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Indoor Air Quality in Schools

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Indoor Air Quality in Schools

KyEHA Annual Education Conference
February 15th, 2018
Clint Pinion, Dr.PH, RS
Eastern Kentucky University



Problem:

- Contacted by a school with teachers complaining about sickness they associated with poor indoor air quality at work.....AGAIN.

What do we do?

About the School

- **GOAL: Net Zero School**
 - Radon Monitors
 - Carbon Dioxide Sensors
 - Temp and Relative Humidity Controls

Introduction

- Required by law in the US
- Huge gap in identifying, tracking, and remediating environmental health threats in school¹



¹Paulson and Barnett (2016)



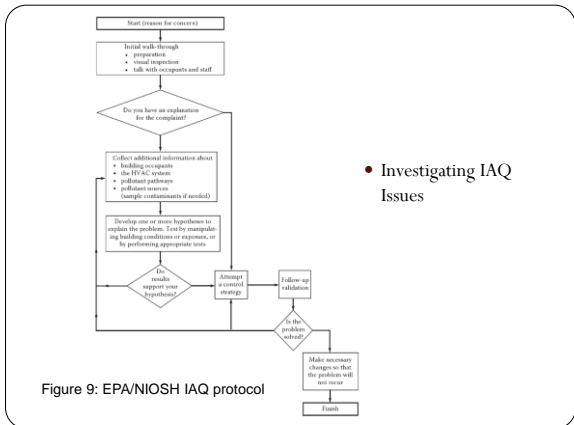
Indoor Air Quality (IAQ) Concerns

- Schools are subject to relatively unique
 - ❖ pollutant exposure
 - ❖ Health
 - ❖ comfort concerns²
 - mechanically ventilated
 - high occupant densities²



Indoor Air Quality

- Attributes of indoor air affecting a person's wellbeing
 - ❖ Pollutant level
 - ❖ Air temperature
 - ❖ Humidity
 - ❖ Air velocity
 - ❖ Odors
 - ❖ Etc.



IAQ Methods

- Visual Survey
 - ❖ Visible signs of past or present water damage
 - ❖ Visible fungal growth
 - ❖ Possible points of water and pollutant intrusion
- Indoor Environmental Quality Survey
 - ❖ Faculty and Staff

IAQ Methods

- Radon Sampling
 - ❖ Charcoal canister
- Comfort Parameter Sampling
 - ❖ VelociCalc 9555-P Multi-Function Ventilation Meter
 - Carbon Dioxide (ppm)
 - Carbon Monoxide (ppm)
 - Relative Humidity (%)
 - Temperature (°F)



Major Indoor Air Pollutants

- These pollutants have been identified as potential health risks in buildings:
 - ❖ Asbestos
 - ❖ Radon
 - ❖ Combustion by-products (CO, CO₂)
 - ❖ Aldehydes
 - ❖ VOCs
 - ❖ Mold



ACM Example



Figure 2: ACM Example

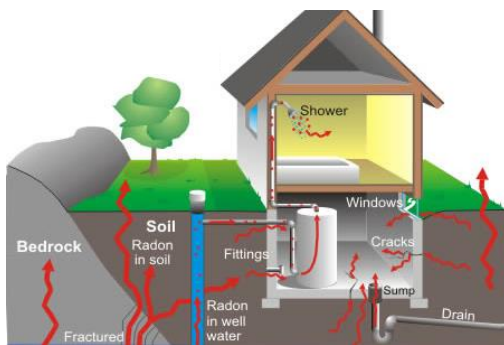


Figure 3: How radon enters a house?

13,000 – 16,000 lung cancer deaths a year

CO Health Effects

- Long-term exposure can lead to **increased risk of heart disease**⁴

Percent CO in Blood	Typical Symptoms
<10	None
10-20	Slight headache
21-30	Headache, slight increase in respirations, drowsiness
31-40	Headache, impaired judgment, shortness of breath, increasing drowsiness, blurring of vision
41-50	Pounding headache, confusion, marked shortness of breath, marked drowsiness, increasing blurred vision
>51	Unconsciousness, eventual death if victim is not removed from source of CO

Figure 4: CO health symptoms



Table 1. CO2 PPM and Health Problems

PPM	Health Problems
1000-2000	Drowsiness and poor air
2000-5000	Headaches, sleepiness, and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate, and nausea
5000	Oxygen deprivation could occur

Formaldehyde (HCHO)

- Widely used industrial and commercial chemical
 - Found in **pressed wood materials**²
- Potent **mucous membrane irritant**
- Chronic exposure may cause **CNS issues**



