



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Daylighting

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The Watt Stopper



Overview -- Potential Benefits of Daylighting

- A pleasant and appealing environment.
- Can aid in academic performance.
- Can provide significant energy savings.
- A more natural interior environment.





What is “Daylighting Design”?

- Designing spaces to use **diffuse** light from the sky.
- Use daylighting to provide the PRIMARY illumination within a space.
- Design the electric lighting system to SUPPLEMENT the daylight.
 - Make sure it is turned off when not needed.
 - Provide adequate light when no daylight is available.
- May involve mechanical controls to reduce glare and to deal with low solar angles.



What is NOT Daylighting?

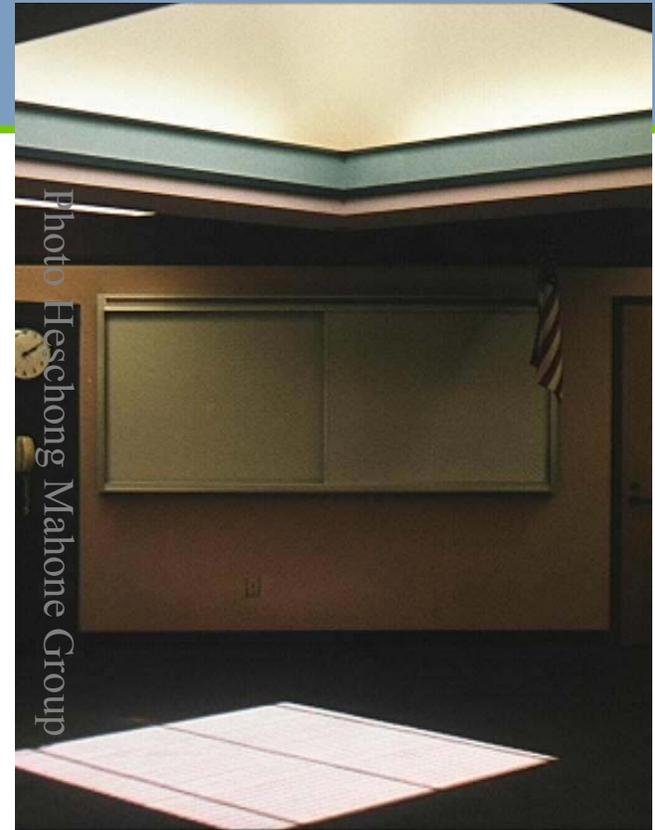


- Buildings architecturally “designed” without careful attention to fenestration.
- Incorrectly designed windows and/or skylights.
- A building with good daylight illumination BUT the electric lights burning away.



Direct Sunlight is NOT daylight

Glare
From
Skylight



Glare from
Window





A Brief History of School Windows

- 50 years ago, most all schools (and workplaces) were daylighted.
- In the late 1960s and 70s, windows began to be considered:
 - A distraction for children.
 - A energy liability.
 - A maintenance liability.
 - A security liability.
- The “Open Classroom” of the 1970s was often a windowless classroom, in a big open plan building.
- “Energy efficiency” retrofits have often removed daylight in an effort to save energy and reduce maintenance.



1965: Windows were fundamental



1995: Retrofitted school to save energy, reduce maintenance



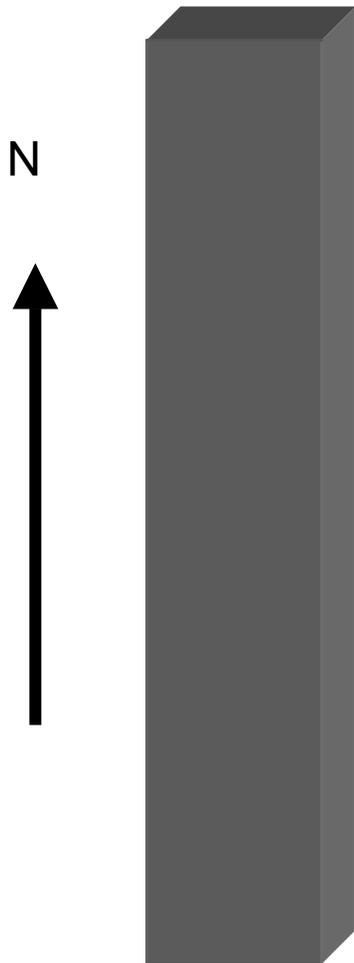
1985: Less fenestration, more electric illumination



Today: Portables are gaining in use in many regions



Basic Principles of Solar Orientation



Worst Exposure

- North and south ends provide minimum interior light.
- East and west sides tend to introduce too much light and heat.
- East and west sides require complex shading systems.
- Shading often requires blocking view glazing.



