

The logo for Ann Arbor Public Schools features a stylized orange bracket at the top. Below it, the text "ANN ARBOR PUBLIC SCHOOLS" is written in a bold, black, sans-serif font. Underneath that, the tagline "LEAD. CARE. INSPIRE." is written in a smaller, black, sans-serif font. At the bottom, there is a horizontal bar divided into three colored sections: blue with a white star, red with a white heart, and yellow with a white exclamation point. The entire logo is framed by orange lines that extend from the bracket above and the bar below.

ANN ARBOR PUBLIC SCHOOLS
LEAD. CARE. INSPIRE.

Environmental Sustainability Preview

Presented to the Board of Education

June 13, 2018

Presented by:

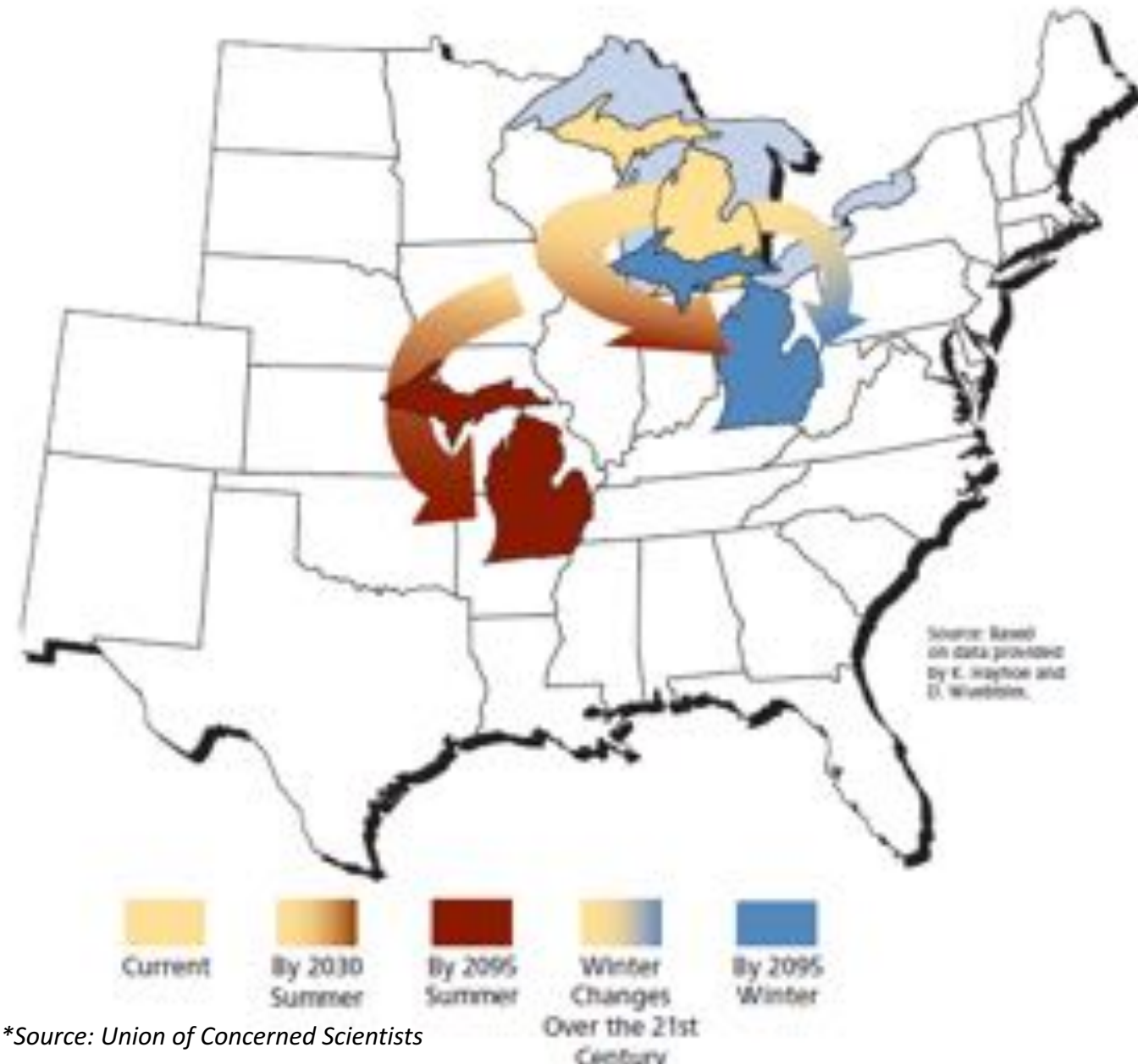
Emile Lauzzana, Executive Director – Physical Properties