Volatile Organic Compounds (VOCs)

- Emitted from a variety of sources:
 - ❖ Building materials and furnishings
 - ❖ consumer products
 - ❖ building maintenance materials
 - ❖ office equipment
 - ❖ tobacco smoke



Mold

- Widely found in building environments
 - ❖ face paper of gypsum board
 - ❖ ceiling tiles
 - ❖ processed wood fiber materials



Student Numbers

Date	Morning	Afternoon
January 9	130	167
January 10	139	173
January 11	142	166
January 12	143	172
January 13	139	169

Weather

Date	Low Temp °F	High Temp °F	Precipitation in inches
January 9	17	37	0
January 10	36	53	0.12
January 11	44	60	0.28
January 12	41	67	0.35
January 13	36	41	0.15
January 14	38	45	0.4
January 15	37	41	0.14
January 16	41	62	0.06
January 17	45	67	1.22

Visual Observations

Water Damage



Leak Residue



Visual Observations

Open Containers



Mold Growth



Visual Observations

Open Containers



Inadequate Filters



Visual Observations

Wrong Ventilation



Inadequate Ventilation



Visual Observations

Non-openable Windows



Chimney Effect



Visual Observations



Additional Observations

- Vents not operable by teachers
- Chemistry lab without vents/hoods
- Chemical storage without ventilation
- Humidifiers in classrooms, labs, and offices

Comfort Parameters

Air Quality Guidelines

Parameter	Limit/Range	Reference
Temperature	Summer: 74 to 82°F (23 to 28°C) Winter: 68 to 78°F (20 to 25.5°C)	ASHRAE Standard 55-2010 ISO 7730
Relative Humidity	30% to 65%	ASHRAE Standard 55-2010 ISO 7730
Air Movement	0.8 ft/s or 0.25 m/s	WHO ISO 7730
Ventilation (fresh air)	15 to 60 ftm/person minimum depending on type of space	ASHRAE Standard 62.1-2010
Ventilation (CO ₂)	About 700 ppm over outdoor ambient	ASHRAE Standard 62.1-2010

Figure 10: Air Quality Guidelines

Impact of Relative Humidity

- Relative humidity levels below 40 percent
 - Increased discomfort
 - Drying of the mucous membranes,
 - Coughing
 - Itching
 - sore throats
- High humidity may provide a growth medium for bacteria and fungi.

School Results (RH and Temp)

- Most rooms below recommended RH of 40%
 - ❖ 30-60% is desired
- Several rooms and hallways below recommended comfort temperature
 - ❖ for winter (68-78°F)

Radon

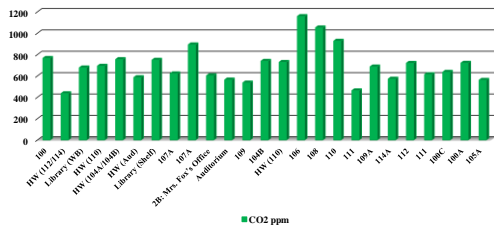
- Three spaces with action levels higher than 4

4 pCi/L (148 Bq/m ³) or greater	Below 4 pCi/L (148 Bq/m ³)
If the testing indicates radon concentrations equal to or greater than 4 pCi/L in any office area, classroom, exercise facility, meeting room, dining area or other common area, reduce the radon to below 4 pCi/L. The higher the radon concentration, the more quickly action should be taken to reduce the concentrations.	Radon concentrations below 4 pCi/L still pose a risk to occupants. Consider fixing the building if test results indicate radon concentrations between 2 and 4 pCi/L (74 and 148 Bq/m ³). Note that reducing and accurately confirming radon concentrations of about 2 pCi/L or below may be difficult. If test results are below the action level, confirm the low results by testing again, at least every 5 years and whenever significant changes to the building's structure or mechanical systems occur.

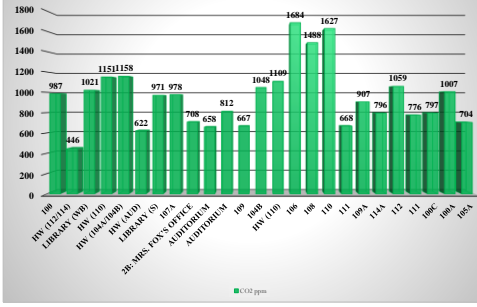
Carbon Dioxide (CO₂)

- Ambient concentration: 300-400 ppm
- Indoor concentration greater than 1000 ppm possibility of inadequate ventilation and complaints
 - Headaches
 - Fatigue
 - Eye and throat irritation