Basic Principles of Solar Orientation



Ideal Exposure

- North side can introduce a maximum of diffuse daylight.
- South side can be passively shaded most of the year without blocking view glazing.
- East and west sides can have minimal fenestration.



Daylighting Design Principles

- Allow NO direct sun penetration, except in circulation spaces.
- Diffuse the light broadly through diffusing glazing and/or shading.
- Introduce daylight as high as possible.
- Use light colored surfaces.
- Keep brightest surfaces out of line of sight.
- Provide blinds or louvers where there is potential for glare or for audio-visual control.





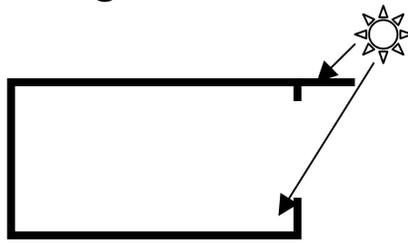
Other Daylighting Design Considerations

- Natural Ventilation.
- Visual Communication.
- Noise Control.
- Radiant Comfort - hot and cold surfaces.
- Safety and Security.
- Air and Water Leakage.
- Condensation.
- Maintenance and Replacement.

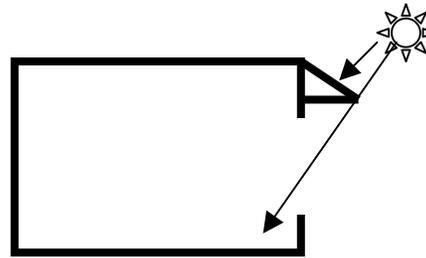


Types of Daylighting

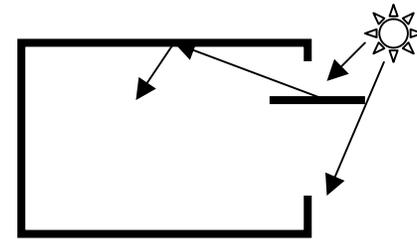
Sidelighting



Window with Overhang

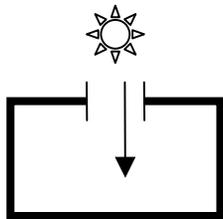


Window with shading

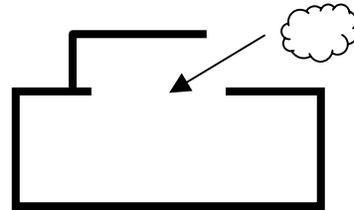


Window with light shelf

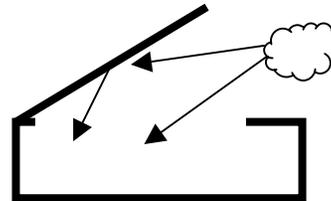
Toplighting



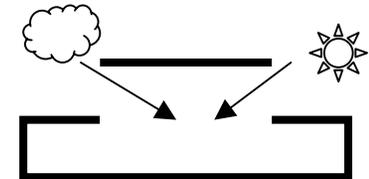
Skylight



Clerestory



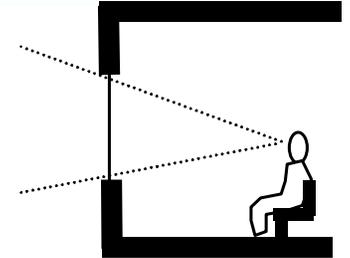
Sawtooth or angled clerestory



Monitor



View Windows

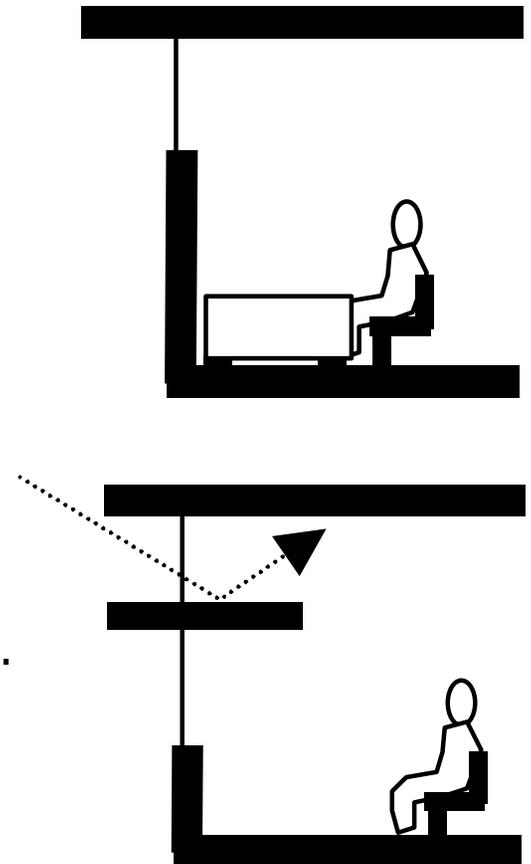


- Provide access to exterior views through view windows for all interior spaces where students or staff will be working for extended periods of time.
- View windows are often inefficient at supplying working daylight to the space. However, areas where many buildings will be multi-story, sidelighting is the only option for lower floor spaces and should be designed to provide as much useful daylight as possible with the least problematic glare.
- Operable view windows provide emergency egress and natural ventilation.