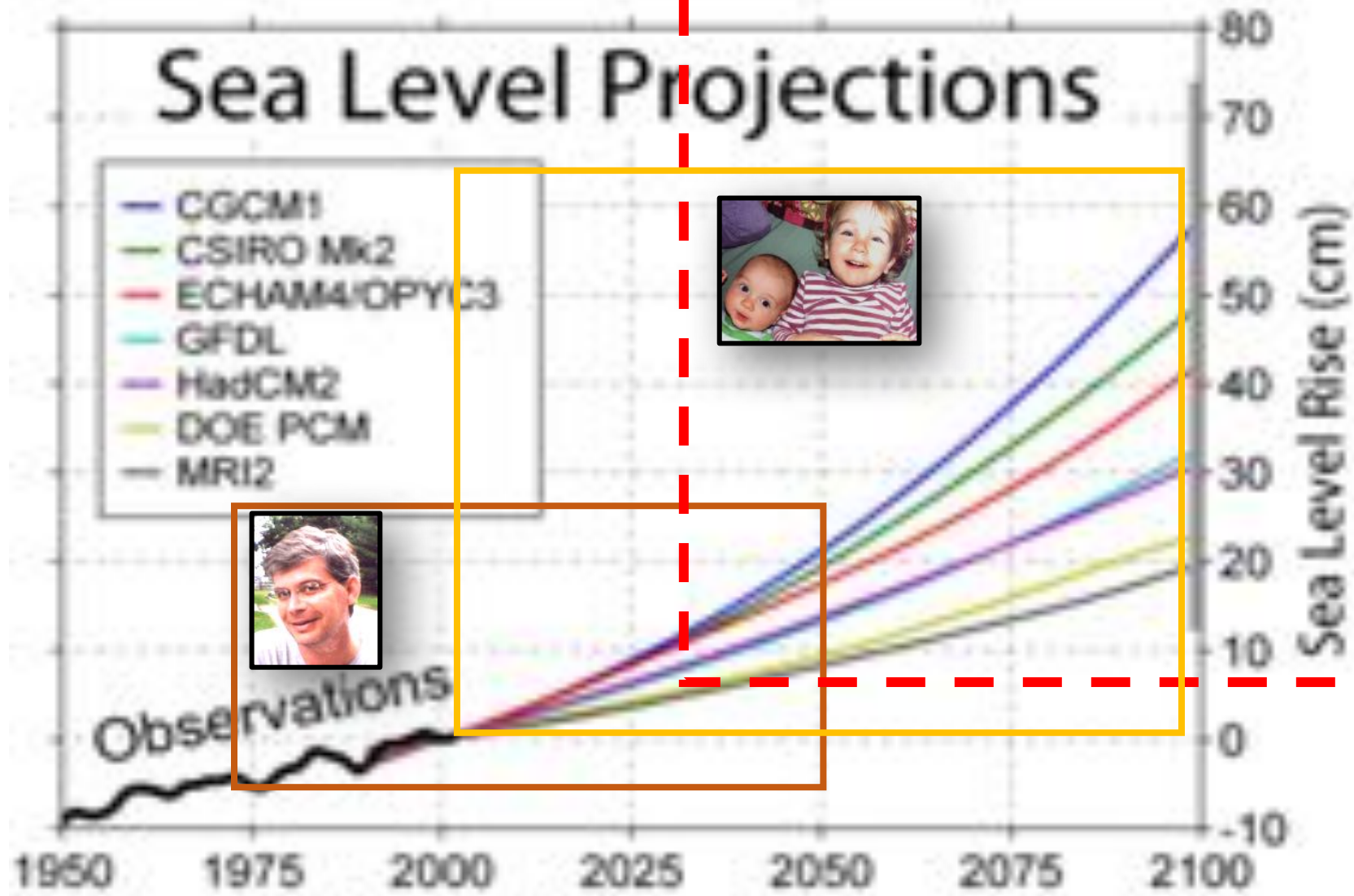
Presentation Overview

- Climate Change is Real Now and for Future Generations
- Responses and Approaches to Climate Change
- Community Input – Advisory Committee
- Classroom Environment Optimization for Learning
- Next Steps

Michigan “The Great Lakes State”

- 3,315 miles of **Coastline**
 - longest in contiguous 48 (2x FL; 4x CA)
- Abundant **Fresh Water**
- Largest **Auto GDP** in US
- More **Engineers** in Michigan than any other state
- 300 **Agricultural Crops**
 - second most diverse in US

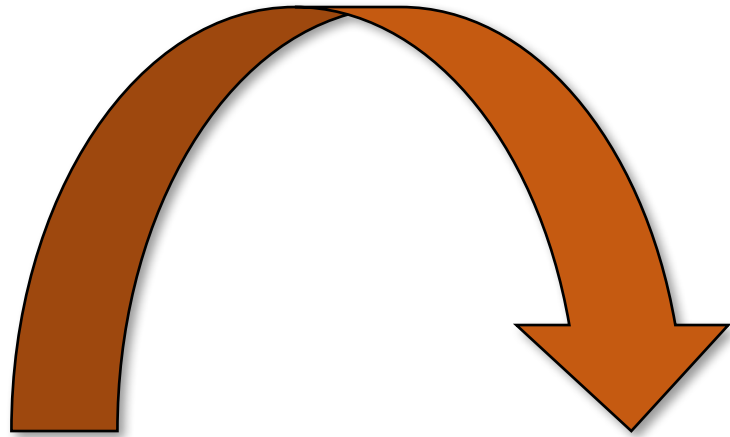




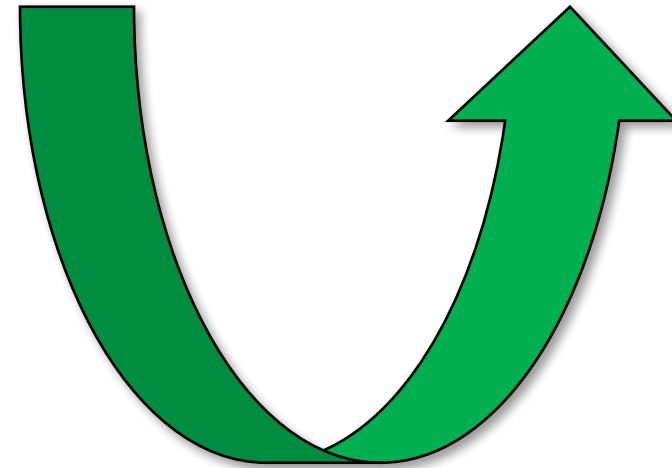
Climate Change Responses

- **Mitigation** – *Reducing Emissions*
- **Adaptation** – *Adapting Practices to Change*
- **Resilience** – *Bouncing Back from Challenges*

