Environmental Quality of a High Performance School: A Holistic Approach to Designing High-Performance Schools

A Study of Environmental Quality, Learning Styles and Crisis Mitigation/Management.

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Environmental Quality of a High Performance School: What are the design goals of a integrated, holistically designed high-performance school

1. Create the physical environment for the well being and education of students
2. Know and Understand Student Learning Styles
3. Utilize Research Based Design Concepts that Lead to Enhanced Student learning
4. Create a Healthy School Environment
5. Create a Safe and Secure School Environment
6. Create a Green School and Environmentally Friendly School
Environmental Quality of a High Performance School:
Outline of presentation

1. Understanding Learning Styles
2. Environmental Systems
3. Classroom Lighting Quality
4. Classroom Acoustics
5. Building and Site Design
6. New Model Proposed
1. Understanding Learning Styles

What is a High Performance Professional Learning Community

1. Shared Mission, Vision, and Values
   Guiding Principle and beliefs

2. Collective Inquiry
   Seek new teaching and learning methods and tools, test new methods

3. Collaborative Teams
   Learn from each other, create the momentum

Source: Adapted from National School Services, 1999
1. Understanding Learning Styles

What is a High Performance Professional Learning Community

4. Action Orientation and Experimentation
   Turning learning and insight into action

5. Continuous Improvement
   Not content with the status quo

6. Results Orientation
   Observable and measurable results

Source: Adapted from National School Services, 1999
1. Understanding Learning Styles

What are learning styles?

- Learning styles pertain to the different ways humans learn new and difficult information.
- Evidence is compelling that we learn and work best in a climate that supports our individual learning needs and productivity preferences.
- No two children are alike
- No two children learn the same way
- An enriched environment for one student is not necessarily enriched for another

Source: Susan Rundle, 2006
1. Understanding Learning Styles

What are learning styles?

**Physiological Elements:**
- Biological Preferences that determine one’s ability to concentrate and focus

**Psychological Elements:**
- Preferences for processing information and preferences for making decisions and solving problems

**Perceptual Elements:**
- Affect the way humans learn and retain new information

**Sociological Elements:**
- Preferred ways of learning and working effectively with others

**Emotional Elements:**
- Influences how and how quickly one completes challenging and complex tasks and assignments

**Environmental Elements:**
- Stress related factors that affect one’s ability to concentrate and focus on tasks

Source: Building Excellence Survey, Rundle and Dunn
1. Understanding Learning Styles

What are learning styles?

1) Lecture
2) Sit and Take Notes
3) Take Test!

Source: Building Excellence Survey, Rundle and Dunn
1. Understanding Learning Styles

What are learning styles?

Most of today’s students are visual or kinesthetic learners

1) Hands-On Approach
2) Interaction
3) Experimentation

Source: Building Excellence Survey, Rundle and Dunn
1. Understanding Learning Styles

The Classroom Organization

- ZONE 2: DISPLAY
- ZONE 3: ACTIVE
- ZONE 4: QUIET
- ZONE 5: SENSORY
- ZONE 6: BRIGHT
- ZONE 7: SAFE

Informal to formal
1. Understanding Learning Styles

Where is safety and Security?

Maslow’s Hierarchy of Needs

PHYSIOLOGICAL NEEDS AND SAFETY NEEDS are in the foundation.
1. Understanding Learning Styles

Where is safety and security?

- Traditional physical safety elements, inside and out of the classroom, are not adequately addressed in LEED or CHPS.

- An integrated approach to design of classrooms and HVAC systems along with EPA, FEMA and other safety programs needs to exist.
Mitigation:
An example of mitigation are activities that either prevent the occurrence of an emergency, inside or outside of the classroom, in order to reduce the vulnerability in ways that minimize the adverse impact of distractions or even disasters within the classroom.
2. Environmental Systems

*Environmental systems and the classroom*

**Environmental Systems**

- IAQ
- Ventilation
- Thermal Comfort
- Safety and Well Being
2. Environmental Systems

*Indoor environmental quality in the classroom*

- Poor indoor air quality in schools affects 1 in 5 children in America’s schools.
- American children miss more than 10 million school days each year due to poor IAQ.
- Improving IAQ in older schools has been proven to reduce absenteeism from 8.31% to 3.75%.