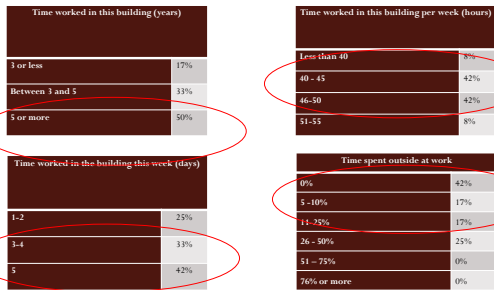
Daily Average Carbon Dioxide Levels



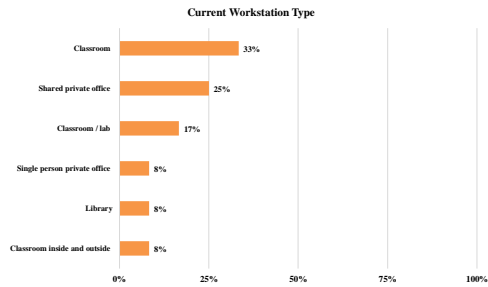
Daily Maximum Carbon Dioxide Readings



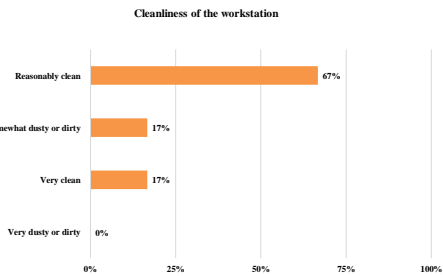
Indoor Environmental Quality Survey



Indoor Environmental Quality Survey

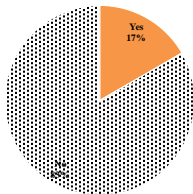


Indoor Environmental Quality Survey

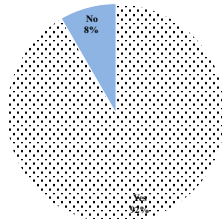


Indoor Environmental Quality Survey

Presence of carpet on all or most of the workstation floor

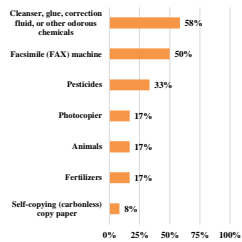


Survey-takers who work with a computer

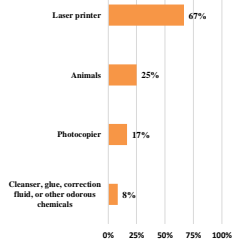


Indoor Environmental Quality Survey

Items used less than 3 times/week



Items used several times a day

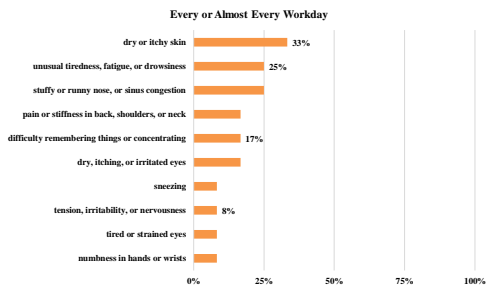


Indoor Environmental Quality Survey

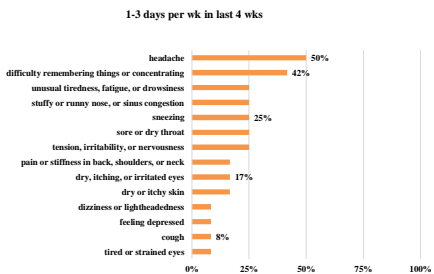
Survey-takers who consider themselves especially sensitive to:

