Connecting Student Performance with Facility Performance

Sustainability PDC

#iasboVC20

ILLINOIS ASBO CONNECTED 2020 VIRTUAL CONFERENCE

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Introductions

Stuart, Brodsky, AIA: Speaker
- *K-12 Practice Leader, CannonDesign*

Arden Herrington: Speaker
- *Senior Account Manager, Frank Cooney Company*

Keith Hammelman, PE: Speaker
- *Mechanical Engineering Leader, CannonDesign*

Steve Kowalski: Moderator
- *Business Development Manager, Performance Services*

“WE SHAPE OUR BUILDINGS, AND IN TURN THEY SHAPE US”

WINSTON CHURCHILL

23% of the U.S. population goes to school every day

56.6 Million attend elementary and secondary schools

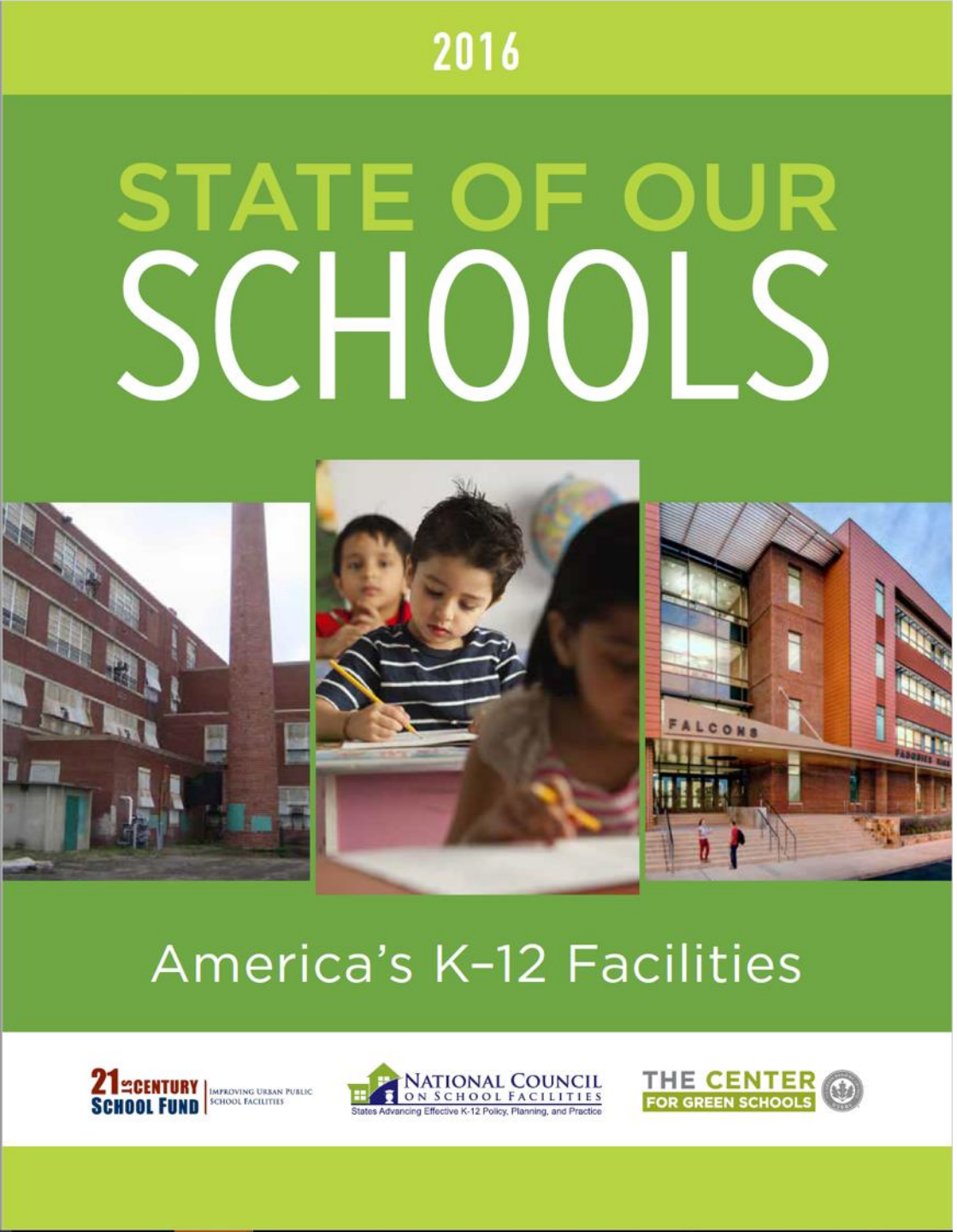
(According to National Center for Education Statistics there are 98,200 public schools, including about 6,700 charter schools. In fall 2015, there were about 34,600 private schools)

19.9 Million attend American colleges and universities

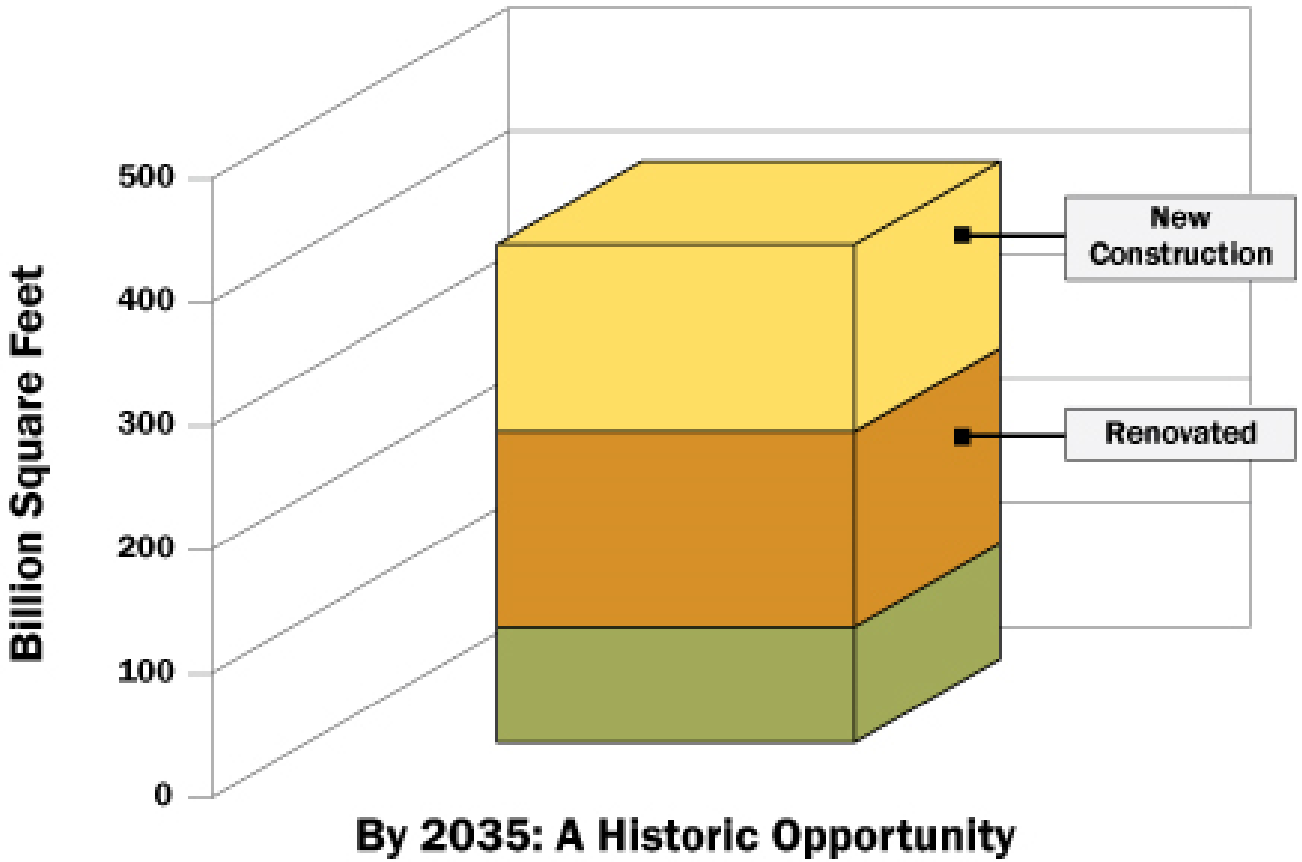
Source: National Center for Educational Statistics

MEDIAN AGE OF EDUCATION BUILDINGS IN THE U.S. IS 33.5 YEARS OLD; 50% BUILT BEFORE 1962

SOURCE: ENERGY INFORMATION ADMINISTRATION



$145 BILLION PER YEAR NEEDED FOR 21ST CENTURY FACILITIES FOR ALL CHILDREN



By 2035: A Historic Opportunity

By the year 2035, approximately **three-quarters** (75%) of the built environment will be either new or renovated

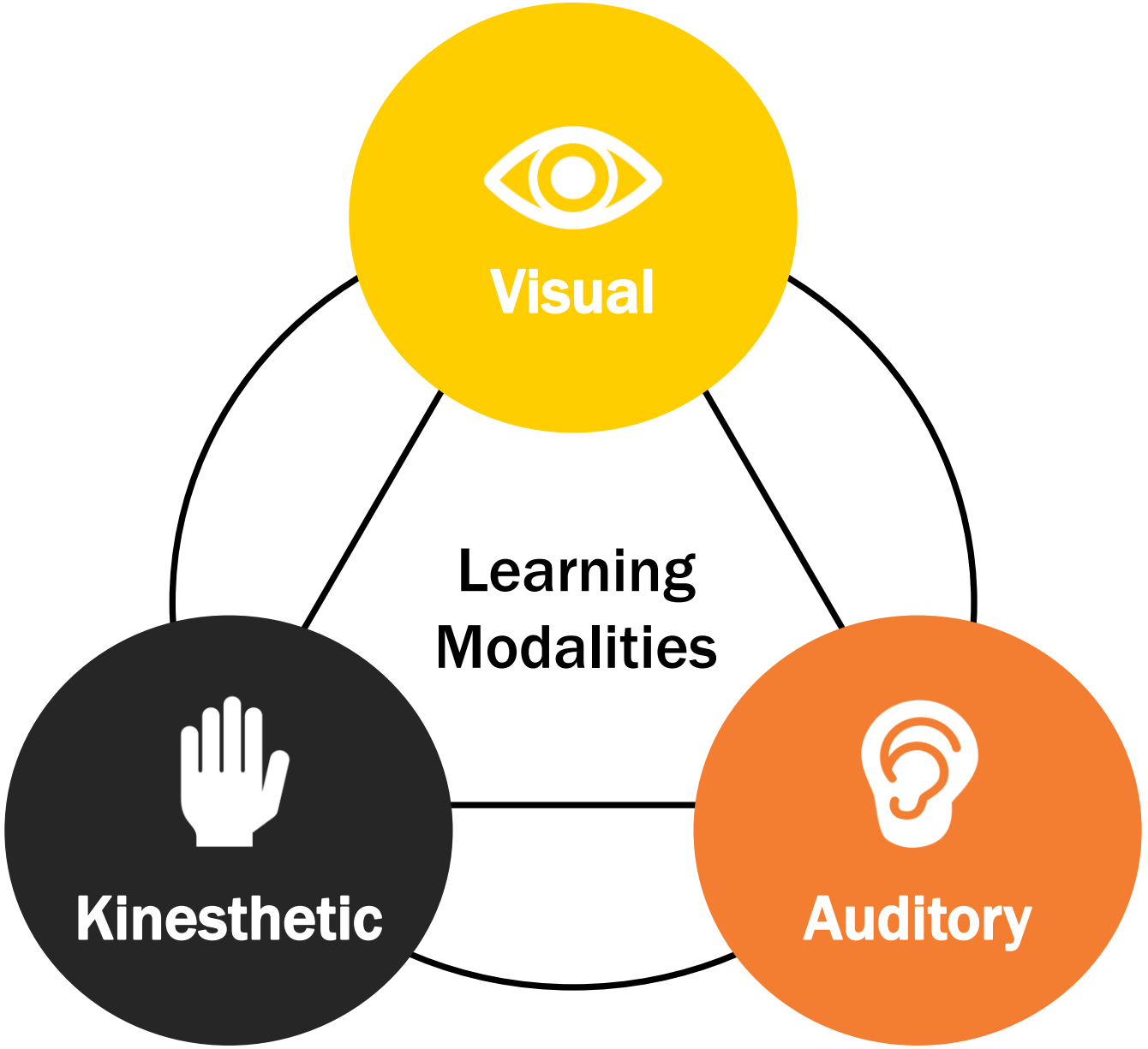
30% of students have attended **counseling** at some point either before or during college.

