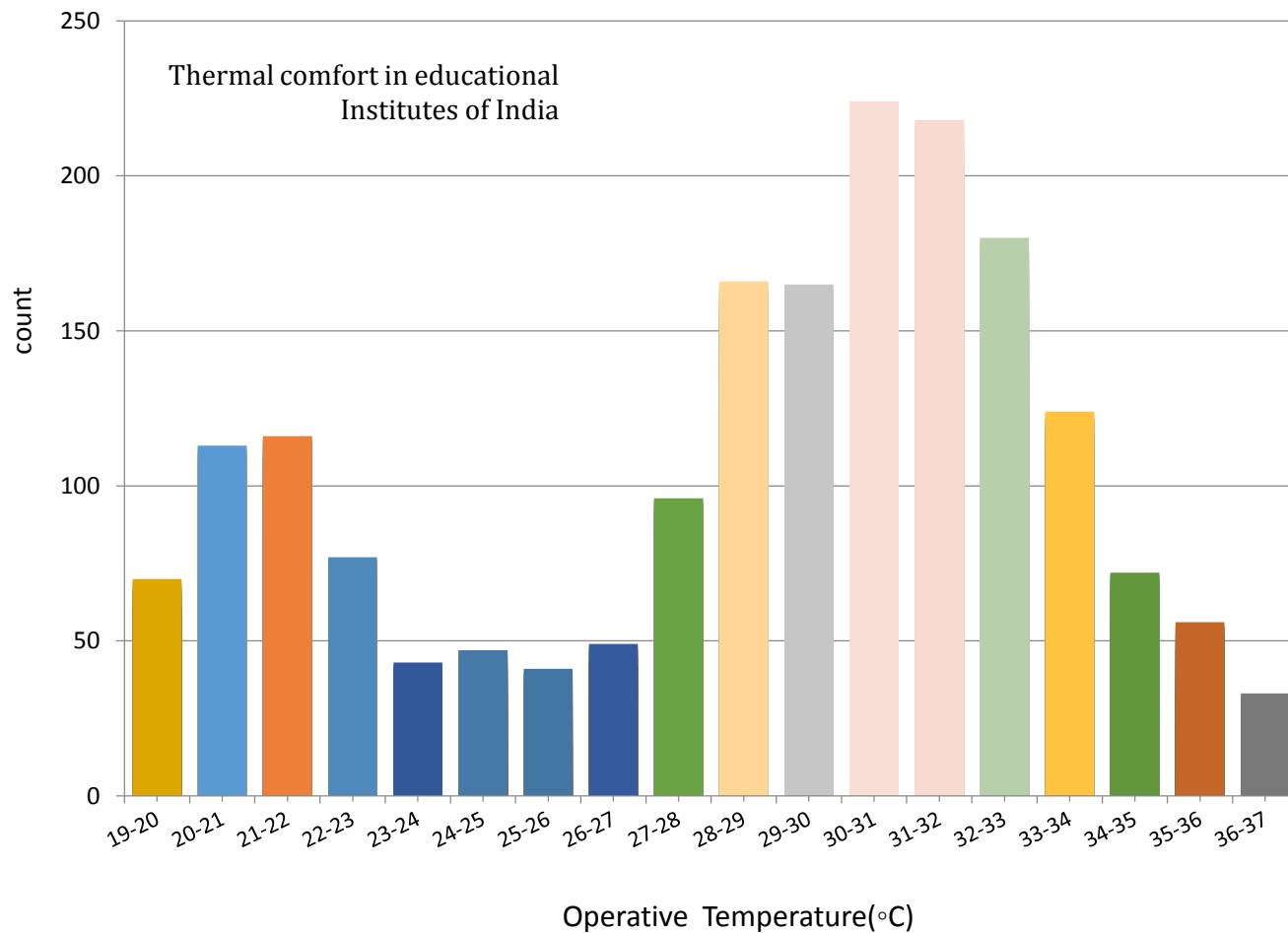
*Horizontal red color lines show limits as per ISHRAE IEQ Std. 10001:2016*