Tobacco Smoke	50%
Other Chemicals in the Air	42%

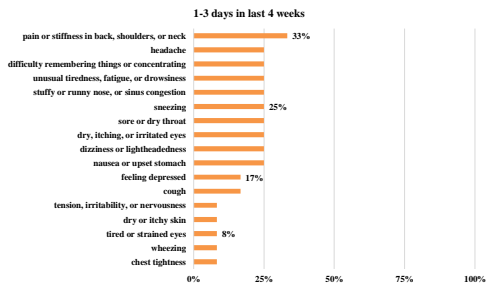
Indoor Environmental Quality Survey



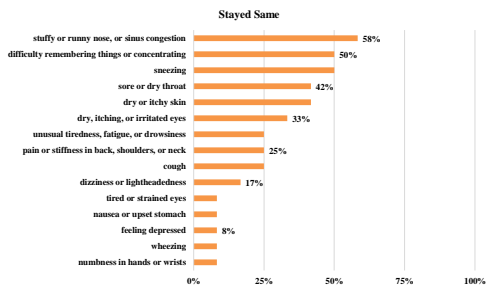
Indoor Environmental Quality Survey



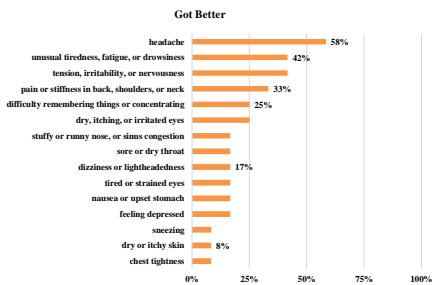
Indoor Environmental Quality Survey



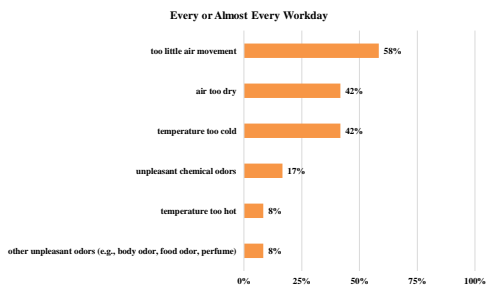
Indoor Environmental Quality Survey



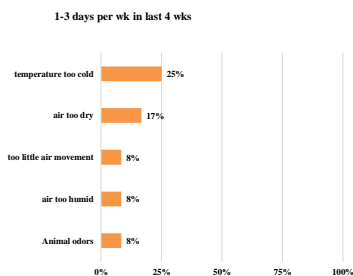
Indoor Environmental Quality Survey



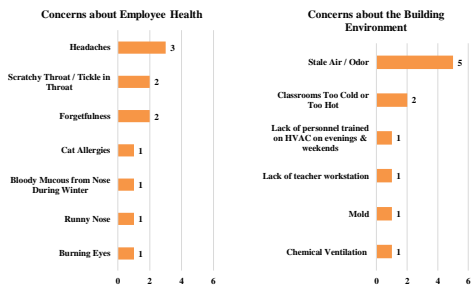
Environmental Conditions



Environmental Conditions



Themes for Health and Environment



Short Term Follow-up

- Follow-up short-term radon measurements for caretaker's apartment.
- Clean ceiling of possible microbial growth above windows
- Replace water damaged ceiling tiles.
- Remove personal dehumidifiers from offices, classrooms, and labs.
- Keep area in front of CO₂ sensors clear.
- The school CO₂ sensors are out of calibration.
- Improve housekeeping and minimize pet dander.

Short Term Recommendations

- Currently the relative humidity for the building is set at 35%, set it to 40%.
- Replace paint booth filters and contact paint booth manufacturer to determine optimal operating pressure.
- Develop a preventative maintenance plan and filter change schedule for the paint booth.
- Sampling for VOCs and welding fumes.

EPA Guidance on School IAQ



Figure 6: Framework for Effective School Indoor Air Quality Management⁵

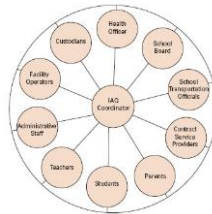


Figure 7: Forming an IAQ Team⁶

Measurement of Indoor Contaminants

- Conducted in most IAQ investigations
- Surface Dust Sampling
- Airborne concentrations of
 - ❖ Gases
 - ❖ Vapors
 - ❖ Biological Contaminants

IAQ Management

- Exclusion
 - ❖ Avoid use of contaminant emitting products (e.g. HCHO-free)
 - ❖ Low-emitting products (e.g. Low levels of HCHO)
- Source Removal
- Source Treatment
 - ❖ Treated or modified to reduce contaminant emissions
 - ❖ Encapsulate furniture containing HCHO
- Ventilation
 - ❖ Infiltration and exfiltration
 - ❖ Natural (e.g. open doors and windows)
 - ❖ Mechanical (e.g. general dilution and local exhaust ventilation)

Addressing risks from IAQ

- One study laid out five ways to address air quality:
 - Type I: Raise Awareness
 - Type II: Change Behavior
 - Type III: Change products/materials and places of activities
 - Type IV: Make technical and technological changes
 - Type V: Make structural changes⁷



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23rd Annual EKU Environmental Health Symposium

When: March 27th, 2018

Time: 9:00 AM – 5:00 PM

Where: Perkins Building (EKU Campus)

Cost: Professionals and Non Students (\$35.00)

Includes lunch and CEUs



College of Health Sciences
ENVIRONMENTAL HEALTH

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