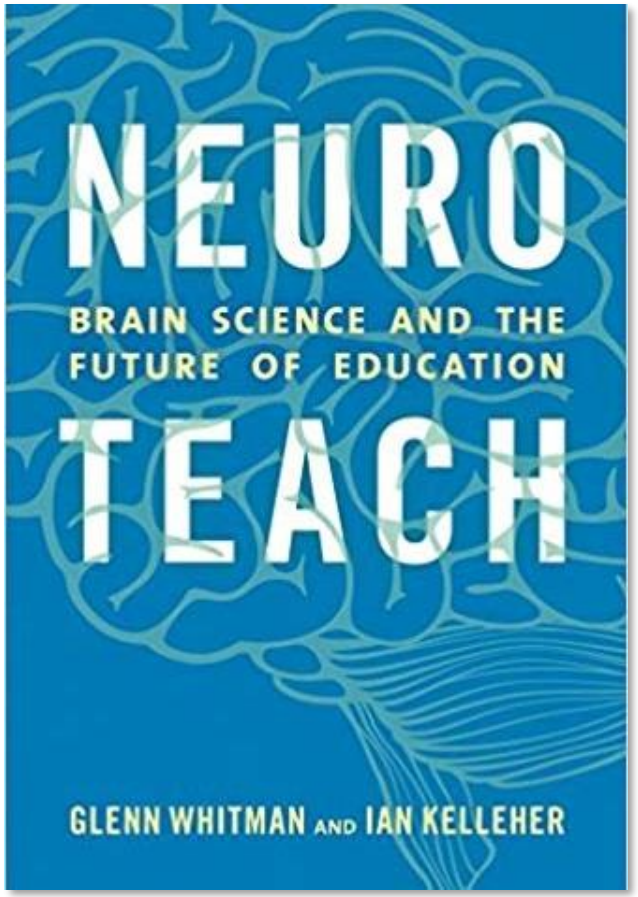
60% of college students have **disturbed sleep-wake patterns.**

Social anxiety and **academic stress** ranked high among students' concerns.

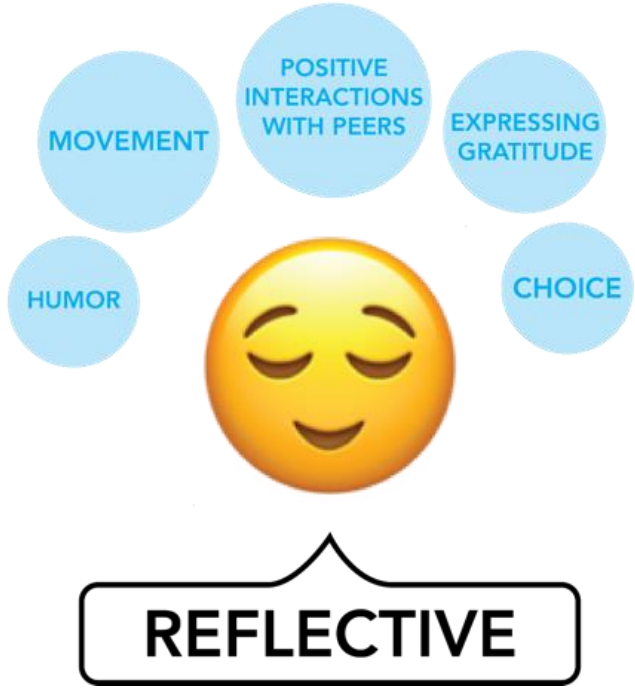
Only **3 in 10 adults** get the recommended amount of **physical activity.**

Source: American College Health Association and the Journal of Adolescent Health


Visual
Learning
Modalities
Kinesthetic
Auditory



Fight, Flight, Freeze
Brain Response



Thinking Brain
Response

The Impact of School Buildings on Student Health and Performance

Authors

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Harvey Bernstein
Vice President,
Industry Insights & Alliances
McGraw Hill Construction

February 27, 2012

www.mcgraw-hillresearchfoundation.org

McGraw-Hill Research Foundation

In partnership with

THE CENTER FOR GREEN SCHOOLS

http://www.centerforgreenschools.org/resources

How students — HEAR

How students — FEEL

How students — BREATHE

How students — SEE

How students — THINK & LEARN

How students — MOVE

HOW STUDENTS HEAR

acoustics are fundamental to learning

MECHANICAL SYSTEMS

Background Noise Levels must be 15 decibels quieter than speech

MATERIAL CHOICES

Reverberation Time and Noise Reduction Coefficient (NRC) affects speech intelligibility

CONNECTION / ADJACENCIES

Sound Transmission Coefficient (STC) determines how effectively walls and doors separate sound

Classroom studies find that there is a significant negative impact on short-term memory and speech perception as reverberation time increases. (Klatte et al, 2011)

HOW STUDENTS FEEL

thermal comfort in the classroom

SYSTEM TYPES

Temperature and humidity significantly affect student comfort and performance

AIR FLOW SYSTEMS

Increasing the amount of fresh air flow into classrooms can improve student attendance

CONFIGURATION OF CONTROLS

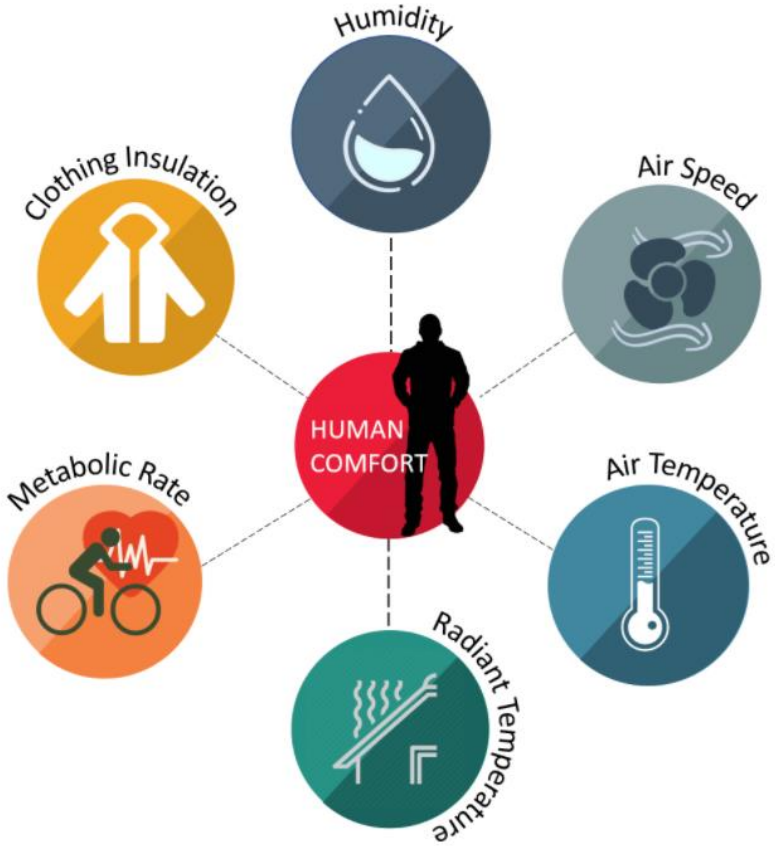
Personal control of their own environment gives occupants a sense of comfort

Studies showed a significant effect on student speed on the same tests when temperatures were lowered from 77 to 69 deg. F. The same result was reported to be a linear relationship, where reducing air temp by 1.8 deg. F "improved performance in terms of speed by from 2% - 4% in all tasks"

Thermal Comfort Factors

What is Thermal Comfort???

- ASHRAE 55 Outlines Six Environmental and Personal Factors
    - Temperature
    - Thermal Radiation
    - Relative Humidity
    - Air-Speed
    - Clothing Insulation
    - Activity Level (Metabolic Rate)



Thermal Comfort

Metabolic Rates

- 1.0 MET is assumed Sitting
- Heat Loss to a space from a person
- Fluctuates based on Activity Level and Environmental Factors