Upper limit including air velocity offset, 0.50 clo value (summer clothing)

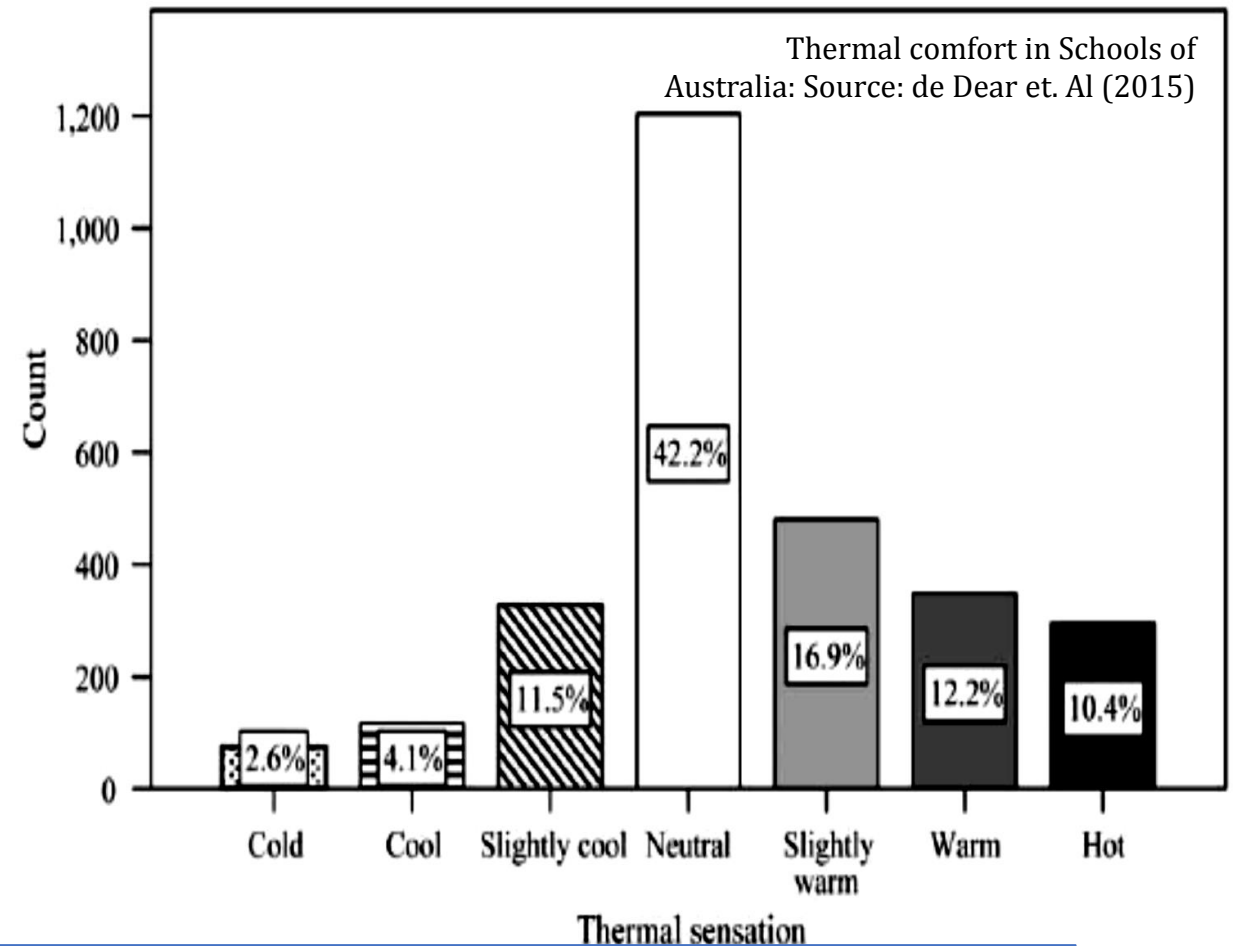