2. Environmental Systems

Thermal Comfort and Humidity in the classroom

- Students will perform **mental tasks** best in rooms kept at **moderate humidity of 40% - 70%**.

- The best temperature range for learning - **reading and math** is **68° and 74°**.

- The ability to control classroom temperature is central to the performance of teachers and students.

2. Environmental Systems

*Trends in mechanical design in the classroom*

- Integrated building automation systems (HVAC, lighting, power, water monitoring signaling systems) with chiller plant optimization

- **Demand Controlled Ventilation**
  - Dedicated Outdoor Air System
  - CO₂ Sensor

- Thermal Displacement Ventilation (low supply, high return, low velocity)

- Enhanced Performance Verification

- Natural Ventilation
2. Environmental Systems

Where is safety and Crisis Mitigation?

Figure 3-7  Example of protecting outdoor air intakes

SOURCE: CDC/NIOSH, PUBLICATION NO. 2002-139, GUIDANCE FOR PROTECTING BUILDING ENVIRONMENTS FROM AIRBORNE CHEMICAL, BIOLOGICAL, OR RADIOLOGICAL ATTACKS, MAY 2002.
3. Classroom Lighting Quality

*Lighting and the classroom*

**Classroom Lighting Quality**

- Natural Light
- Artificial Light
- Safety and Well Being
3. Classroom Lighting Quality

The dark facts of lighting and the classroom

- **Malillumination** is the term used to describe sunlight deficiency and the negative effects of pink or cool white fluorescent lighting on behavior, learning, health, hardiness, longevity.

- Cool white fluorescent lighting has been associated with hyperactivity, **fatigue**, irritability and **attention deficits**.

- **Students working in malilluminated rooms show** increased depression, and observable deficiencies such as **visual difficulties**, nutritional problems and chronic fatigue.

Source: Martel 1998; Titoff, 1999; Harmon, 1938; Ott, 1973
What does the research tell us?

“... appropriate lighting improves test scores, reduces off-task behavior, and plays a significant role in students’ achievement.”


Mark Schneider
November 2002

On any given school day, about twenty percent of American households in a school building. The average age of our schools is close to five years, and studies by the U.S. General Accounting Office have shown that many school buildings are not designed to meet modern educational needs. These schools are often built on a tight budget, and their lighting systems are often neglected.

There is a growing body of work linking educational achievement and student performance to the quality of lighting, air quality, and thermal comfort. Lighting, ventilation, and thermal comfort are all factors that can affect student performance and well-being.

Indoor Air Quality

Poor indoor air quality (IAQ) is widespread, and its effects are not yet fully understood. The U.S. General Accounting Office has identified several factors that can negatively impact IAQ in schools, including age of buildings, ventilation systems, and the use of air conditioners.

Indoor Air Quality, Ventilation, and Thermal Comfort

There is a growing body of work linking educational achievement and student performance to the quality of lighting, air quality, and thermal comfort. Lighting, ventilation, and thermal comfort are all factors that can affect student performance and well-being.

Mark Schneider
November 2002

Do School Facilities Affect Academic Outcomes?

National Clearinghouse for Educational Facilities

200 First Street, NE, Suite 400, Washington, D.C. 20002-4870 800-352-6040 www.nceef.com
3. Classroom Lighting Quality

The dark facts of lighting and the classroom

What does the research tell us?

“... 20% - 26% improved learning rate......as evidenced by increased test scores over one school year...”

Heschong & Knecht  CEFPI Educational Facilities Planner V37-2
3. Classroom Lighting Quality

The dark facts of lighting and the classroom

- Tooth Decay 9X less
- Attendance increase 3.2 - 3.8 days
- Growth increased as much as \( \frac{3}{4} \)” taller

*Source: Alberta Department of Education*
3. Classroom Lighting Quality

*Lighting challenges in the classroom*

**Challenges in the Classroom**

**Computer usage and mobility**

- Light needs to ideally come from the right or left, to minimize glare.
- However, with flexible learning environments, often times direct lighting can come from the front or behind, and reflect off the screen, causing eyestrain.