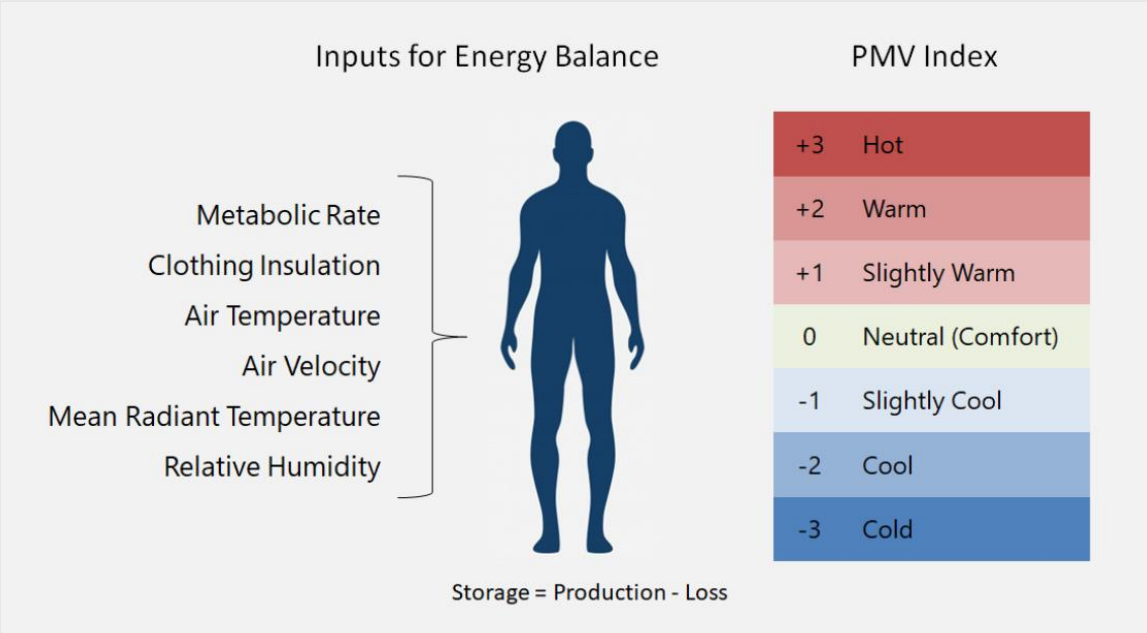
Thermal Comfort

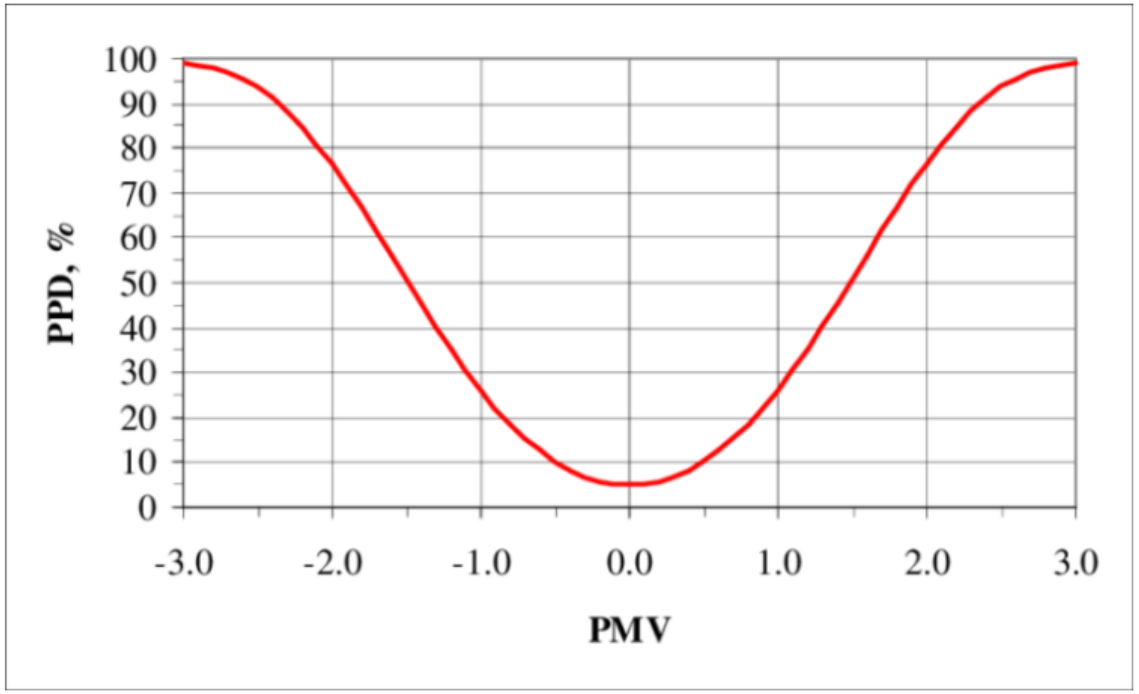
Predicted Mean Vote (PMV)

- 7 Step Scale of Thermal Sensation
- Balance of Internal Heat production with Heat Loss

Predicted Percentage of Dissatisfied (PPD)

- Quantitative prediction of occupants too warm or too cold





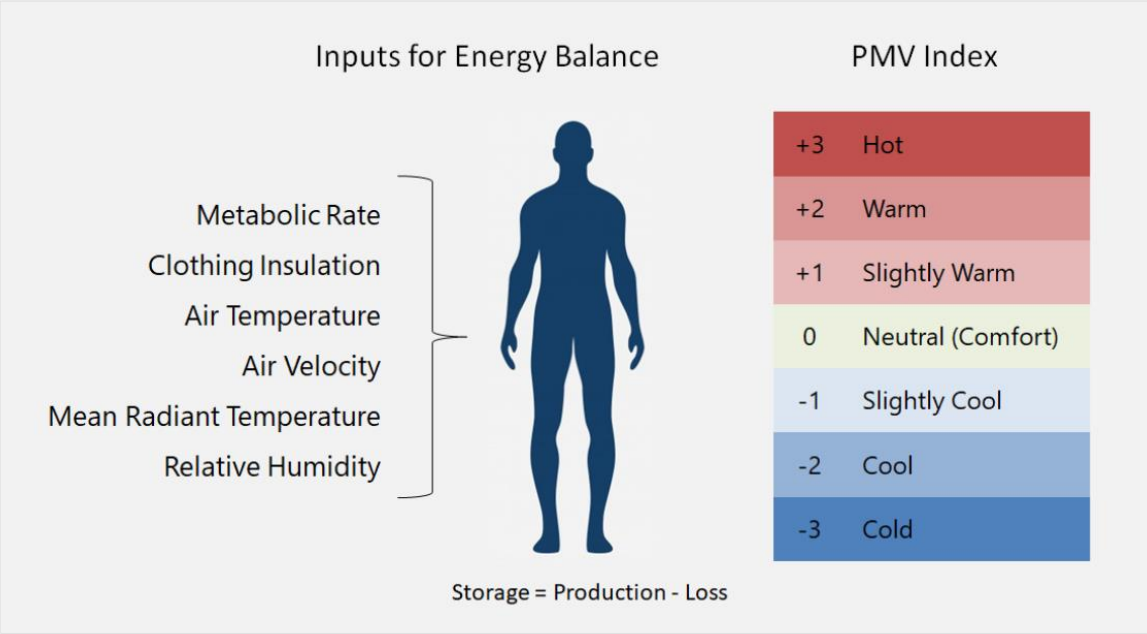
Thermal Comfort

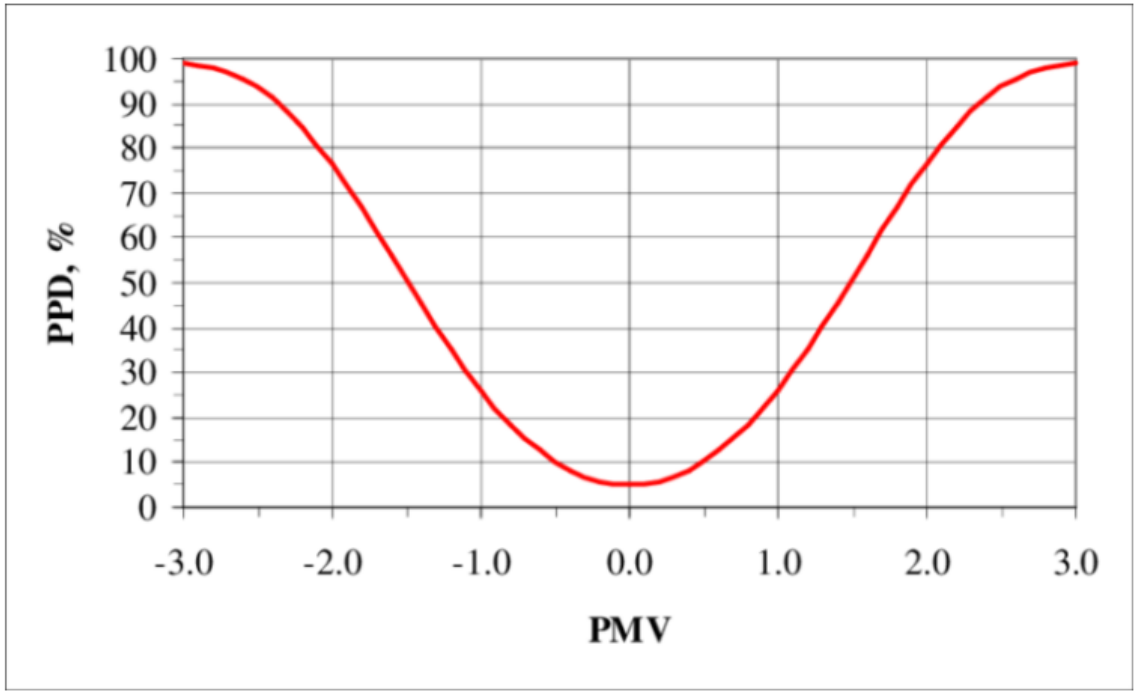
Compliance with ASHRAE 55

- 80% of occupants are satisfied
- PMV between 0.5 and -0.5

Other Factors to Address

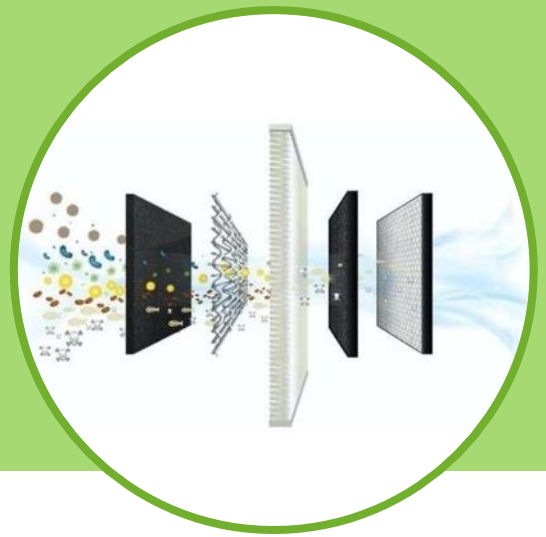
- Comfort parameters
  - Clothing Insulation
  - Metabolic Rate
  - Airspeed
  - Seasonal Conditions
- Local Discomfort
  - Location next to radiator
  - Location in room based on vents
  - Solar radiation
  - Building Envelope Design





HOW STUDENTS BREATHE

clean indoor air is an important resource



BUILDING SYSTEMS

*Building systems control **filtration** of particulates, air flow, and moisture content*

MATERIALS AND FINISHES

*Materials and finishes selected should be **low in toxins and particulates***

CLEANING PRACTICES

*Limit the VOC content of **cleaning solutions***

Study results confirm that with IAQ management, including source control and adequate ventilation, student performance improves. (Myhrvold, A.N., E. Olsen, and O. Lauridsen, 1996)

Indoor Air Quality

Why is IAQ Important?

