Table 1. Thermal comfort indicators, measurement methods, and reference standards.

Indicator	Type	Unit	Measurement Method	Reference Standard
Dry-bulb temperature (Air temperature)	Objective	°C	Measured at occupant level using calibrated digital thermometer or temperature sensor	ASHRAE 55-2020; ISO 7726
Wet-bulb temperature	Objective	°C	Measured using psychrometer or hygrometer with wet-bulb probe	ISO 7726
Mean radiant temperature	Objective	°C	Measured using globe thermometer or calculated from surrounding surface temperatures	ISO 7726; ASHRAE 55-2020
Relative humidity	Objective	%	Measured using calibrated thermo-hygrometer	ASHRAE 55-2020; ISO 7726
Air velocity	Objective	m/s	Measured at occupant breathing zone using hot-wire or vane anemometer	ASHRAE 55-2020; ISO 7726
Operative temperature	Objective	°C	Calculated from air temperature, mean radiant temperature, and air velocity	ASHRAE 55-2020
Metabolic rate	Subjective / Estimated	met	Estimated based on occupant activity using standard metabolic rate tables	ISO 8996; ASHRAE 55-2020
Clothing insulation	Subjective / Estimated	clo	Determined from clothing ensemble tables or occupant self-report	ISO 9920; ASHRAE 55-2020
Thermal sensation	Subjective	7-point scale (−3 to +3)	Occupant survey using ASHRAE Thermal Sensation Scale questionnaire	ASHRAE 55-2020
Mechanical cooling/heating system	Objective (Building system variable)	N/A	Presence and operational condition assessed through observation checklist	ASHRAE 55-2020; ISO 7730
Predicted Mean Vote (PMV)	Objective (Model output)	Index (−3 to +3)	Computed from environmental and personal parameters using PMV model	ISO 7730; ASHRAE 55-2020
Predicted Percentage of Dissatisfied (PPD)	Objective (Model output)	%	Derived mathematically from PMV values	ISO 7730; ASHRAE 55-2020
Note: Objective indicators are directly measured using field instruments, while subjective indicators are obtained through occupant surveys or estimations based on standardized tables. PMV and PPD indices are calculated variables derived from air temperature, mean radiant temperature, air velocity, relative humidity, metabolic rate, and clothing insulation, in accordance with ISO 7730 and ASHRAE Standard 55.				

Table 2. Indoor air quality indicators, measurement methods, and reference

Indicator	Type	Unit	Measurement Method	Reference Standard
HVAC system	Objective (Building system variable)	N/A	Assessment of system type, operation, and maintenance through inspection checklist	ASHRAE 62.1-2019
Amount of fresh air	Objective	L/s per person	Determined from HVAC specifications or airflow measurements	ASHRAE 62.1-2019
Air velocity / Air flow	Objective	m/s	Measured using hot-wire or vane anemometer at supply diffusers and occupant level	ISO 7726; ASHRAE 55-2020
Ventilation rate	Objective	Air changes per hour (ACH)	Calculated from airflow measurements and room volume	ASHRAE 62.1-2019
Core pollutant categories	Objective	N/A	Classification of contaminants measured in indoor environment	WHO IAQ Guidelines
Carbon dioxide (CO_2) concentration	Objective	ppm	Measured using non-dispersive infrared (NDIR) CO_2 sensor	ASHRAE 62.1-2019; WHO IAQ Guidelines
Particulate matter ($PM_{2.5}$ / PM_{10})	Objective	$\mu g/m^3$	Measured using optical particle counter or aerosol monitor	WHO Air Quality Guidelines
Total volatile organic compounds (TVOC)	Objective	mg/m^3 or ppm	Measured using photoionization detector (PID) or VOC monitor	ISO 16000; WHO IAQ Guidelines
Ozone (O_3)	Objective	ppm or $\mu g/m^3$	Measured using electrochemical or UV absorption ozone sensor	WHO Air Quality Guidelines
Radon	Objective	Bq/m^3	Measured using radon detector or passive radon dosimeter	WHO Handbook on Indoor Radon
Carbon monoxide (CO)	Objective	ppm	Measured using electrochemical CO sensor or gas analyzer	WHO IAQ Guidelines; ASHRAE 62.1
Note: All IAQ indicators listed are objective parameters measured using calibrated environmental monitoring instruments or obtained through building system inspection. Ventilation-related indicators are assessed in accordance with ASHRAE Standard 62.1 requirements for acceptable indoor air quality. Pollutant concentration limits are benchmarked against WHO indoor air quality guidelines.				

Table 3. Acoustic quality indicators, measurement methods, and reference standards.