**Window Placement**

- Haphazard introduction of windows is often a bigger issue than no natural light at all.

Source: Fielding, 2000
3. Classroom Lighting Quality

*Lighting challenges in the classroom*

**Circa 1900**
Classroom lighting a century ago.

**1940’s**
Post-war classroom lighting, incandescent pendant fixtures.

*Source: Litecontrol*
3. Classroom Lighting Quality

*Lighting challenges in the classroom*

Classroom lighting in the 60’s. Architectural pendant fixtures.

Traditional direct lighting was designed for the 70’s classroom and simply cannot solve lighting problems associated with the modern classroom.

Source: Litecontrol
3. Classroom Lighting Quality

Electric Lighting

Provide multi-scene indirect/direct lighting with two rows of pendant luminaires that use T8 lamps and electronic ballasts. Provide the teacher with controls at the teaching wall to operate the two lighting modes, general illumination and A/V. Incorporate a separately-switched whiteboard luminaire. Provide manual or automatic controls to reduce electric lighting when daylight is sufficient or the room is not occupied.

Optional Stem Mount (SS) positions the top of the fixture 3” from the ceiling. Additional stem lengths available for hard ceilings. Consult factory for additional requirements.
3. Classroom Lighting Quality

**Lighting challenges in the classroom**

### Windows

- Locate primary windows on the north or south so that solar gain into the classroom can be controlled.
- Provide separate blinds or control for the daylight portion – the part above the height of the door.
- If windows are not continuous, locate them in the corners to more effectively daylight the teaching surfaces.
- Select fenestration that reduces heat loss and improves comfort, while providing adequate for daylighting.
- Provide light shelves, overhangs for south facing windows.
3. Classroom Lighting Quality

Where is safety and security?

- Window placement
- Sightlines
3. Classroom Lighting Quality

Goals

Slogan: “Bright and Responsible”

1. Window Placement
2. Indirect Lighting a MUST
3. As much natural light as possible
4. Task Lighting to Supplement
5. Higher Ceiling Heights
6. Safety and Well Being
4. Classroom Acoustics

Acoustics and the classroom

Classroom Acoustics

- Sound reinforcement
- Sound enhancement
- Environmental systems and distractions
- Safety and Well Being
4. Classroom Acoustics

Acoustics and the classroom

1/3 of the school systems studied shows noise is the most critical environmental concern affecting student performance.

Source: Texas Society of Architects’ Committee on Architecture for Education-General Accounting Office Study 1999
4. Classroom Acoustics

Acoustics and the classroom

The Facts ......with no sound amplification or reinforcement

• Half of all teachers experience voice disorder at some time in their career

• U.S. schools may lose as much as $2.5 billion annually in sick leave for teachers with vocal problems

• The average grade school student misses 25% of what a teacher says

• Even in an acoustically good classroom children receive from teacher:
  85% in front row
  66% in middle row
  55% in back row

Source: University of Iowa National Center for Voice and Speech; Berg, 1987; Crandell & Smaldino, 1994; Dahlquist, 1998
4. Classroom Acoustics

Acoustics and the classroom

Acoustics

- Provide gypsum board surfaces on a slope behind the teacher and in the middle of the room to reflect the teachers voice.
- Provide acoustic materials around the perimeter of the ceiling and above the 6’8” wainscot.
4. Classroom Acoustics

Acoustics and the classroom

Reduce ambient noise from Mechanical Systems and other sources

Avoid

Main supply air duct

Preferred
4. Classroom Acoustics

**Acoustics and the classroom**

**Displacement Ventilation**
Deliver 400-800 cfm of 100% outside air near the floor at a temperature of 63-68°F. Exhaust air at or near the ceiling. In colder climates, provide supplemental heating at the building perimeter.

**Materials**

- Use gypsum board surfaces on walls behind the teacher and in the front of the room to reflect the teacher's voice.
- Use acoustic materials around the perimeter of the ceiling and the 6'8" wainscot.

**Insulation**

- Insulate floors, walls, and ceilings to reduce noise transmission.

**Furnishings and Finishes**

- Use materials that are non-porous, durable, and resistant to dust and noise.
- Choose finishes that provide a good acoustic environment.