- Nearly 1 in 13 children of school-age has asthma

- Failure to respond promptly to IAQ has short and long-term impacts on staff and students
    - Coughing
    - Eye Irritation
    - Headaches
    - Allergic Reaction
    - Fatigue
    - Aggravating Asthma or other respiratory issues
    - Rare cases contribute to life-threatening events

- Some more susceptible to effects of IAQ
    - Asthma, allergies, or chemical sensitivities
    - Respiratory diseases
    - Suppressed immune systems
    - Those with contact lenses

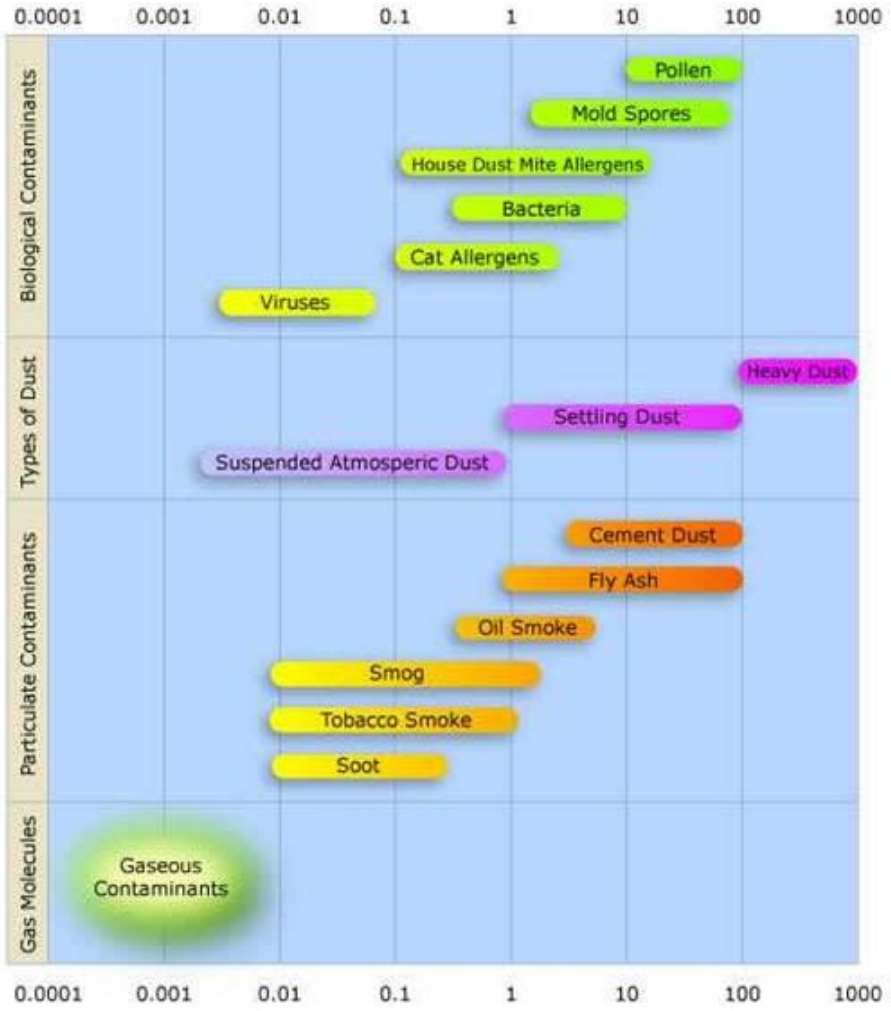
Indoor Air Quality

Possible Impacts associated with Indoor Air Quality

- Impact Student attendance, comfort and performance
- Reduce teacher and staff performance
- Reduce efficiency of HVAC equipment
- Increase potential for School Closings
- Strain relationships between school administration, parents and staff
- Create negative publicity and impact community trust.

Indoor Air Quality

Target Filtration Levels for Spaces



Std. 52.2 Minimum Efficiency Reporting Value (MERV)	Application Guidelines: Typical Controlled Contaminant	Typical Applications and Limitations	Typical Air Filter/Cleaner Type
16	**0.30 to 1.0 µm Particle Size**	Hospital inpatient care	**Bag Filters**
	All bacteria	General surgery	Nonsupported (flexible) microfine fiberglass or synthetic
15	Most tobacco smoke	Smoking lounges	media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
	Droplet nuclei (sneeze)	Superior commercial	**Box Filters**
14	Cooking oil	buildings	Rigid style cartridge filters 150 to 300 mm
	Most smoke		(6 to 12 in.) deep may use lofted (air laid) or paper (wet laid)
13	Insecticide dust		media.
	Copier toner		
	Most face powder		
	Most paint pigments		
12	**1.0 to 3.0 µm Particle Size**	Superior residential	**Bag Filters**
	Legionella	Better commercial	Nonsupported (flexible) microfine fiberglass or synthetic
11	Humidifier dust	buildings	media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
	Lead dust	Hospital laboratories	**Box Filters**
10	Milled flour		Rigid style cartridge filters 150 to 300 mm
	Coal dust		(6 to 12 in.) deep may use lofted (air laid) or paper (wet laid)
9	Auto emissions		media.
	Nebulizer drops		
	Welding fumes		
8	**3.0 to 10.0 µm Particle Size**	Commercial buildings	**Pleated Filters**
	Mold	Better residential	Disposable, extended surface, 25 to 125 mm
7	Spores	Industrial workplaces	(1 to 5 in.) thick with cotton-polyester blend media,
	Hair spray	Paint booth inlet air	cardboard frame.
6	Fabric protector		**Cartridge Filters**
	Dusting aids		Graded density viscous coated cube or pocket filters,
5	Cement dust		synthetic media.
	Pudding mix		**Throwaway**
	Snuff		Disposable synthetic media panel filters.
	Powdered milk		
4	**>10.0 µm Particle Size**	Minimum filtration	**Throwaway**
	Pollen	Residential	Disposable fiberglass or synthetic panel filters
3	Spanish moss	Window air conditioners	**Washable**
	Dust mites		Aluminum mesh, latex coated animal hair, or foam rubber
2	Sanding dust		panel filters
	Spray paint dust		**Electrostatic**
1	Textile fibers		Self charging (passive) woven polycarbonate
	Carpet fibers		panel filter

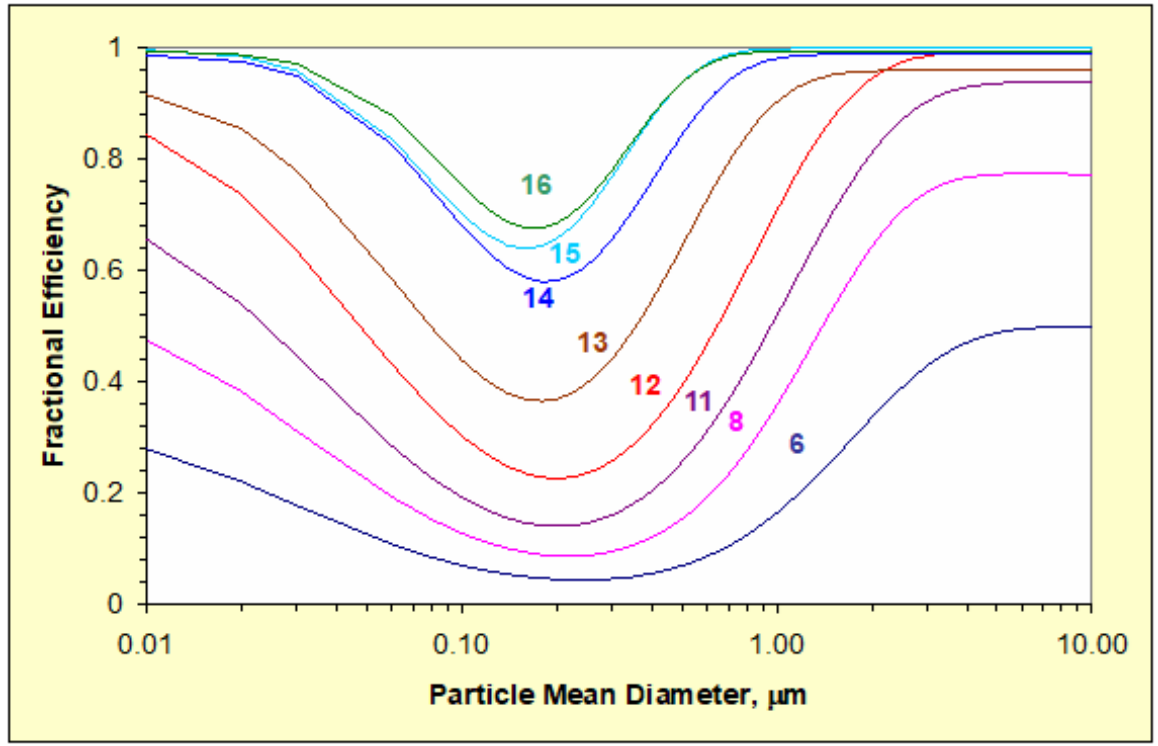
Note: A MERV for other than HEPA/ULPA filters also includes a test airflow rate, but it is not shown here because it has no significance for the purposes of this table.

Indoor Air Quality

Target Filtration Levels for Spaces

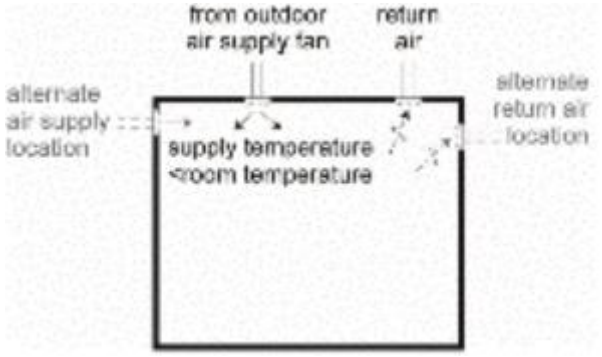
TABLE J-2 KCl Conditioned Per Appendix J Minimum Efficiency Reporting Value (MERV-A) Parameters

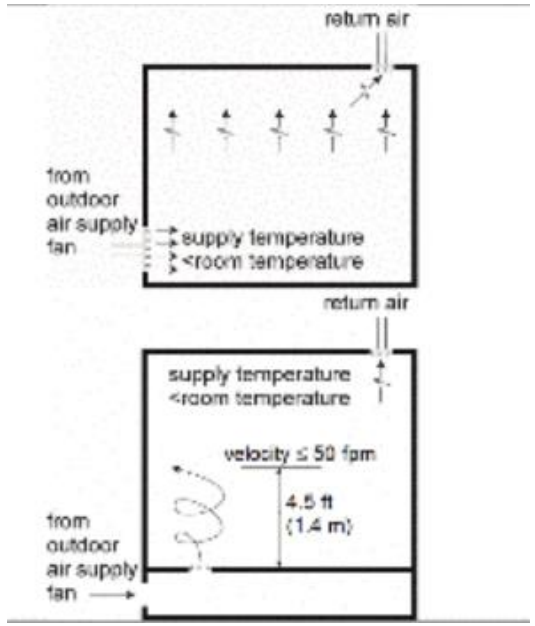
Standard 52.2 Appendix J Minimum Efficiency Reporting Value (MERV-A)	Composite Average Particle Size Efficiency in Size Range, %			Average Arrestance, %
	Range 1 (0.3–1.0µm)	Range 2 (1.0–3.0µm)	Range 3 (3.0–10.0µm)	
1–A	n/a	n/a	E_3–A < 20	A_{avg} < 65
2–A	n/a	n/a	E_3–A < 20	65 ≤ A_{avg} < 70
3–A	n/a	n/a	E_3–A < 20	70 ≤ A_{avg} < 75
4–A	n/a	n/a	E_3–A < 20	75 ≤ A_{avg}
5–A	n/a	n/a	20 ≤ E_3–A < 35	n/a
6–A	n/a	n/a	35 ≤ E_3–A < 50	n/a
7–A	n/a	n/a	50 ≤ E_3–A < 70	n/a
8–A	n/a	n/a	70 ≤ E_3–A	n/a
9–A	n/a	E_2–A < 50	85 ≤ E_3–A	n/a
10–A	n/a	50 ≤ E_2–A < 65	85 ≤ E_3–A	n/a
11–A	n/a	65 ≤ E_2–A < 80	85 ≤ E_3–A	n/a
12–A	n/a	80 ≤ E_2–A	90 ≤ E_3–A	n/a
13–A	E_1–A < 75	90 ≤ E_2–A	90 ≤ E_3–A	n/a
14–A	75 ≤ E_1–A < 85	90 ≤ E_2–A	90 ≤ E_3–A	n/a
15–A	85 ≤ E_1–A < 95	90 ≤ E_2–A	90 ≤ E_3–A	n/a
16–A	95 ≤ E_1–A	95 ≤ E_2–A	95 ≤ E_3–A	n/a