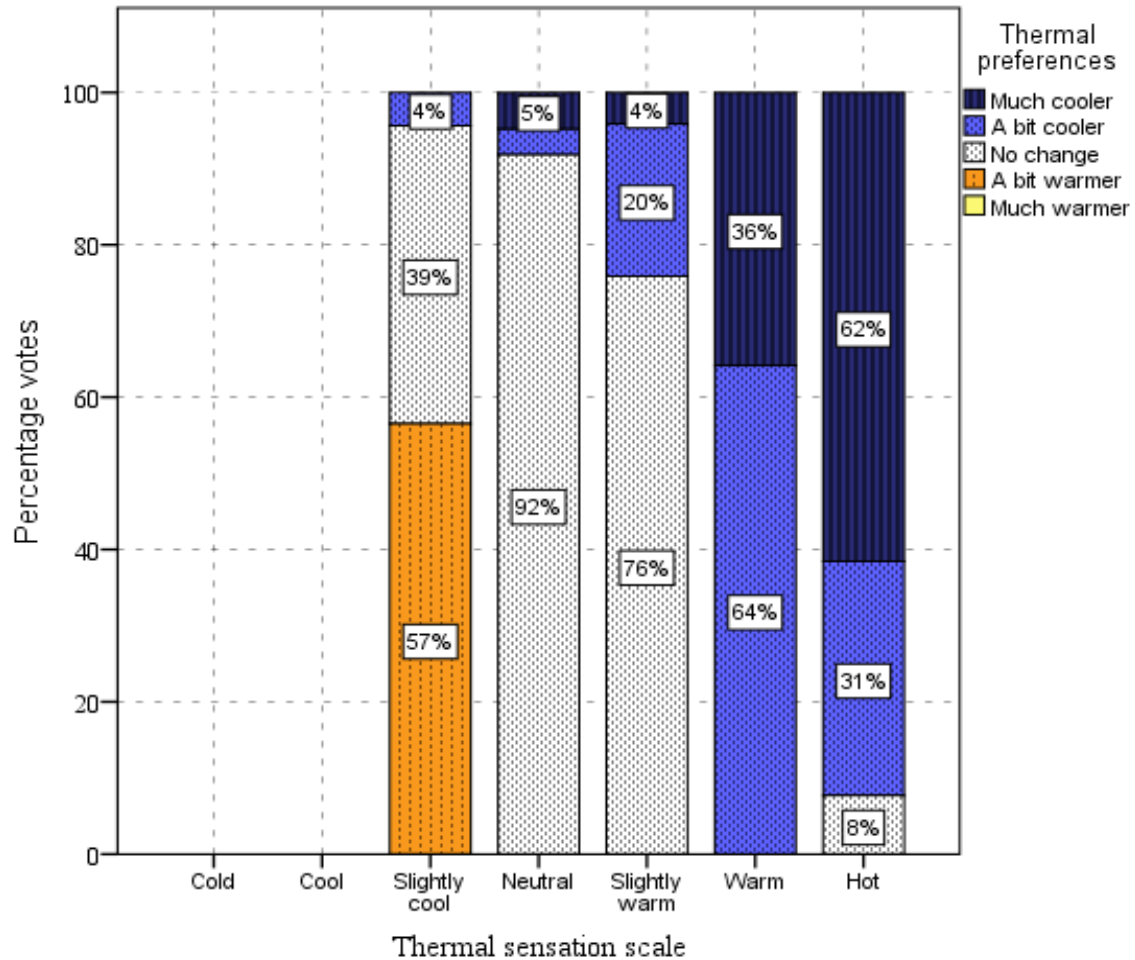
Lower limit for still air, 1.0 clo value (winter clothing)