Degenerative vs Regenerative Cycles

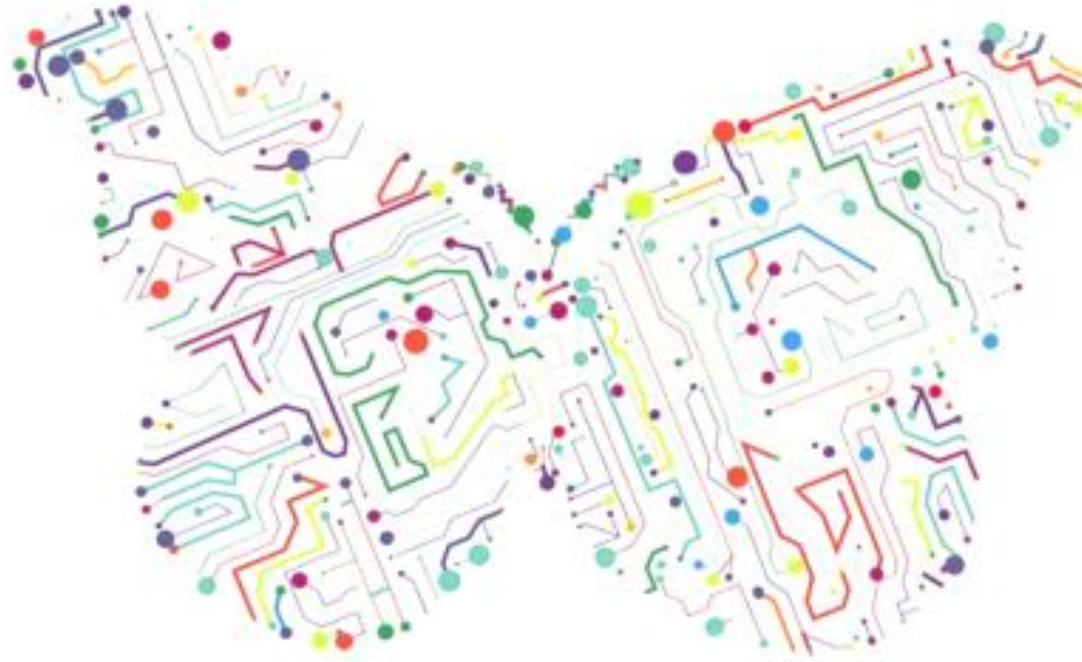


Degenerative



Regenerative

Biomimetic Design



What would Nature do?

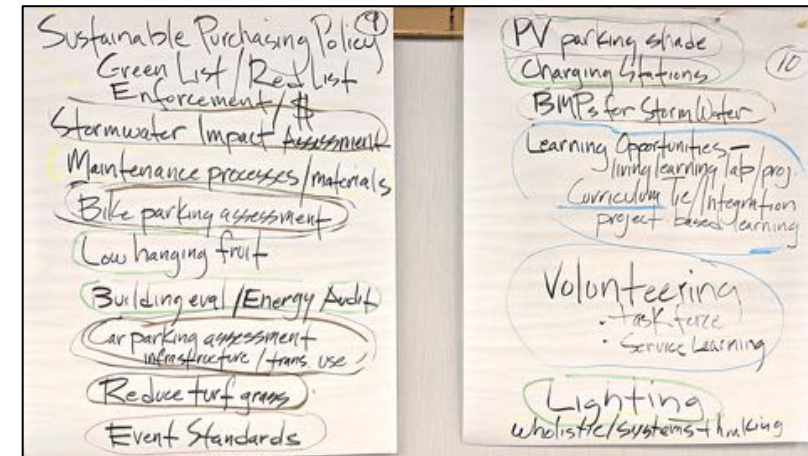
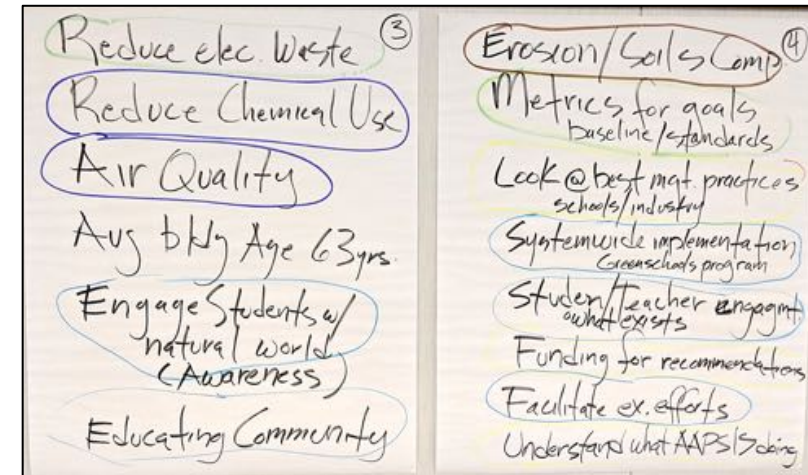
Environmental Sustainability Advisory Committee

TOPIC TEAM AREAS

- Student, Staff, and Community Engagement
- Building Energy and Water Usage
- Waste Reduction
- Indoor Environment
- Site and Grounds

Environmental Sustainability Advisory Committee

Name	Name
Adam Simon	John Beeson
Andrew Fillmore	Katie Stoffel-Duffy
Andrew J Horning	Kevin Morgan
Carlene Colvin-Garcia	Malini Ratan
Chris Curtis	Molly Bachelor
Dan Ezekiel	Nicole Berg
Jan Culbertson	Richard Garcia
Janette Lutz	Seth Penchansky
Jason Bing	Stacy Dieve
Jennifer Chapman	Tara D'Andrea
Jenny York	Theresa Tanin
Jo Ann Teller	