Indicator	Type	Unit	Measurement Method	Reference Standard
Background noise level	Objective	dB(A)	Measured using calibrated sound level meter under unoccupied or typical classroom conditions	ISO 1996; ANSI S12.60
Equivalent continuous sound level (LAeq)	Objective	dB(A)	Time-averaged measurement using sound level meter over representative period	ISO 1996; IEC 61672
Reverberation time (T30)	Objective	seconds (s)	Measured using impulse response or interrupted noise method with sound analyzer	ISO 3382-2
Speech Transmission Index (STI)	Objective	Index (0–1)	Determined using STI analyzer or software-based acoustic measurement system	IEC 60268-16
Sound insulation property	Objective	dB	Evaluated through field measurement of airborne sound insulation between rooms	ISO 16283; ISO 717-1
Note: Acoustic quality indicators are objective parameters measured using standardized electroacoustic instruments. Background noise and LAeq quantify ambient sound pressure levels, while reverberation time (T30) and Speech Transmission Index (STI) evaluate classroom acoustic performance and speech intelligibility. Sound insulation property reflects the effectiveness of building elements in reducing sound transmission between spaces.				

Table 4. Visual comfort indicators, measurement methods, and reference standards.

Indicator	Type	Unit	Measurement Method	Reference Standard
Illuminance levels	Objective	lux	Measured at workplane height using calibrated lux meter	EN 12464-1; ISO 8995
Illuminance uniformity	Objective	Ratio (U_0)	Calculated as minimum to average illuminance across measurement grid	EN 12464-1
Daylight factor / Daylight availability	Objective	%	Determined through on-site measurement or simulation of indoor to outdoor illuminance ratio	CIE 108; EN 17037
Glare	Objective / Subjective	DGP or UGR	Evaluated using luminance measurements or occupant glare perception survey	CIE 117; ISO 8995
Color temperature	Objective	Kelvin (K)	Measured using colorimeter or lighting meter	CIE 15; ISO 3664
Artificial lighting	Objective (System variable)	N/A	Assessment of lighting type, layout, and lamp characteristics through inspection checklist	EN 12464-1
Access to natural light	Objective / Subjective	N/A	Evaluated through window-to-floor ratio, daylight access assessment, and occupant perception	EN 17037; WELL v2
Note: Visual comfort indicators comprise both objective photometric measurements and occupant-based assessments. Illuminance and uniformity are evaluated using lux meters, while daylight availability and glare are assessed using standardized daylight metrics and glare indices. Access to natural light reflects both quantitative building characteristics and user perception of daylight adequacy.				

Table 5. Environmental quality indicators, measurement methods, and reference standards.

Indicator	Type	Unit	Measurement Method	Reference Standard
Cleanliness	Subjective / Objective	Rating scale (1–5)	Visual inspection checklist and occupant perception survey	ISO 14644 (general cleanliness principles); WELL v2
Moisture and mold	Objective / Subjective	N/A	Visual inspection for dampness, staining, or microbial growth; occupant reports	WHO Guidelines on Dampness and Mould
View conditions	Subjective / Objective	Rating scale or %	Assessment of window view quality and occupant satisfaction survey	EN 17037; WELL v2
Landscaping	Subjective / Objective	N/A	Observation of outdoor green space quality and accessibility	LEED v4; WELL v2
Energy consumption	Objective	kWh	Derived from utility meters or building energy records	ISO 50001; ASHRAE 90.1
Energy efficiency	Objective	kWh/m²-year	Calculated from energy use intensity (EUI) of the building	ASHRAE 90.1; ISO 52000
Access to electric outlets	Subjective / Objective	N/A	Observation checklist and user satisfaction survey	WELL v2; Post-Occupancy Evaluation (POE) guidelines
Note: Environmental quality indicators integrate physical building characteristics with occupant-based assessments. Parameters such as cleanliness, moisture and mold, and access to amenities are primarily evaluated through structured observation checklists and occupant surveys, while energy-related indicators are quantified using building energy records and performance metrics.				

Table 6. Spatial quality indicators, measurement methods, and reference standards.

Indicator	**Type**	**Unit**	**Measurement Method**	**Reference Standard**
Building condition	Objective / Subjective	Rating scale (1–5)	Visual inspection checklist and occupant perception survey	ISO 15686 (Building performance); POE guidelines
Furniture and furnishings	Objective / Subjective	N/A	Assessment of adequacy, layout, and quality through checklist and user feedback	WELL v2; ISO 9241
Technology	Objective	N/A	Evaluation of availability and functionality of instructional technology	ISO 21001; POE guidelines
Building characteristics	Objective	N/A	Observation of room dimensions, layout, and spatial configuration	ISO 16817; EN 15251
Building system	Objective	N/A	Assessment of operational status of HVAC, lighting, and electrical systems	ASHRAE 55; ASHRAE 62.1
Distance to window	Objective	meters (m)	Measured from occupant workstations to nearest window opening	EN 17037
Controlling windows, lighting, and shading	Objective / Subjective	N/A	Observation of user control availability and occupant satisfaction survey	ASHRAE 55; WELL v2
Ergonomics	Subjective / Objective	Rating scale	Evaluation of furniture suitability and user comfort using ergonomic checklist	ISO 9241; EN 1335
Note: Spatial quality indicators evaluate the adequacy and functionality of classroom physical environments. Assessments combine objective measurements and structured observations with occupant-based evaluations to capture user interaction with space, furniture, technology, and environmental controls.				