**Conclusion:**  
For significant duration, children are exposed to uncomfortable warm conditions

# Operative temperature comparison

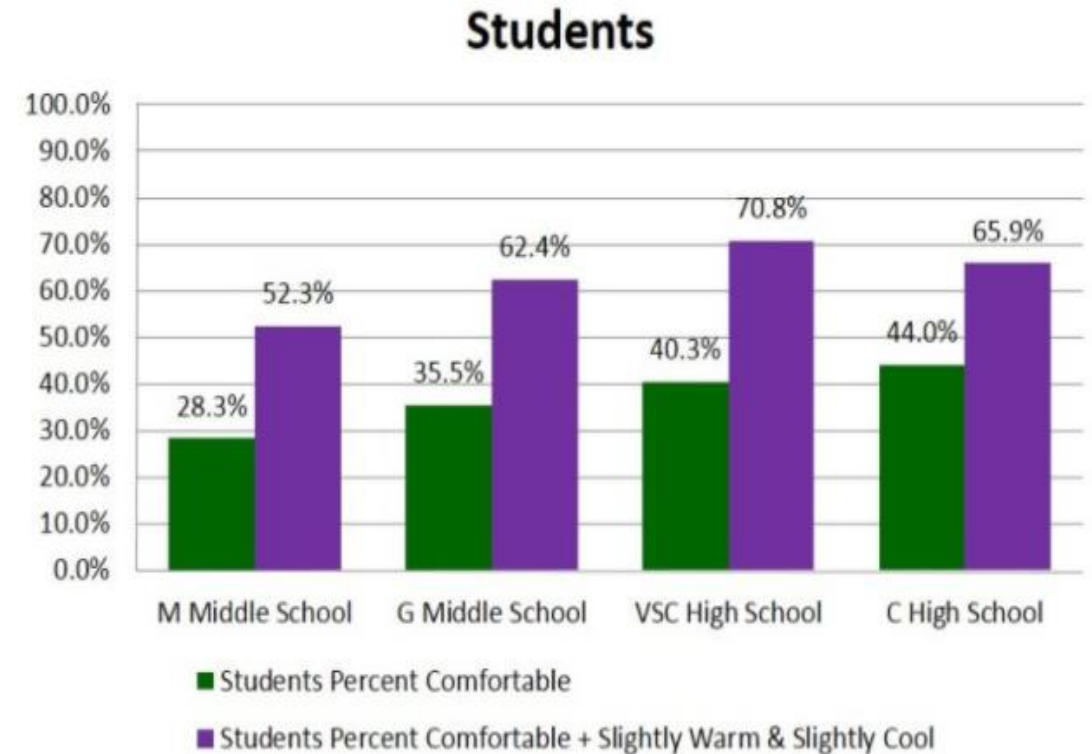
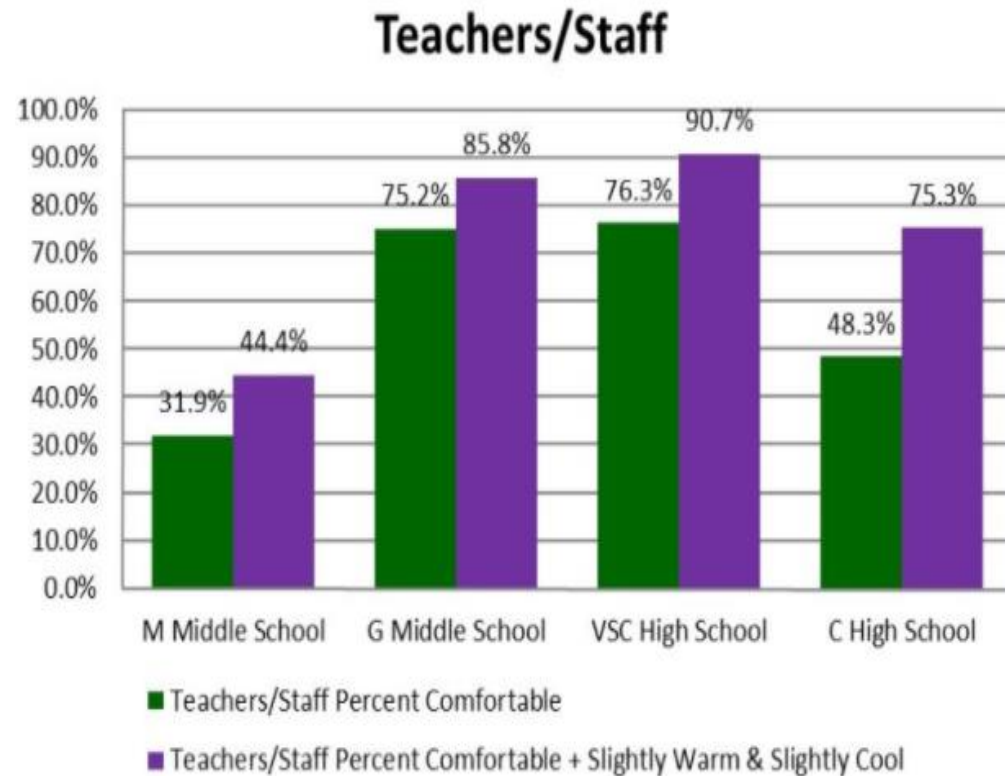