Student, Staff, and Community Engagement

Action	Student Outcomes	Environmental Impact	Budget and Staff Time
Implement a district-wide Sustainable Schools Program	7.21	9.36	6.93
<u>Use school campus and building as a living/learning lab with curriculum integration</u>	9.71	7.86	6.73
Leverage students to educate the community	8.21	6.86	4.13
Create more opportunities for volunteerism and service learning	8.21	6.14	4.21
Focus on Climate Change	5.79	8.07	4.87
Study how environmental factors impact student health, wellness, and performance	5.79	6.57	5.27
Document current school-based initiatives	7.21	9.36	6.93

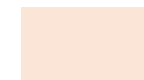
Advisory Committee Members rated action items with 10 having the most impact and 1 having the least



High Priority



Medium Priority



Low Priority

Building Energy and Water Usage

Action	Student Outcomes	Environmental Impact	Budget and Staff Time
Reduce utility consumption - Electric, Natural Gas, Water and Stormwater	4.57	9.57	6.2
Install solar photovoltaics	4.71	7.07	7.13
Monitor and Benchmark Performance	5.07	8.00	5.80
Building Envelope Improvements	5.50	7.71	6.80
Develop comprehensive energy plan	4.00	8.43	6.33
Implement a robust property management software	3.71	7.57	5.87
Focus on low-hanging fruit (lighting, controls, etc.)	4.93	7.50	4.87
Conduct energy audits	4.43	7.07	5.67
Develop proactive HVAC upgrade program	5.43	7.57	6.07

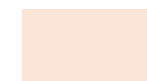
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High Priority



Medium Priority



Low Priority

Waste Reduction

Action	Student Outcomes	Environmental Impact	Budget and Staff Time
Enhance/Repair current recycling system	6.79	9.00	6.40
Develop district-level composting program	6.57	8.79	6.93
Promote reusable water bottles	6.64	7.79	4.20
Reduce Styrofoam use	5.21	8.21	5.67
Develop event standards for waste	6.07	7.93	4.87
Reduce food waste	5.71	8.79	4.40
Reduce use of single use items	6.29	8.71	4.73

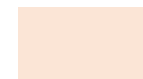
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High Priority



Medium Priority



Low Priority

Indoor Environments

Action	Student Outcomes	Environmental Impact	Budget and Staff Time
Manage environmental factors for impact on student health, wellness and performance	9.50	7.21	6.93
Develop formal green cleaning policy	6.71	8.00	5.07
Reduce chemical use	6.79	8.21	5.60
Measure and improve indoor air quality	7.86	6.86	6.07
Reduce exposure to Wi-Fi/cellular radiation	4.14	4.36	5.86

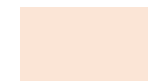
Advisory Committee Members rated action items with 10 having the most impact and 1 having the least



High Priority



Medium Priority



Low Priority

Site and Grounds

Action	Student Outcomes	Environmental Impact	Budget and Staff Time
Improve erosion control	3.77	7.57	6.40
Increase native landscaping	8.31	6.93	5.07
Install more rain gardens	5.08	7.43	5.40
Reduce invasive species	5.46	8.36	5.67
Plant trees for shade	4.46	7.29	5.33
Aerate and fertilize grounds	7.08	7.86	5.13
Conduct a storm water impact assessment	4.15	5.57	5.57
Reduce outdoor water usage	3.23	6.43	5.00
Reduce use of salt for snow removal	2.85	6.64	4.00
Enhance School Gardens	3.38	8.43	4.50

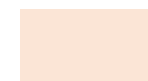
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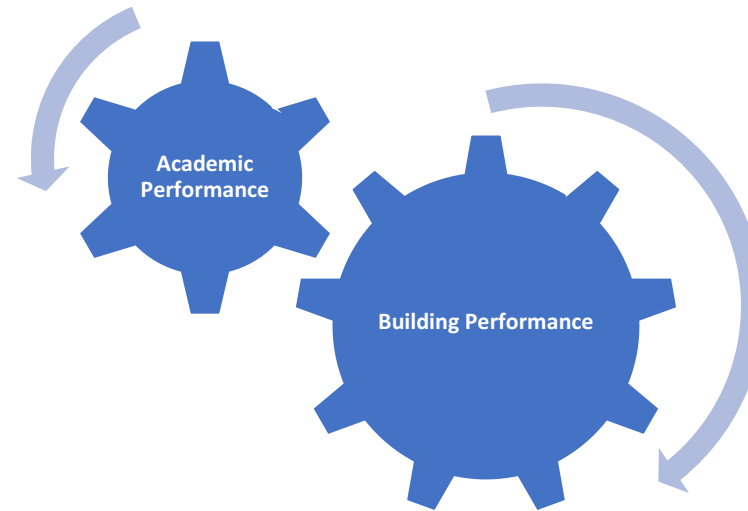


Low Priority

Linking Academic Performance

with

Building Performance



From Anecdote to Evidence



- **Quantitative research today:** good sense of how to build and maintain healthy school buildings
- **Emerging research** across the United States and Europe attempting to demonstrate, connect and quantify the relationship between building improvements and student performance
- Universities, research laboratories, nonprofit organizations, trade associations/industry participating in the process

“Schools for Health: Foundations for Success”

Harvard School of Public Health 2016 report on

How School Buildings Influence Student Health, Thinking, and Performance



Forhealth.org

Research Overview – How Students:

HEAR

BREATHE

SEE

FEEL

**THINK
AND
LEARN**

Source: “The Impact of School Buildings on Student Health and Performance: A Call for Research”
<http://www.usgbc.org/Docs/Archive/General/Docs18534.pdf>

HEAR

- Clear connection between quality acoustical environments and enhanced performance
- Research: As **reverberation time** increased (above 0.5 to 0.6 seconds), researchers found significant negative impact on short-term memory and speech perception (Klatte et al, 2011)
- Studies identify importance of **low background noise** for speech intelligibility