**Occupancy and/or Daylight Sensors**

- Consider installing automatic controls that adjust electric lighting to the level of daylight available and the presence of occupants in the space.

**Lighting**

- Select lighting that reduces heat loss and improves comfort, while providing adequate for daylighting.
- Provide light shelves, overhangs, and south-facing windows.

**Classroom Layout**

- Create an interior space that positions the principal visual lines to reduce glare and provide good vertical illumination on the teaching wall.
5. Building and Site Design

*Site design and Safety*

**Site Design**
- Site Acquisition and Site Design
- Site Layout and Design
- Vehicular & Pedestrian Circulation
- Landscape Design
- Controlled Access Zones
5. Building and Site Design

*Site design and Safety*

- Adjacent Natural Hazards
- Adjacent Man-Made Hazards
- Access to Site *(pedestrian/vehicular)*
- Proximity to fire and power stations & hospitals
- Prevailing Winds
5. Building and Site Design

Site design and Safety

- Adjacent Natural Hazards
- Prevailing Winds

Figure 5-1 Example of chemical dispersion
5. Building and Site Design

Site design and Safety

SITE SELECTION

GAS STATION....WITH GAS!!!

ELEMENTARY SCHOOL
5. Building and Site Design

Site design and Safety

SITE CONSIDERATIONS

- MAIN ENTRY & MONUMENTS
- PUBLIC TRAFFIC
- BUS DROP OFF
- LANDSCAPE FEATURES
- STUDENT PARKING
- NATURAL BARRIER
- LANDSCAPE FEATURES

- MAIN ENTRY
- VISITOR PARKING
- STAFF PARKING
- 50 SPACES
- 250 SPACES

- COMPETITION TRACK & FIELD
- BASEBALL FIELD
- TENNIS COURTS
- FOOTBALL FIELD
- GYMNASIUM
5. Building and Site Design

Site design and Safety

CHPS and LEED promote Urban Development but do not address potential urban safety and security issues such as:

- Views from taller buildings
- Location of bus and auto areas
- Access to playfields and mechanical yards.
CHPS and LEED promote Joint-Use of Playfields and Playgrounds but do not address issues such as:

- Access to playfields
- Location of parking
- Access to building envelope
- Hiding Places/Alleyways
5. Building and Site Design

Building Design

- Building and Classroom Configuration
- Understand your classroom, building & building systems as a holistic design
- Handicap & Special Needs
- Assess your risk & develop a plan to manage risk
- Safety and Well Being
5. Building and Site Design

Classroom organization

Informal to formal

ZONE 1: ACTIVE

ZONE 2: DISPLAY

ZONE 3: SENSORY

ZONE 4: QUIET

ZONE 5: SAFE

ZONE 6: BRIGHT
5. Building and Site Design

Classroom organization

- **Sociological**
  - informal seating
  - low light
  - low noise

- **Analytic**
  - formal seating
  - visual/analytic
  - auditory

- **Kinesthetic**
  - active/noisy
  - large motor

- **Visual**
  - bright light

- **Sociological**
  - individual seating
  - formal
  - quiet

- **Sociological**
  - informal seating
  - active/noisy

- **Sociological**
  - group seating

Source: Building Excellence Survey, Rundle and Dunn
5. Building and Site Design

Where is learning styles, safety and well being

The CHPS Classroom

Displacement Ventilation
Deliver 400-600 cfm of 100% outside air near the floor at a temperature of 63-68°F. Exhaust air at or near the ceiling. In colder climates, provide supplemental heating at the building perimeter.

Skylights
For classrooms that are one-story and have windows on just one side, locate two 4x8 diffusing skylights near the back wall to balance daylighting.

Ceiling Height
Provide a ceiling height of at least 10 ft.

Furnishings and Finishes
Select furnishings, casework, materials, and finishes that are non-toxic, durable, resource efficient and which provide a good acoustic environment.

Occupancy and/or Daylight Sensors
Consider installing automatic controls that adjust electric lighting to the level of daylight available and the presence of occupants in the space.