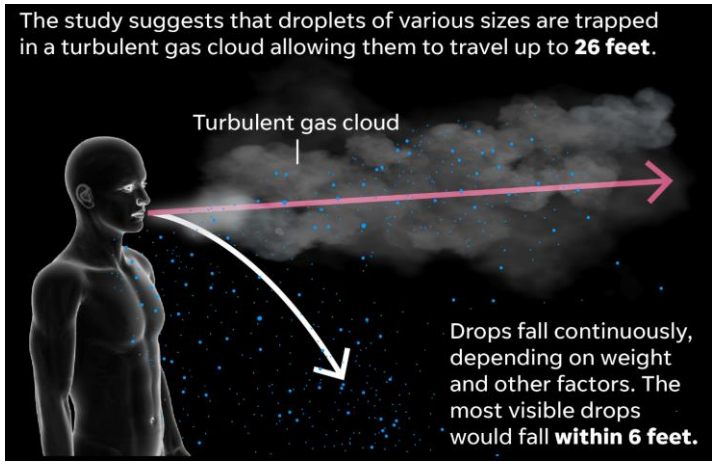
Indoor Air Quality

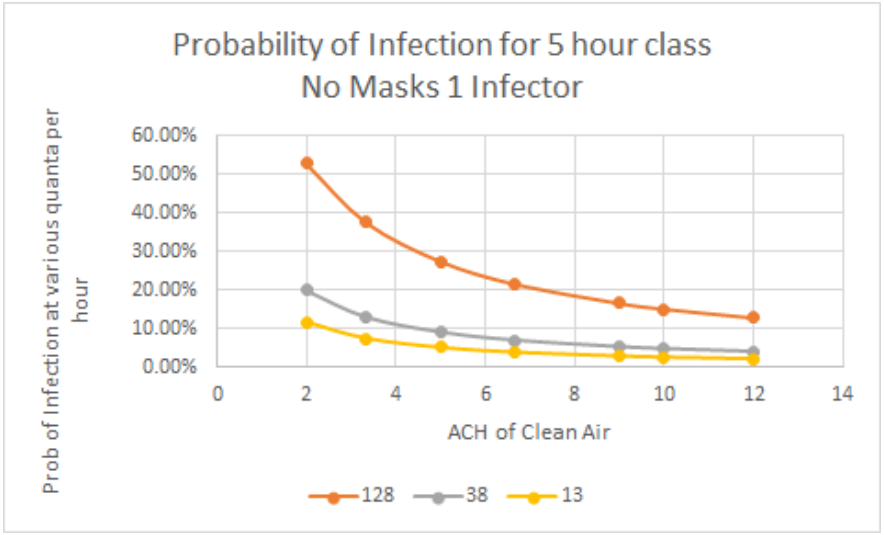
- Outdoor air intakes – Location away from exhaust
- System cleanliness – Clean system during installation and on-going maintenance.
- Outdoor Air Location – Evaluate proximity to local contaminate sources
- Effective Room Air distribution – Ensure effectiveness for airflow in room
- Exhaust systems
- Quantity of outdoor air
  - Review against code requirements
  - ASHRAE 62.1 requirements





Indoor Air Quality





Air Change of Clean Air

Increasing air change rate can decrease in-room concentration of Infectious Particles or Quanta

There is a point of diminishing return in the reduction of Quanta within a room:

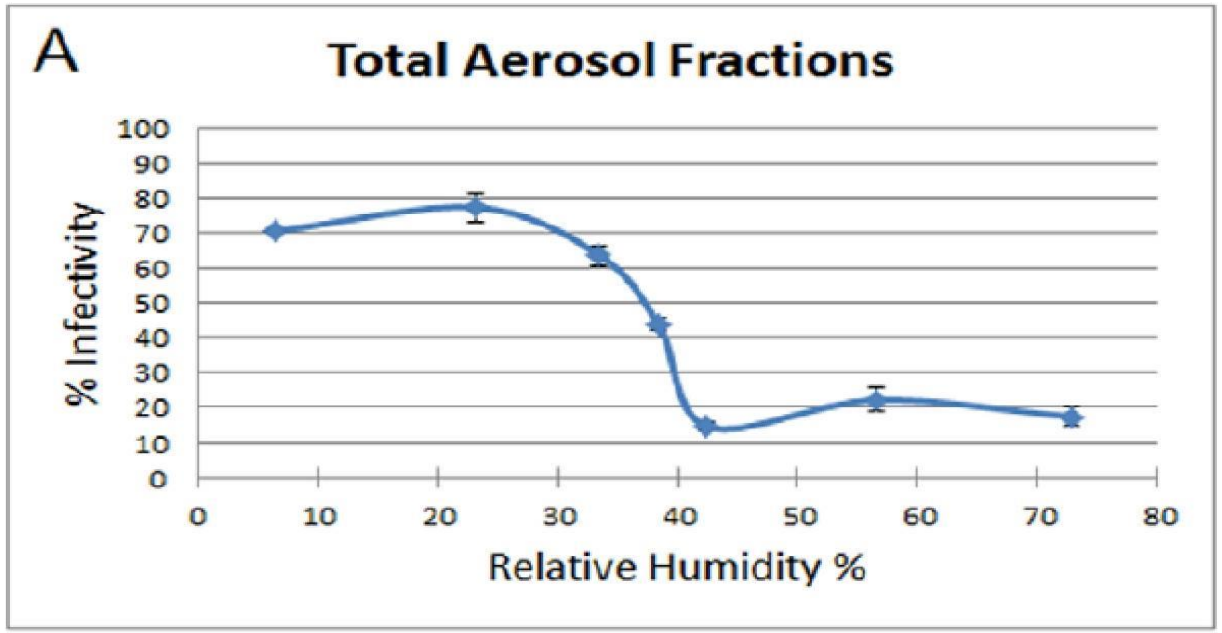
6 Air Changes per Hour

An Air Change per Hour is defined as how many times the air in the room is turned over and passed through a filtered device or Outside Air and complies with ASHRAE Std. 62.1 and ASHRAE position document on filtration and cleaning

Humidity Impact

What do we know* about Airborne Transmission?

Relative Humidity between (40%-60%) slows the Transmission of Viruses



Influenza A is the subject of the study

*High RH results in droplet stability

** Noti, John D., et al. "High humidity leads to loss of infectious influenza virus from simulated coughs." PloS one 8.2 (2013).*

** Wan Yang and Lindsey Mars, "Mechanisms by Which Ambient Humidity May Affect Viruses in Aerosols", 2012 Oct.*

Indoor Air Quality

Watch out for Ozone

UV-C and UV Tech to Consider

- Electronic air filters/air cleaners
- **UV-C in ductwork and UV-C in upper-air units**
- UVGI – ultraviolet germicidal irriation
- UV-A (400-315 nm)
- UV-V (under 200 nm) can generate ozone
- Photocatalytic Oxidation (PCO)
- Bipolar Ionization/Corona Discharge
- Vaporized Hydrogen Peroxide (VHP)
- Pulsed Xenon (Pulsed UV)
- 405 nm visible light (“Near UV”)
  - Virus Kill Effectiveness NOT well documented, see study “the environmental control of epidemic contagion, wells”
- Far UV (205 to 230 nm)
  - Can be harmful to people; limited effect on viruses

HOW STUDENTS SEE

classroom lighting and the visual experience

DAYLIGHTING

Natural light improves student performance

GLARE CONTROL / SHADING

When utilizing natural light, glare control, shading, and heat gain control are all factors to be considered

LIGHTING CONTROLS

Lighting controls can create different zones within a single space

Lighting & Learning

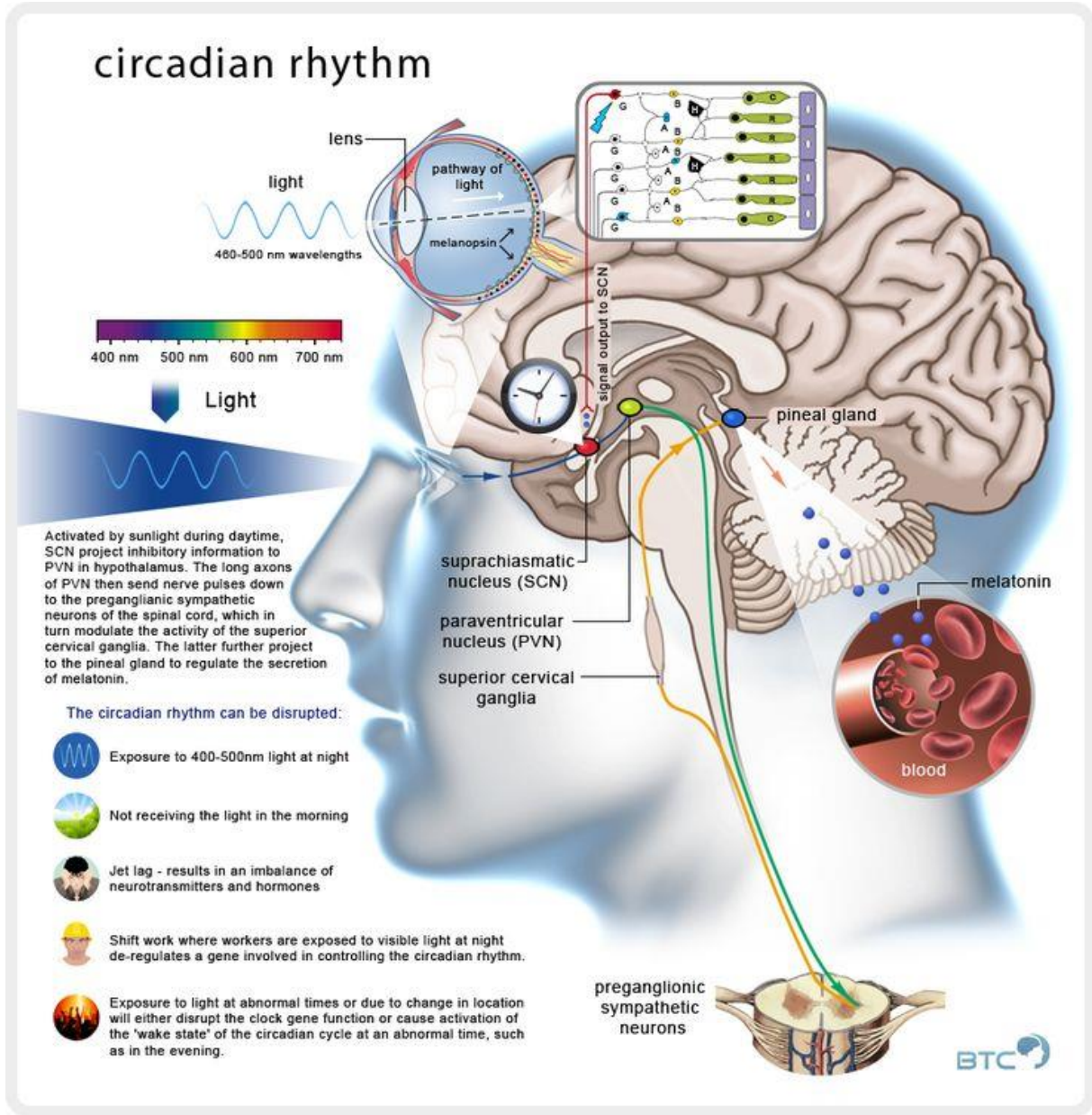
Students in daylit classrooms had greater improvement over the course of one school year in math and reading standardized tests than students in windowless classrooms.