Reverberation time
above 0.5 to 0.6 seconds
+ Higher Background Noise



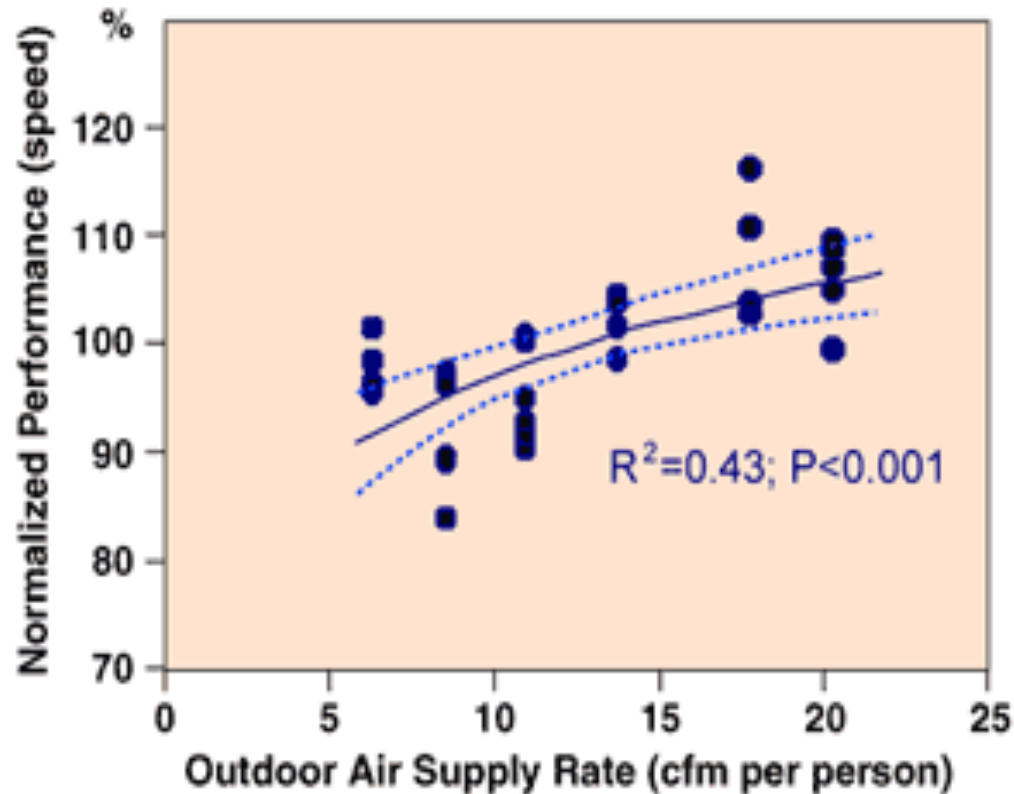
Short-term memory
+ Speech perception

BREATHE

- There are a number of known pollutants that impact indoor air quality:
 - Particulate matter
 - Volatile Organic Compounds (VOCs)
 - Mold/Moisture
 - Other toxins and irritants
- According to the EPA, **air quality is often 2-5 times worse indoors**, and sometimes much greater (Kats, 2006)
- Research to date has focused primarily around **ventilation rates**
- Emerging research targeting **effective filtration**
- Ventilation research studies show **impact on task speed, average daily attendance, and proficiency**

Ventilation Rates and Performance

Experiment conducted in Denmark:



As ventilation rates increase, students' performance increases (related to task speed)

Source: Lawrence Berkeley National Laboratory. 2017. *Temperature and School Work Performance*

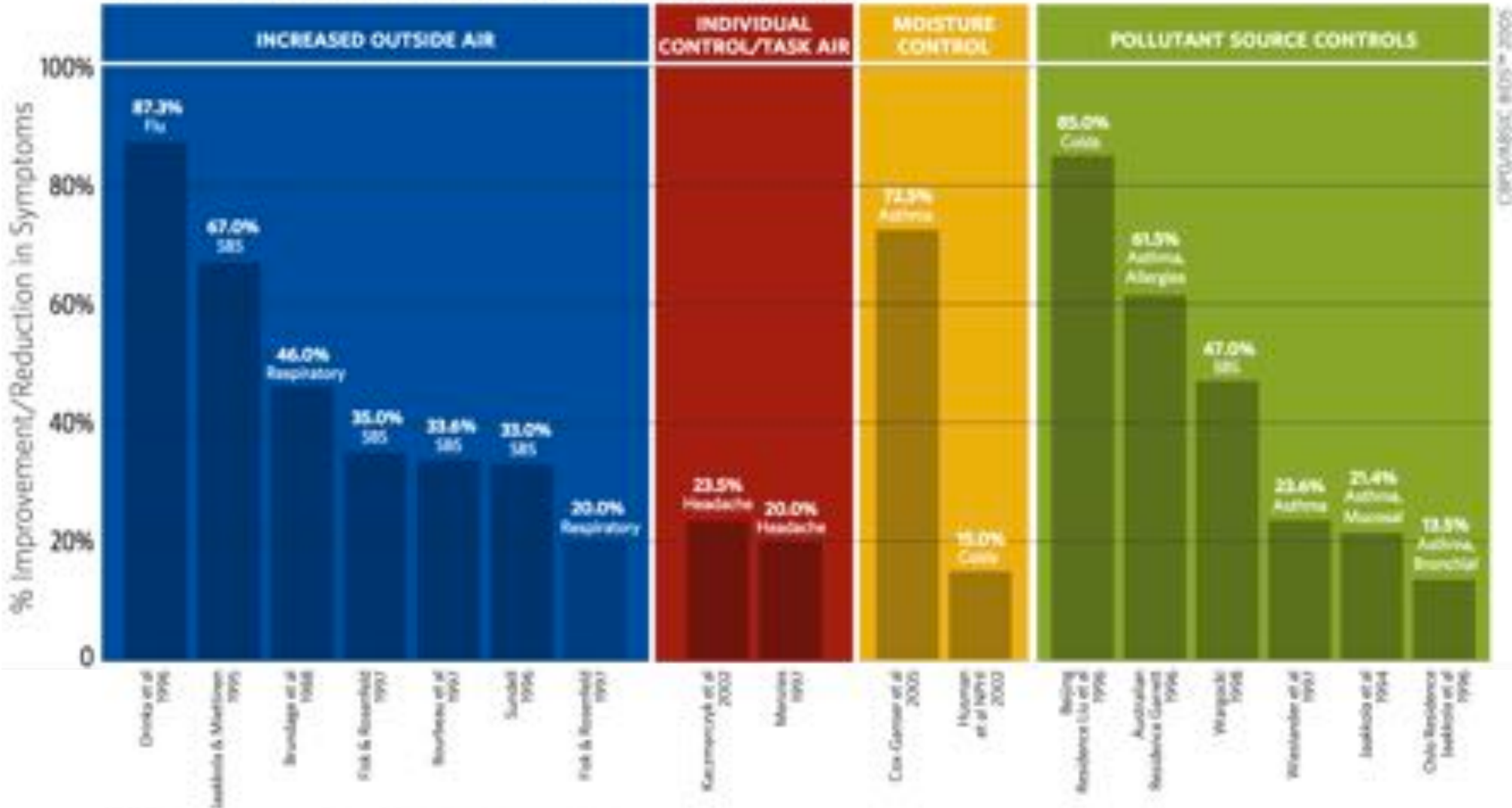
Ventilation Rates and Performance cont.