# Thermal response of students



**Conclusion:** Country specific studies are required for thermal comfort guidelines!!

# Students v/s Adults: Significant difference



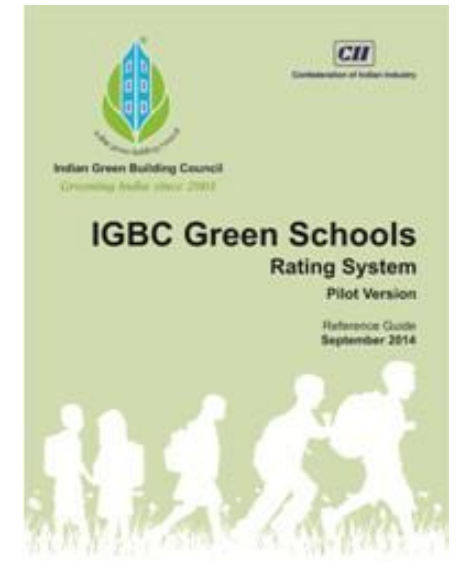
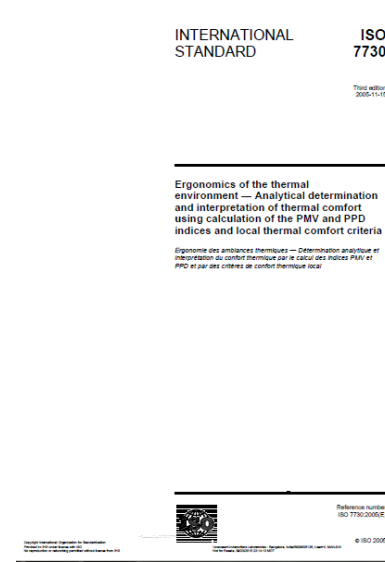
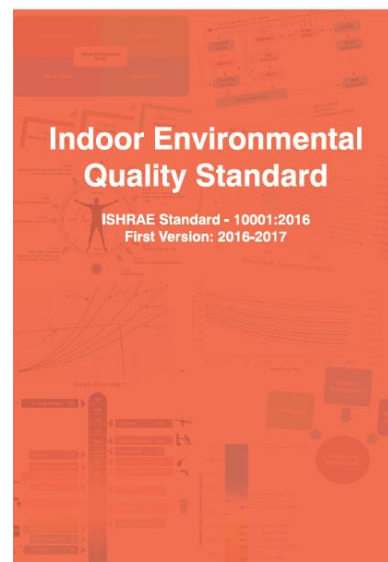
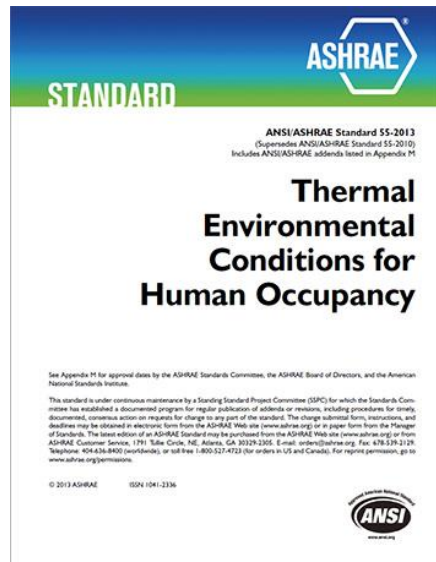
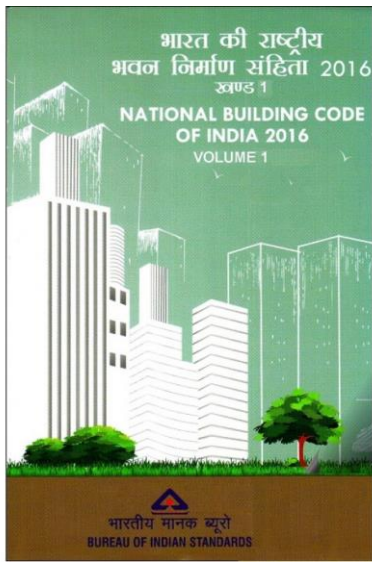
*Source: Thermal comfort (or lack thereof) in PK-12 facilities: Marcel-Harmon (2016)*