Source: Heschong Mahone Group, 1999

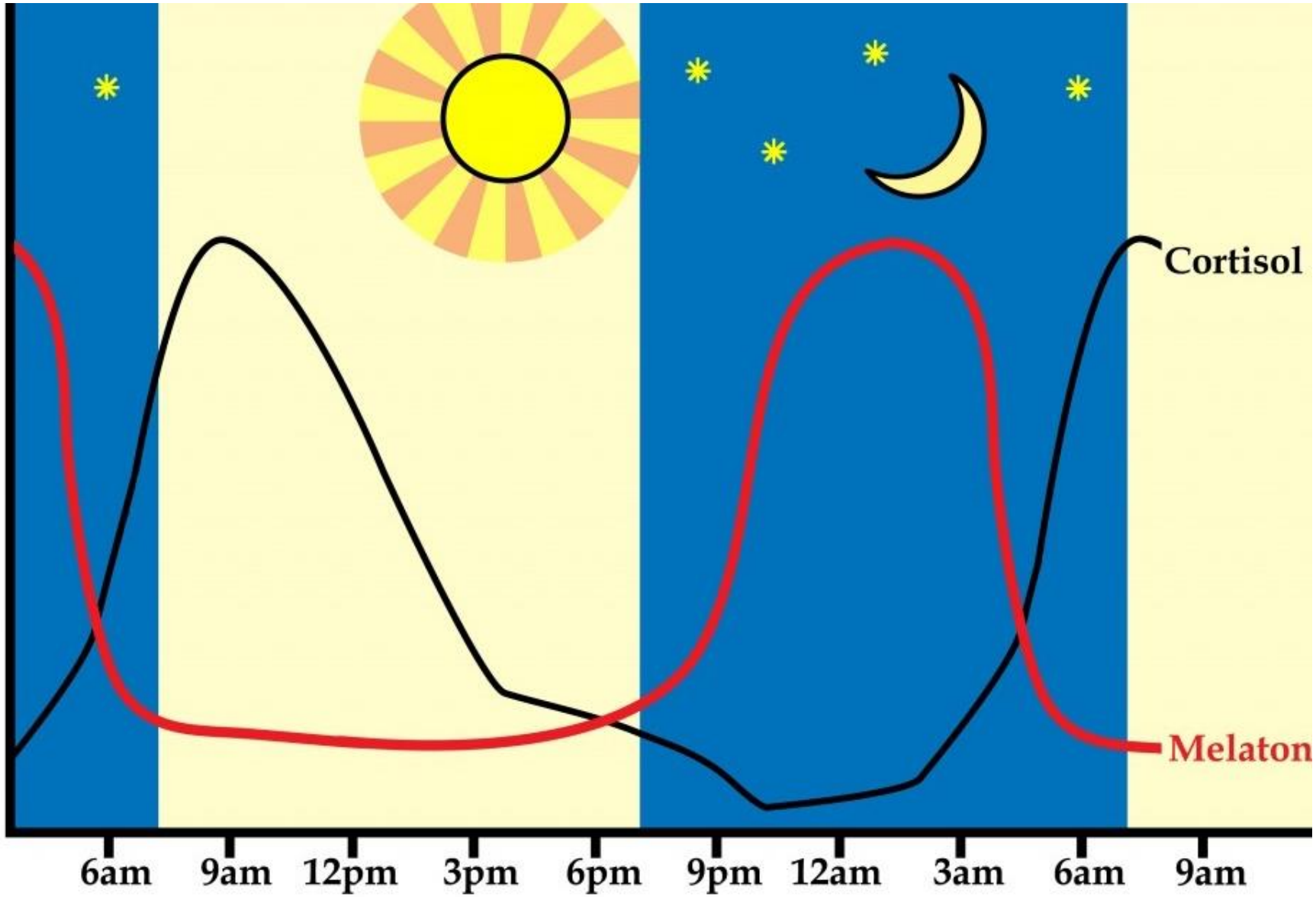
Elementary school students in classrooms with the most daylight showed a 21% improvement in learning rates compared to students in classrooms with the least daylight. (Heschong Mahone Group, 2001)

In another study by the Heschong Mahone Group, Windows and Classrooms, researchers found an association between academic achievement and classroom views to the outdoors (Heschong, 2003)

Source: https://dropality.com/



Source: http://www.sleepdisordersresource.com/circadian-rhythm-sleep



Source:
https://www.thepaleomom.com/regulating-circadian-rhythm/

Biological Focus

Fixed Color Temperature and
Single Wavelength (the “good blue”)

- Support robust daytime cycle
- Cool light to align with sustained daytime circadian rhythm (suppressed melatonin response)

Behavioral Focus

“Tunable” Variable Color Temperature
and Wavelength

- Immediate and/or scheduled adjustability
- Dual Biological (increased or decreased melatonin response)
- Selective daytime adjustment to illicit short-term behavioral responses
  - Cool light to achieve alertness
  - Warm light to achieve calmness

LUTHER BURBANK
ELEMENTARY SCHOOL

“The natural lighting throughout the building has made staff and students feel happier. Teachers have commented on how happy they feel when they are in the building.”

HOW STUDENTS THINK & LEARN

cognitive functioning and the environment

PERSONALIZED LEARNING

Encourage a pedagogy that allows each student to achieve their full potential, through movement, visual stimulus, and even food

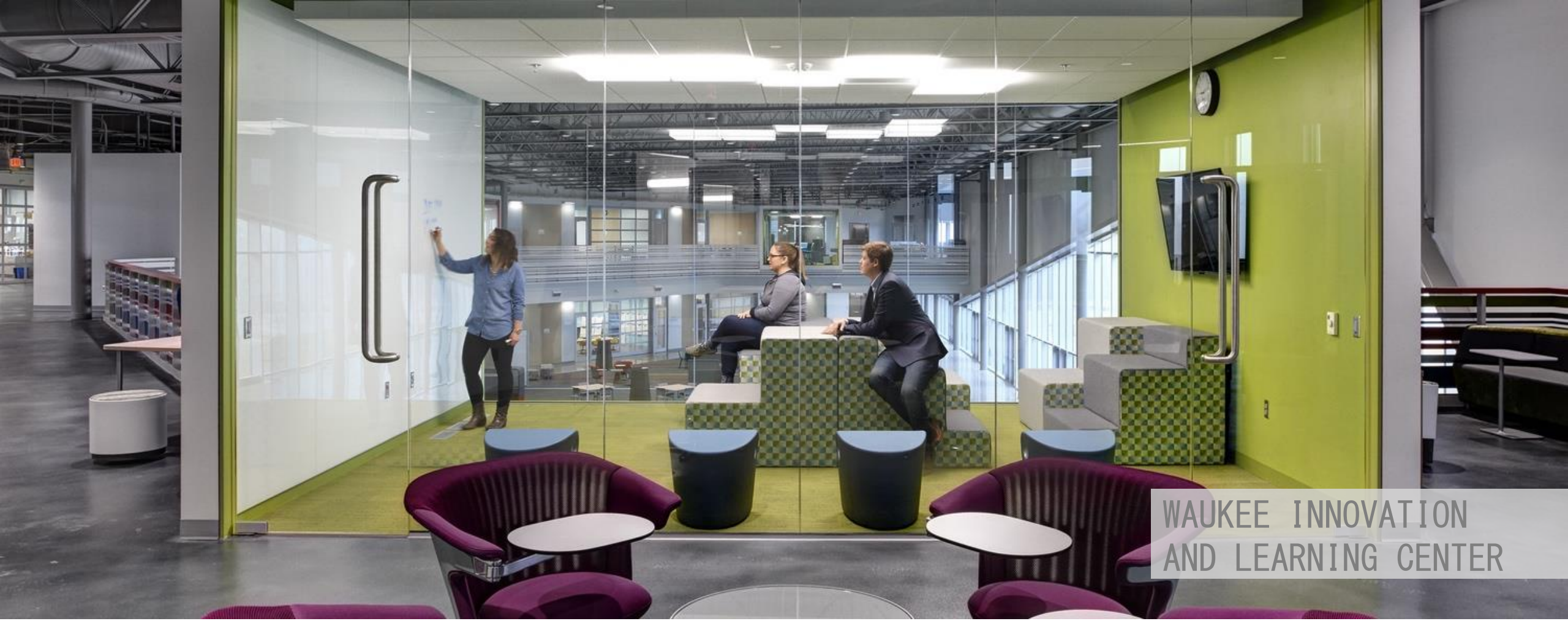
FLEXIBLE AND AGILE SPACES

Design and furnishings create multi-use spaces for different learning environments

COMMUNITY AND SOCIAL SPACES

Break out of the traditional classroom and promote a natural flow and mingling of people and ideas

There is a 25% contribution to better learning due to classroom design that integrates design features within a neuroscience framework. (Barrett, 2013)



A study looked at one school district in Connecticut and found that when school space improvement projects were undertaken by the district, test scores across renovated schools went up noticeably afterward (Neilson and Zimmerman, 2011)

HOW STUDENTS MOVE

physical activity affects cognitive function

PHYSICAL HEALTH

Preventing and combating childhood obesity helps students live longer, healthier lives