U.S. study of fifth-grade classrooms in 100 schools studied student performance in standard academic tests as the measure of performance and estimated that there was nearly a 3 percent increase in the proportion of students passing standardized math and reading tests for each 2 cfm/person increase in the ventilation rate across the range of 2 to 15 cfm/person

Source: Wargocki, P. and Wyon, D.: Research report on effects of HVAC on student performance. October 2006. ASHRAE Journal, 48: p. 22-28

FIGURE B
Health Gains from Improved Indoor Air Quality



17 separate studies all found positive health impacts from improved indoor air quality, ranging from 13.5% up to 87%

SOURCE: Carnegie Mellon University Center for Building Performance, 2005

Source: http://www.usgbc.org/sites/default/files/Greening_Americas_Schools.pdf


SEE

- The visual qualities of a learning environment are some of the most crucial building aspects to design properly **since children depend heavily on sight in the learning process**
- Recognized relationship between higher student performance and presence of **daylight and views** (Boyce et al., 2003)
- Optimized lighting environments led to as much as **21% increase in student learning rates** (Gordon, 2010)
- Emerging research is targeting **circadian systems** and the potential for visual environments to influence overall academic performance



Color Temperature and Standard LED Retrofits

10-15% Increase
in Visual Acuity and
Reading Comprehension



Hippopotamus

Many people think a hippopotamus would eat a person if it had the opportunity. But hippos are plant eaters. They do not eat people. Still, they are more wild than you think they are. They like to walk on the bottom of rivers, but they are not looking for food. They are trying to stay cool. Hippos are excellent swimmers. They can hold their breath for five or six minutes while submerged in the water.


Hippos are nocturnal. At night they come on land to eat grass and plants. They can live for six hours a night. They can eat 100 pounds of food at a single meal. Eating large meals allows hippos to live for weeks without eating anything if they need. They live in large mud pits and stay as still as possible to conserve energy.

Hippos have enormous mouths with huge teeth. Their lips are two feet wide, and each tooth weighs about six pounds. Most hippos weigh around 5,000 pounds. Only the elephant and the rhinoceros are larger land animals.

1. What is the main idea of this story?
 a. Hippos are quick and mean.
 b. Hippos walk in rivers to stay cool.
 c. Hippos are large, nocturnal animals.

2. Why do hippos spend most of the day in the water?
 a. They are excellent swimmers.
 b. They are looking for food.
 c. They are trying to stay cool.

3. Why do hippos live in large mud pits?
 Include information from the story to explain your answer.



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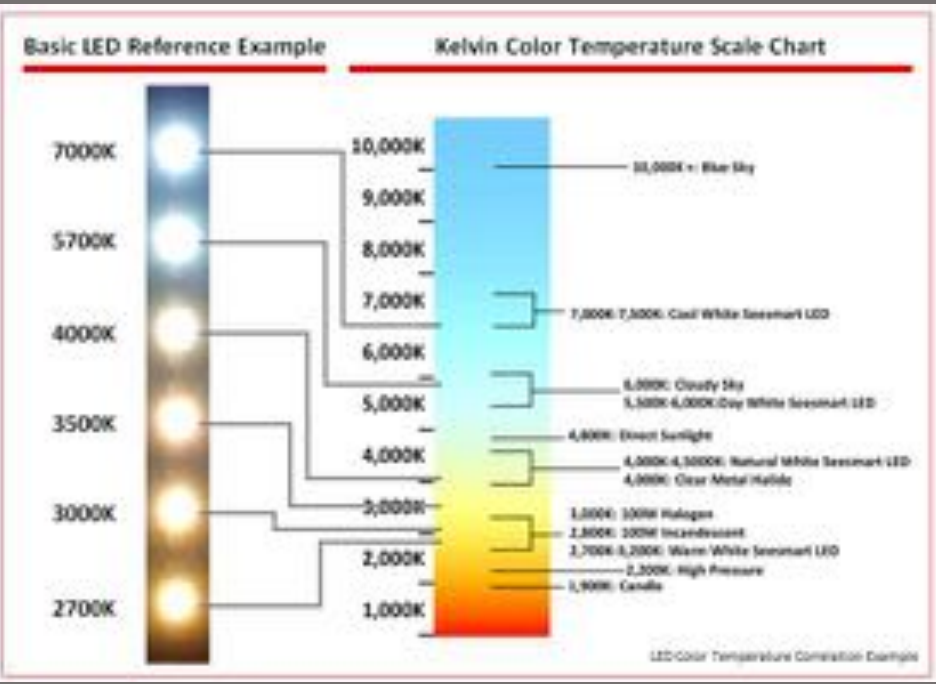
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Basic LED Reference Example