In 11 out of 16 seasons (4 seasons in four schools), poor correlation has been found between thermal vote of teachers/staff and students

**Conclusion:** Country specific – school specific studies are required for thermal comfort guidelines!!

# School focussed considerations so far

- ASHRAE Standard 55 and the ISO 7730 Standard are based on experimental studies of adults, not children
- NBC of India 2016: **No separate thermal comfort guidelines for schools**
- ISHRAE IEQ Standard - 10001:2016: **No separate dealing of schools**
- **IGBC Green School Rating System**



# IGBC-School Rating: Daylight requirements

- Mandatory: At least 40% of regularly occupied spaces shall meet the daylight factor as mentioned below.
- Credit points for higher values

S No	Visual task	Prescribed Daylight Factor
1	Classroom desk top, chalkboards	2.5
2	Laboratory/ Workshops/ Drawing	2.5
3	Library reading tables	2
4	Staff room, office area	2

# IGBC-School Rating: Indoor air quality requirements

## **TVOC**

- Use paints and coatings with low or no VOC content for 100% of interior wall and ceiling surface area

## **Dust free environment**

- Use dust-free products in interiors such as chalk pieces, duster, etc.
- Every classroom should have a foot mat.
- Every classroom should be cleaned on a daily basis.

## **Ventilation in critical areas (toilets, kitchen, labs)**

- Minimum CFM of forced ventilation specified

# IGBC-School Rating: Exhaust air requirements

Design exhaust systems in kitchen, toilets and laboratories as per the requirements provided in the table below:

Location	Minimum Airflow	
Kitchen / Mess	For < 9.3 sq.m (100 sq.ft) floor area	100 cfm
Toilets	For < 4.64 sq.m (50 sq.ft) floor area	50 cfm
Laboratories	For < 50 sq.m (538 sq.ft) floor area	500 cfm

# IGBC-School Rating: Ventilation requirements

- Mandatory: At least, 40% of regularly occupied spaces shall have openings equal to or greater than 15% of the carpet area.
- Credit points are awarded for higher values

Thermal comfort related requirements are nearly missing in IGBC Green School Rating as well!!

# Summary and road ahead

- Adult based thermal comfort standards may not apply to children/schools
- Improvement in thermal conditions likely to boost performance, enhance wellness
- Lack of India specific studies focussing on thermal comfort of school children
- Need to conduct school based studies, covering Indoor Environment, establish its influence on performance
- Embedding findings in design guide for schools

Thank You!!!  
Any questions???