REGULAR PARTICIPATION

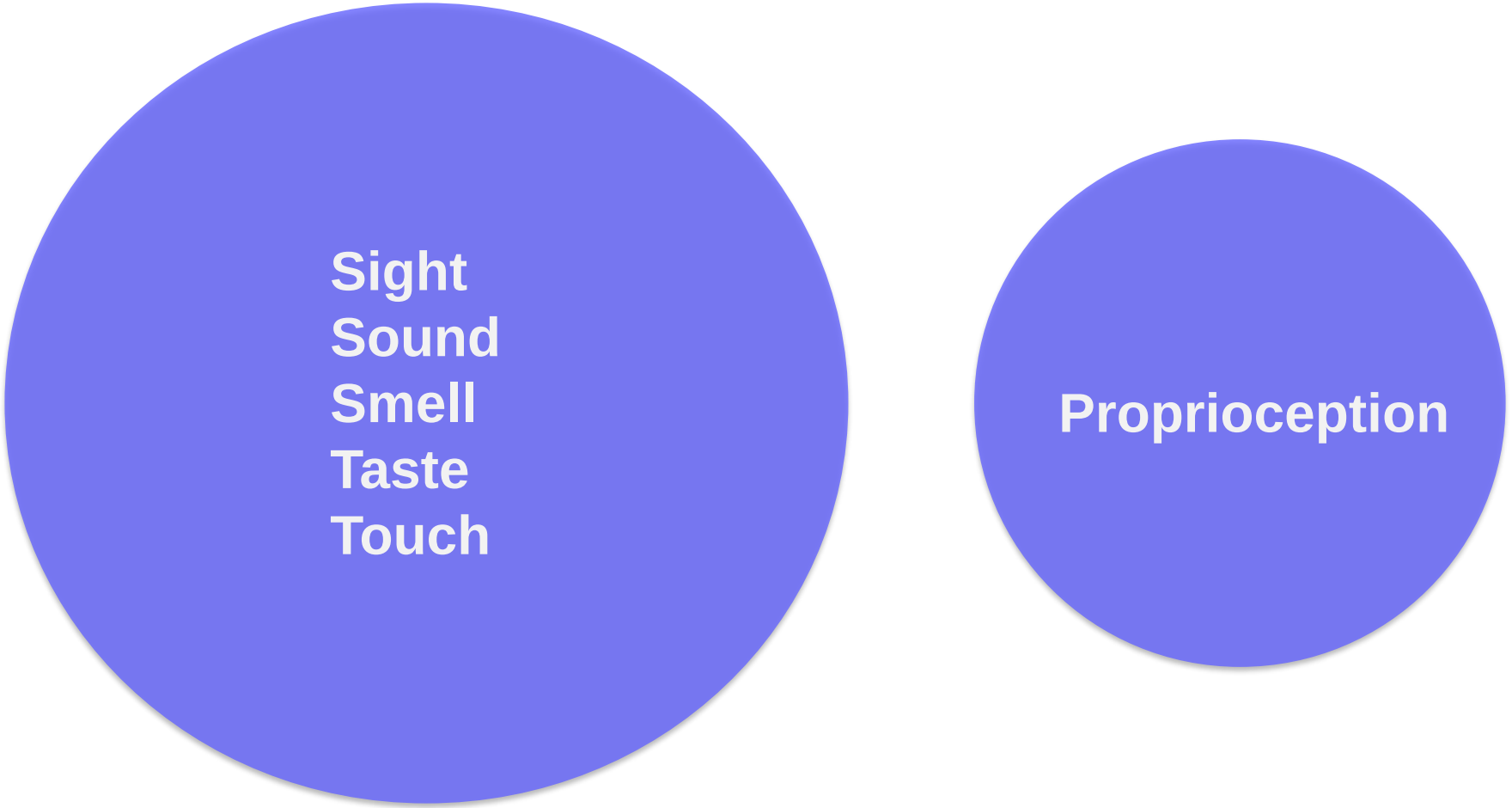
Schools play a big role in ensuring that students participate in physical activity every day

ACADEMIC PERFORMANCE

Health benefits of physical activity extend past the body to the brain itself

Children respond faster and with greater accuracy to a variety of cognitive tasks after participating in a session of physical activity. A single bout of moderate-intensity physical activity can increase neural and behavioral concomitants associated with the allocation of attention to a specific cognitive task. (Hillman et al., 2009)


Sight
Sound
Smell
Taste
Touch


Sight
Sound
Smell
Taste
Touch
Proprioception

(Image: www.childrensfactory.com)

MUSCLE ACTIVITY = **NOURISHMENT FOR THE BRAIN**

(Breithecker, 2017)

(Image: www.lemonlimeadventures.com)

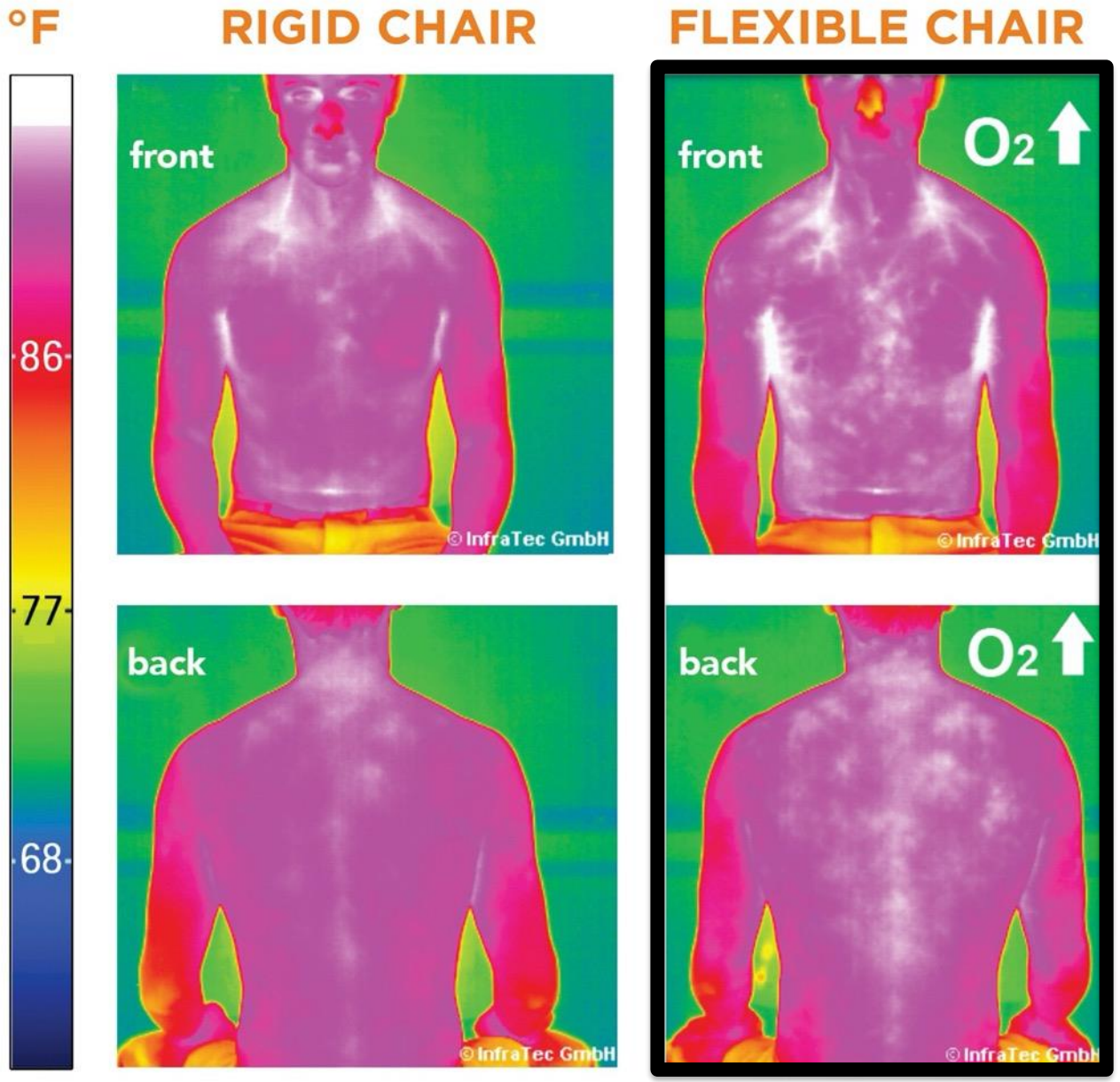
RECOMMENDATIONS FOR STUDENTS

(Image: VS America)

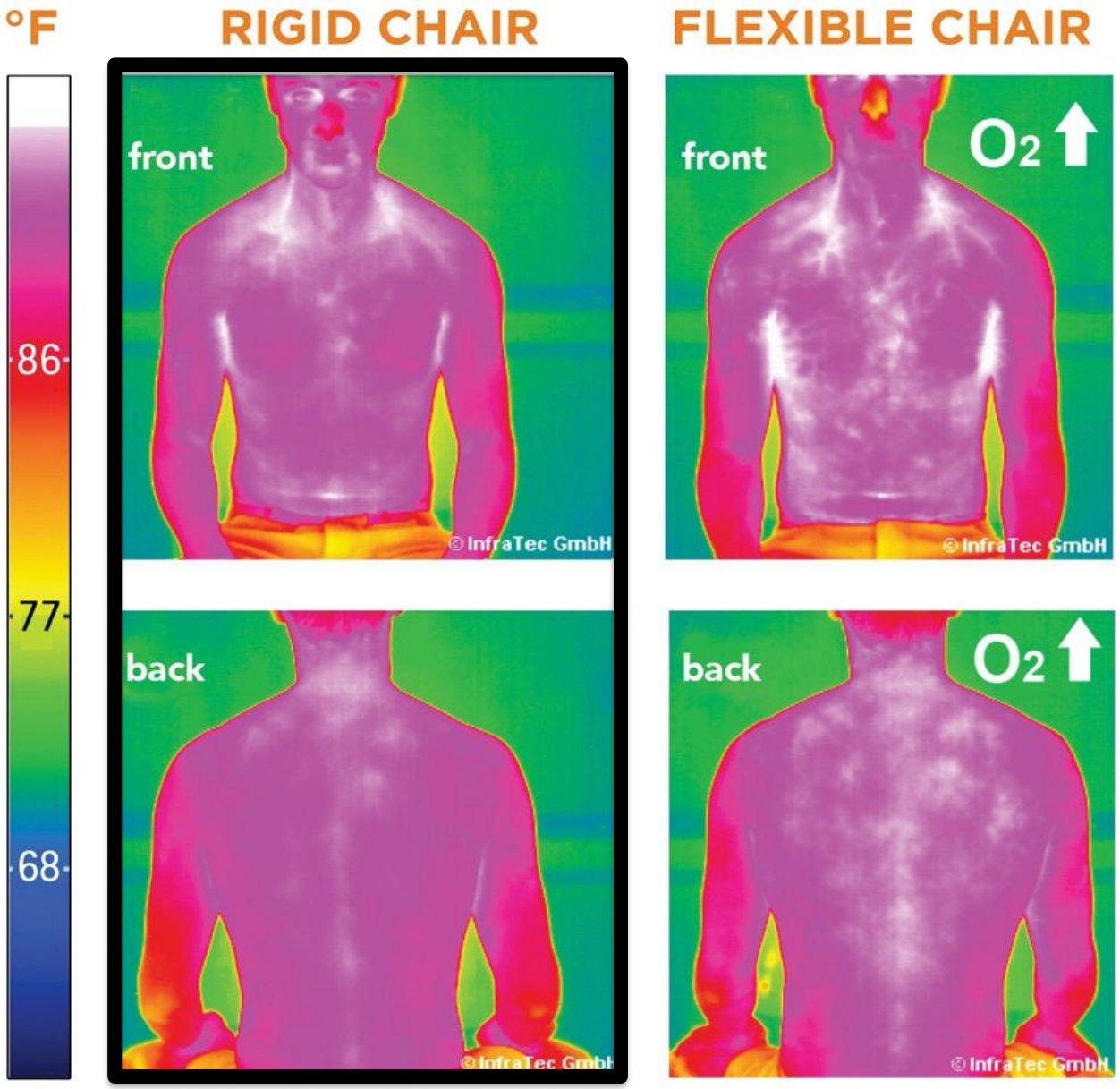
SEATING OPTIONS

Choosing a Chair

(Image: VS America)