Clerestories – with or without lightshelves

- Clerestories can be used in all school spaces to provide deep penetration of daylight.
- A light shelf is a horizontal panel placed below high clerestory glazing (generally with a view window below it) that improves light distribution.
 - Daylight reflects off top surface onto the ceiling.
- Use light shelves or louvers to improve daylight distribution, block direct sun penetration, and minimize glare.





Skylights – Simple and Reliable Daylighting

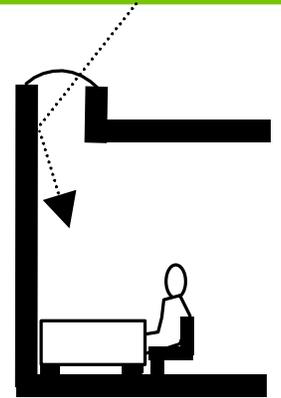
- Proper sizing needed.
- Modern skylights using prismatic refractors and other technologies increase efficiency.
- Skylights are:
 - Effective all day long.
 - Effective under sunlight or cloudy skies.
 - Comparatively inexpensive.
 - Relatively independent of building orientation.





Wall Wash Toplighting

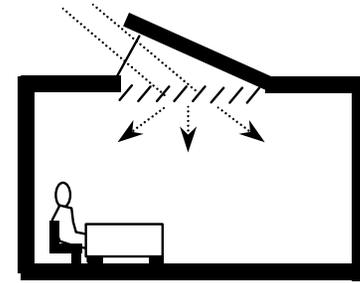
- Use wall wash toplighting for interior classroom walls to balance daylight from window walls, brighten interior classrooms, and make them seem more spacious.





Central Toplighting

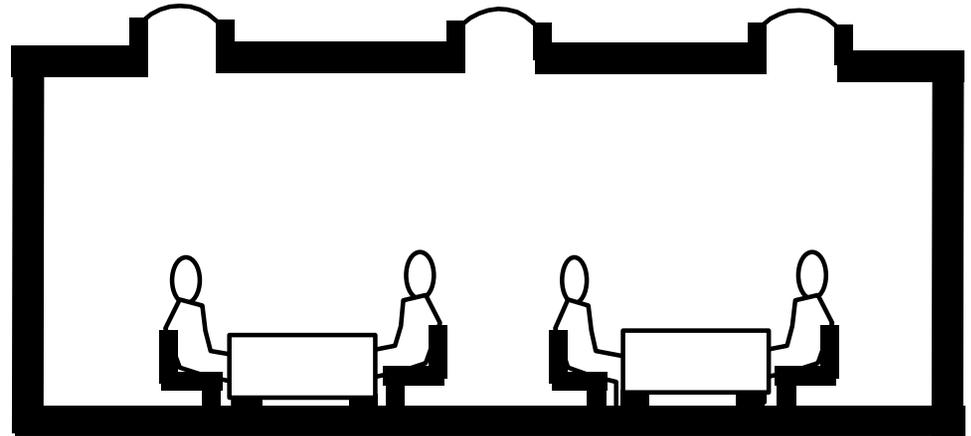
- Central toplighting is accomplished by a central monitor or skylight (or cluster of skylights) that distributes daylight evenly across the room.





Patterned Toplighting

- Use patterned toplighting in interior spaces that need even, low glare illumination across a large area, like gyms, cafeterias, and libraries.