Kelvin Color Temperature Scale Chart

Color Temperature (K)	Light Description
10,000K	10,000K = Blue Sky
9,000K	
8,000K	
7,000K	7,000K/7,000K: Cool White Standard LED
6,000K	
5,000K	5,000K: Cloudy Sky 5,000K/4,000K: Day White Standard LED
4,000K	4,000K: Direct Sunlight 4,000K/4,000K: Natural White Standard LED 4,000K: Clear Metal Halide
3,000K	3,000K: 100W Halogen 2,800K/2,800K: Incandescent 2,700K/3,200K: Warm White Standard LED
2,000K	2,000K: High Pressure
1,000K	1,000K: Candle

LED Color Temperature Comparison Examples

Circadian Rhythm

Lighting levels and color temperatures that vary throughout the day and year regulate our bodies and impact hormone production

200 years ago we lived most of our lives outside

We now spend 90% of our time indoors

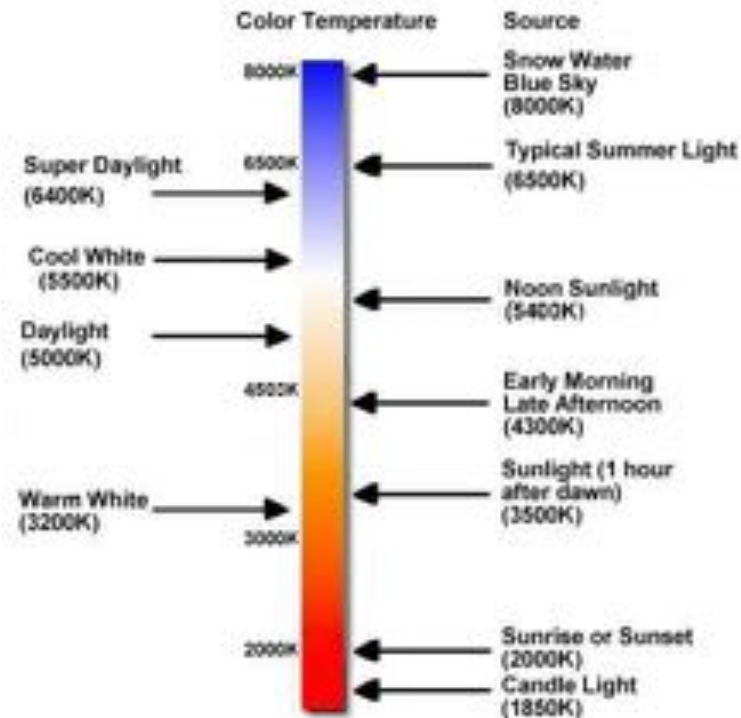


Dynamic Lighting

Modulates color temperatures and light levels throughout the day to increase performance

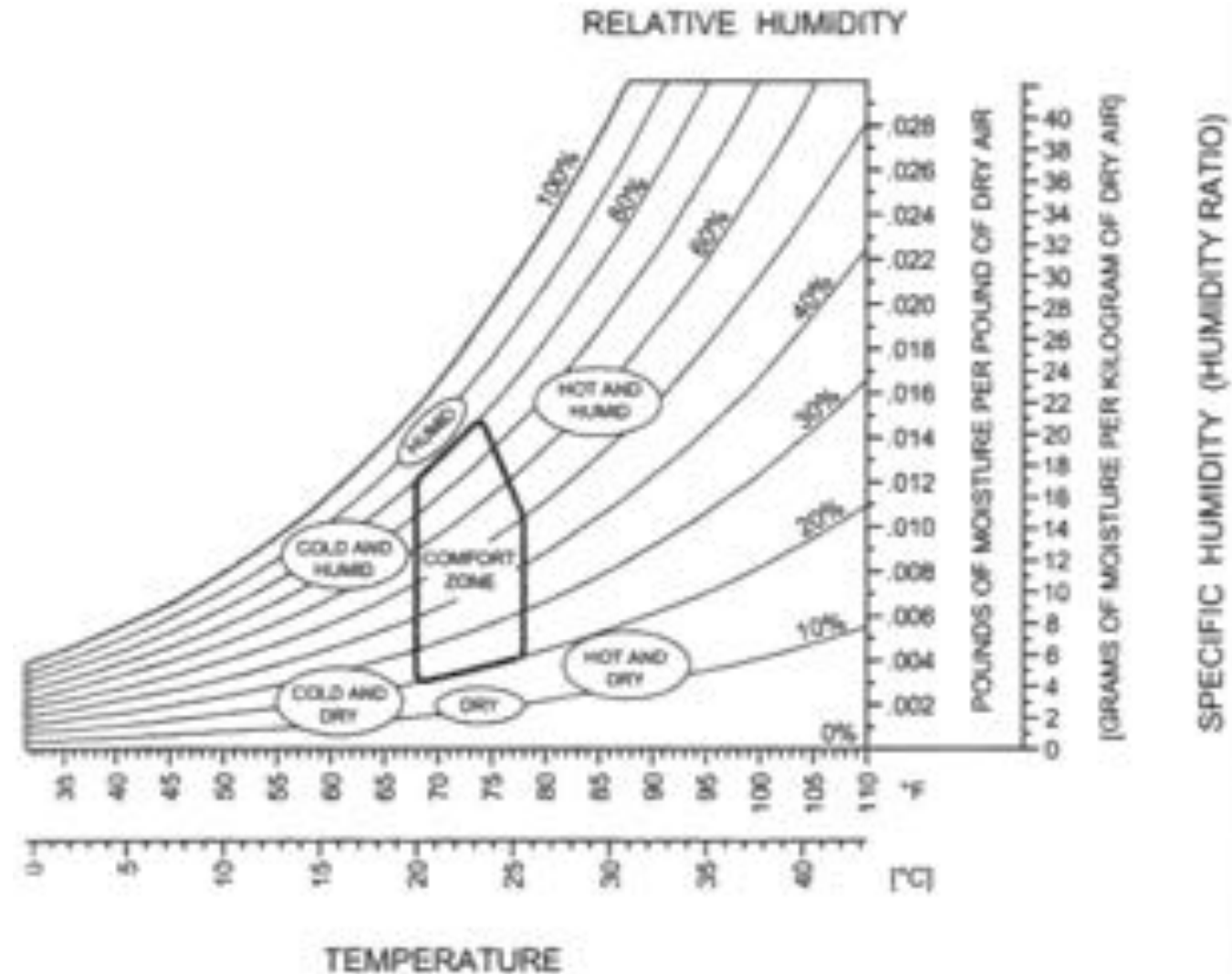
Up To 33% increase in student performance