(Ludwig, Breithecker., 2008)



, Breithecker., 2008)

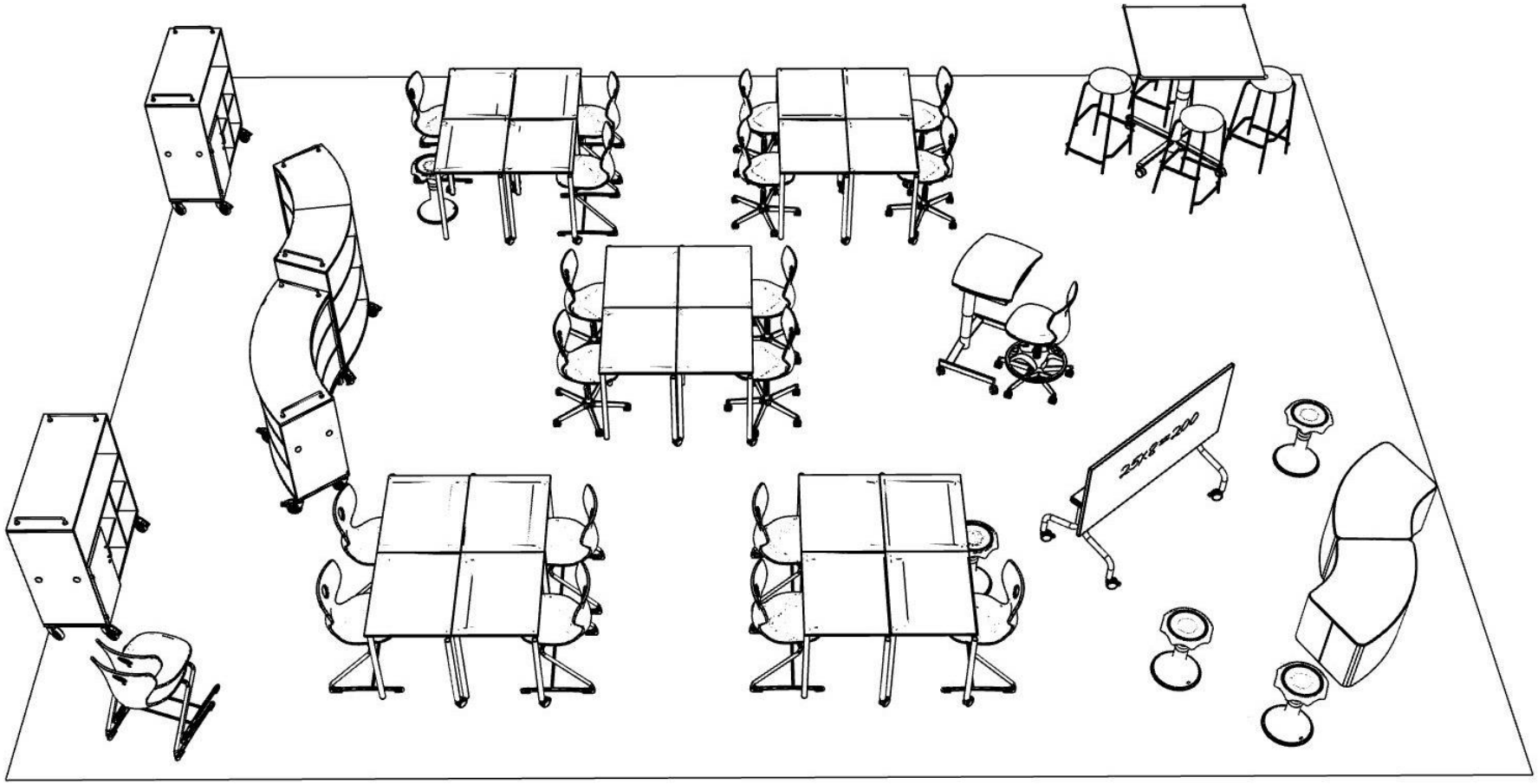
SEATING OPTIONS

Stools + Lounge

(Image: VS America)

TABLE OPTIONS

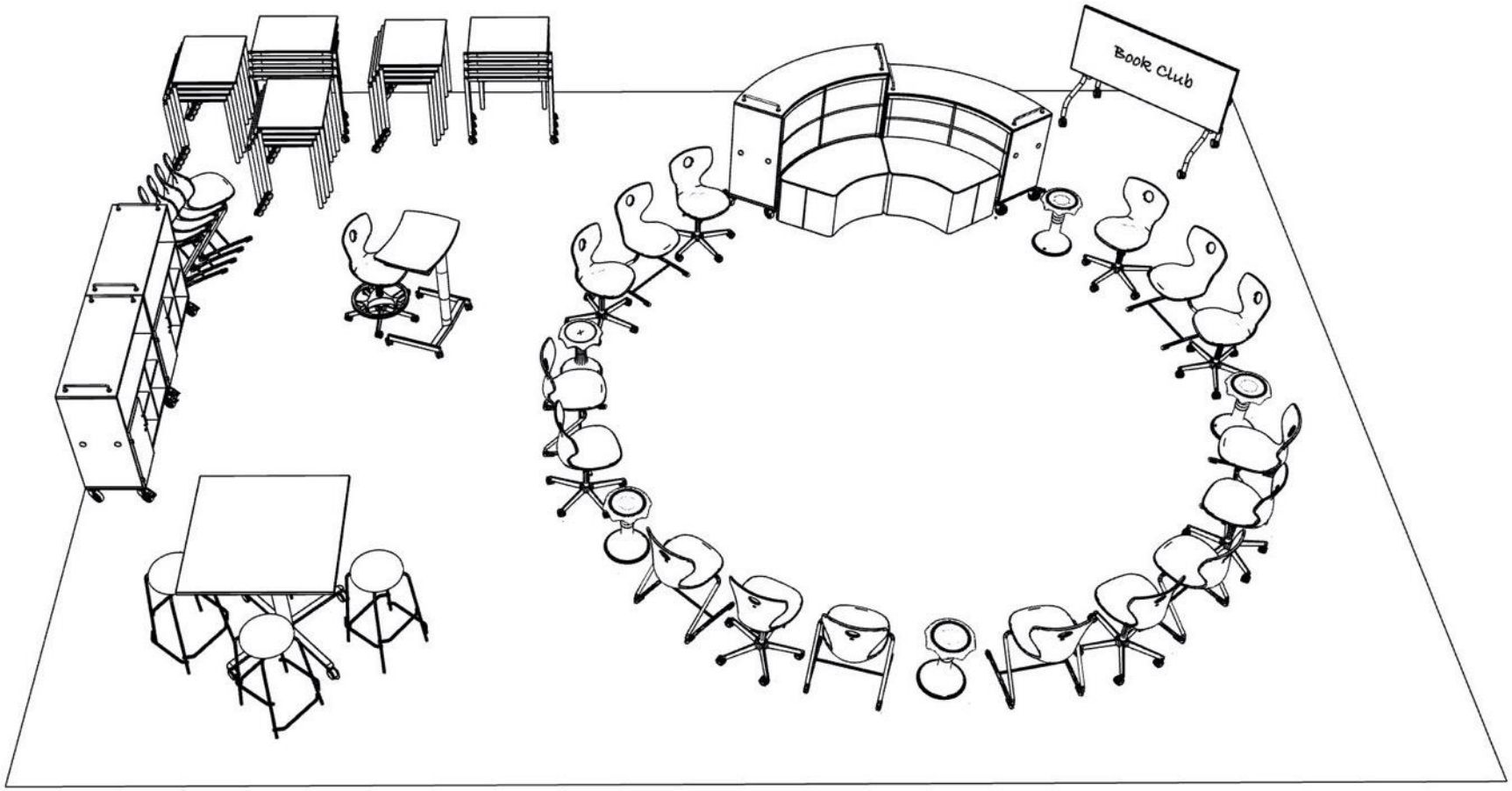
(Image: VS America)



CLASSROOM LAYOUT

Cluster – Group Work

(Image: VS America)



CLASSROOM LAYOUT

Circle - Discussion

(Image: VS America)

Incorporate Movement Into Curriculum

Create Spaces for Flexible Configurations

Implement Student – Centered Learning


THE
WELL
BUILDING STANDARD®
v1 with January 2017 addenda
INTERNATIONAL
WELL
BUILDING
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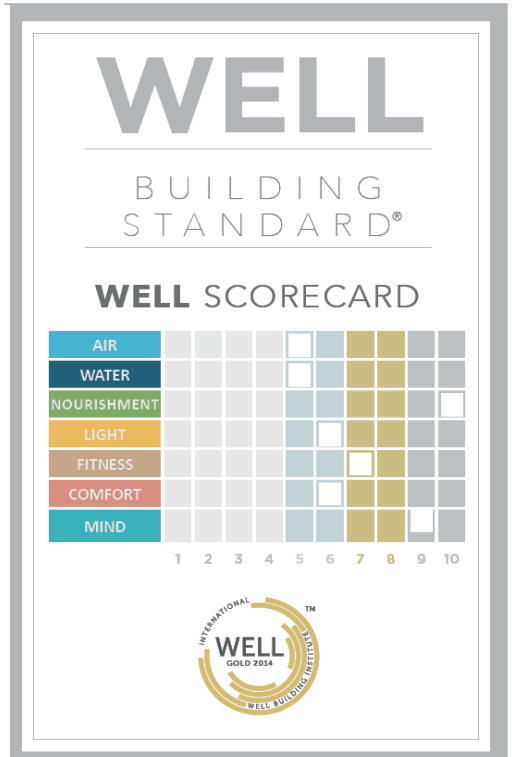
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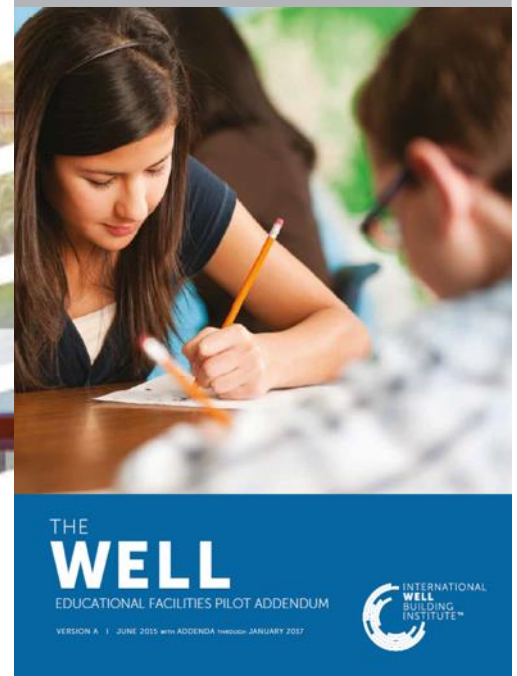
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- Indoor Air Quality
- Energy Efficiency
- Visual Quality
- Acoustics
- Thermal Comfort
- Water
- Conservation
- Waste Reduction

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Questions and Answers

We thank you for your time!

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