Colors
Use a white finish for the ceiling and the portion of the wall above the 6’6” wainscot. The ceiling and upper walls are part of the lighting system.

Classroom Layout
Provide an interior space layout that positions the principal visual tasks to reduce glare and provide good vertical illuminance on the teaching wall.

Acoustics
- Provide gypsum board surfaces on a slope behind the teacher and in the middle of the room to reflect the teachers voice.
- Provide acoustic materials around the perimeter or on the ceiling and above the 6’6” wainscot.

Electric Lighting
- Provide multi-scene interconnected lighting with two rows of pendant luminaires that use TL lamps and electronic ballasts.
- Provide the teacher with controls at the teaching wall to operate the two lighting modes, general illumination and A/V. Incorporate a separately-switched whiteboard luminaire. Provide manual or automatic controls to reduce electric lighting when daylight is sufficient or the room is not occupied.

Windows
- Locate primary windows on the north or south so that solar gain into the classroom can be controlled.
- If windows are not continuous, locate them in the corners to move effectively daylight the teaching surfaces.
- Select fenestration that reduces heat loss and improves comfort.
- Provide light shelves, overhangs for south-facing windows.
5. Building and Site Design

Mechanical Systems Where is Safety and Crisis Mitigation?
5. Building and Site Design

Emergency Evacuation

*Exit Paths*

*Corridors*

*Exit and Fire Doors*

*Stair Wells*

*Building Exits*

*Elevators*

What else can we do?

Consider handicap and special needs
5. Building and Site Design

Emergency Evacuation

a. Elevator
b. Stairs/Area of Rescue Assistance
c. Handicap & Special Needs
d. Secured Outside Areas
e. Move Off-Site
5. Building and Site Design

Remember, Nothing!! Never Happens

But this did......

- Styrene leak
- Building run into
- Nowhere to go for tornadoes
- Neighborhood lock down and no lockable doors
- Get the graffiti off before the mayor’s visit
- The cell phones don’t work here
- I can’t see the door from the reception desk
5. Building and Site Design

Top 20 Overlooked safety and well being issues

1. Shelter In Place
2. Evacuation/Sheltering (Special Needs Student)
3. Access Control (no unsupervised entry)
4. Stand-off Distance from Streets
5. Storm Safe Sheltering
6. Use of Tempered or Laminated Glass
7. Surveillance
8. Rapid Lock Down Capability
9. Elevated Air Intakes
10. System Redundancy
5. Building and Site Design

Top 20 Overlooked safety and well being issues

11. Utility Security (including generator and roof top)
12. Preventing Criminal Activity with Design and Landscaping – “CEPTED”
13. Obstructed Views
14. Prevention of High Speed Approach
15. Room in Lobby for Additional detection Tools
16. Dumpsters Away From Building
17. Elimination of Hiding Places (inside and Outside)
18. Loading Dock and Critical Utilities
19. Mail Handling at Exterior Wall (with venting)
20. Hazardous Materials Storage
6. New Model Proposed

New model proposed

Where is Learning Styles, Safety, and Crisis Mitigation?

CHPS
Leadership, Education and Innovation
Sustainable Sites
Water
Energy
Climate
Materials and Waste Management
Indoor Environmental Quality

LEED
Sustainable Sites
Water Efficiency
Energy and Atmosphere
Materials and Resources
Indoor Environmental Quality
Innovation and Design Process
6. New Model Proposed

New model proposed

Traditional Facility Design
- Needs Assessment
- Program of Requirements
- Schematic Design
- Design Development
- Construction Documentation
- Construction Administration

All Hazards Planning Model
- Vulnerability assessment
- Mitigation
- Prepare
- Response
- Recovery
6. New Model Proposed

New model proposed

- Integrated Holistic Design tied directly to:
  - Learning Styles
  - Student Performance
  - Building Systems
  - Hazards Mitigation
- Moves Facility and Security Assessments forward and not assessment after the fact.
- “Feed-Forward” vs. “Feed-Back” Re-work is not sustainable
- CHPS and LEED designed facilities should address these issues.
6. New Model Proposed

New model proposed

The New Model Proposed
A Study of Environmental Quality, Learning Styles and Crisis Mitigation/Management.

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