- Phillips SchoolVision Research



FEEL

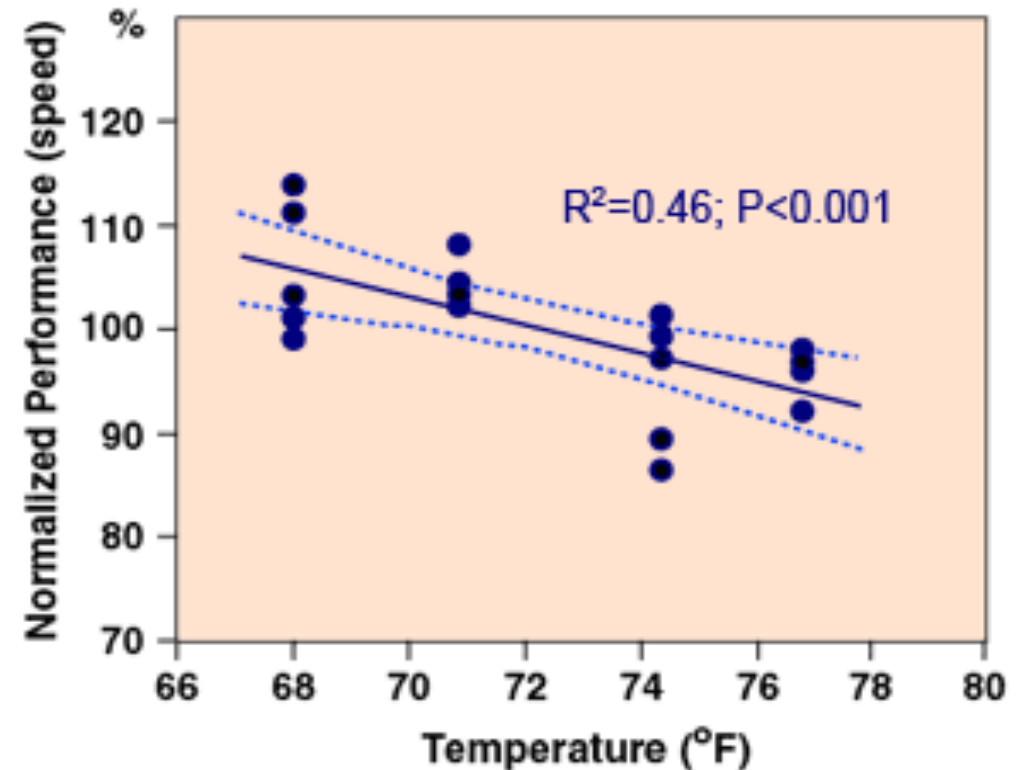
- A reasonable and constant temperature and humidity has been shown to positively impact student health and learning and teacher wellbeing
- Research continues to emphasize linkages between thermal comfort and performance



Temperature and Performance

Experiment conducted at Kansas State

- The average speed of eight simulated school work tasks decreased by approximately 1.1% per each 1° F as temperatures increased from 68° F to 77° F



Source: Lawrence Berkeley National Laboratory. 2017. *Temperature and School Work Performance*.

AAPS Next Steps for Optimized Learning Environments:

HEAR

Sound
Field
Systems

BREATHE

Air Filters
and
Ventilation

SEE

LED Lighting
(Solar
Powered)

FEEL

Climate
Control
Systems

**THINK
AND
LEARN**

Sustainability
Curriculum

More Information

U.S. GREEN BUILDING COUNCIL CENTER FOR GREEN SCHOOLS:

<https://www.centerforgreenschools.org/>

HARVARD STUDY, SCHOOLS FOR HEALTH:

<https://schools.forhealth.org/>

U.S. DEPARTMENT OF ENERGY, ZERO ENERGY SCHOOLS:

<https://betterbuildingsinitiative.energy.gov/accelerators/zero-energy-schools>

KENDEDA REGENERATIVE ROADMAP, ZERO ENERGY SCHOOLS:

<https://livingbuilding.kendedafund.org/2017/04/11/net-zero-energy-schools-roadmap/>

SCHOOL PLANNING AND MANAGEMENT, REGENERATIVE SCHOOLS

<https://webspm.com/Articles/2014/05/01/Regenerative-Education.aspx>

ZERO ENERGY SCHOOL CASE STUDY VIDEO:

[Building Brighter Futures Through Zero Energy: Discovery Elementary School](#)

THANK YOU

People



Systems



Ecology