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Daylighting Examples





Two Sides of Light – a very good thing



Photos Heschong Mahone Group

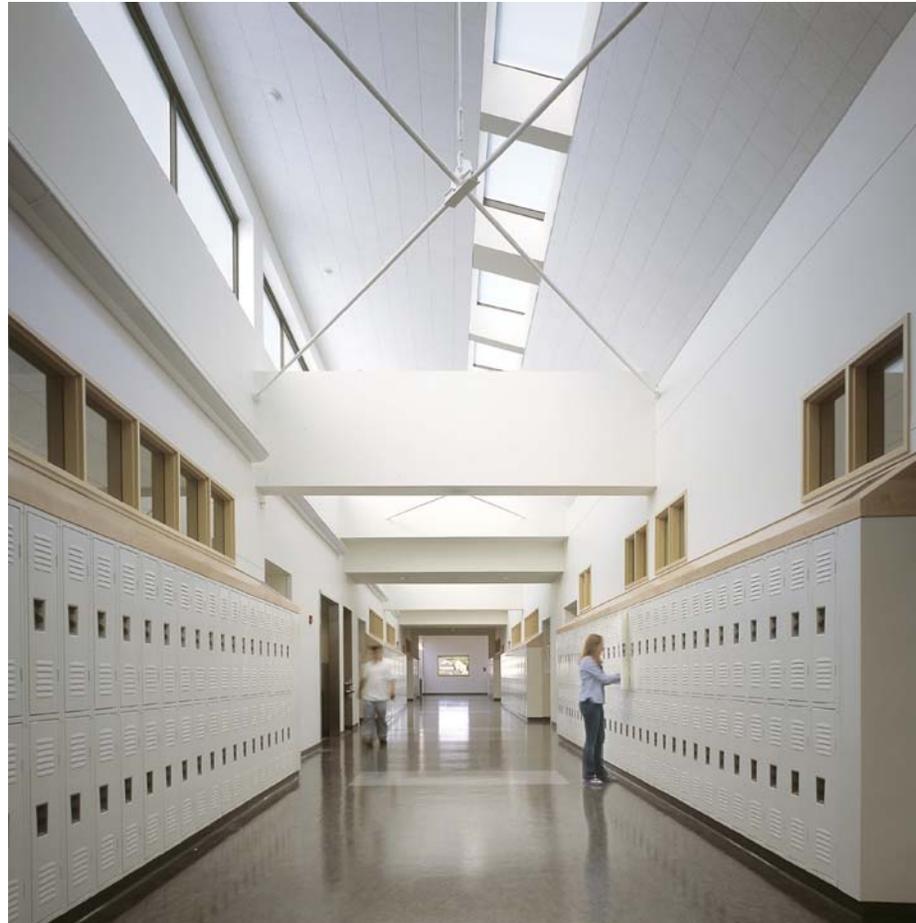


Carefully Integrated Sidelighting with Shelf and Angled Ceiling





An Excellent Example of Toplighting





Sidelighting for the Library





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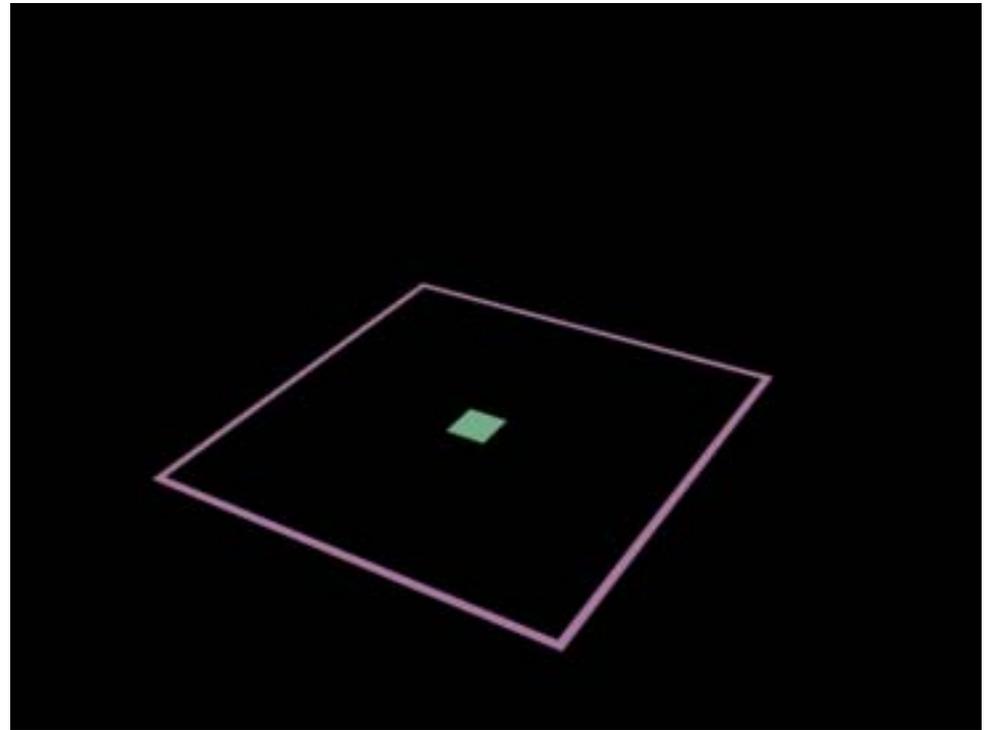
Integrating Daylighting and Electric Lighting





High Ceilings

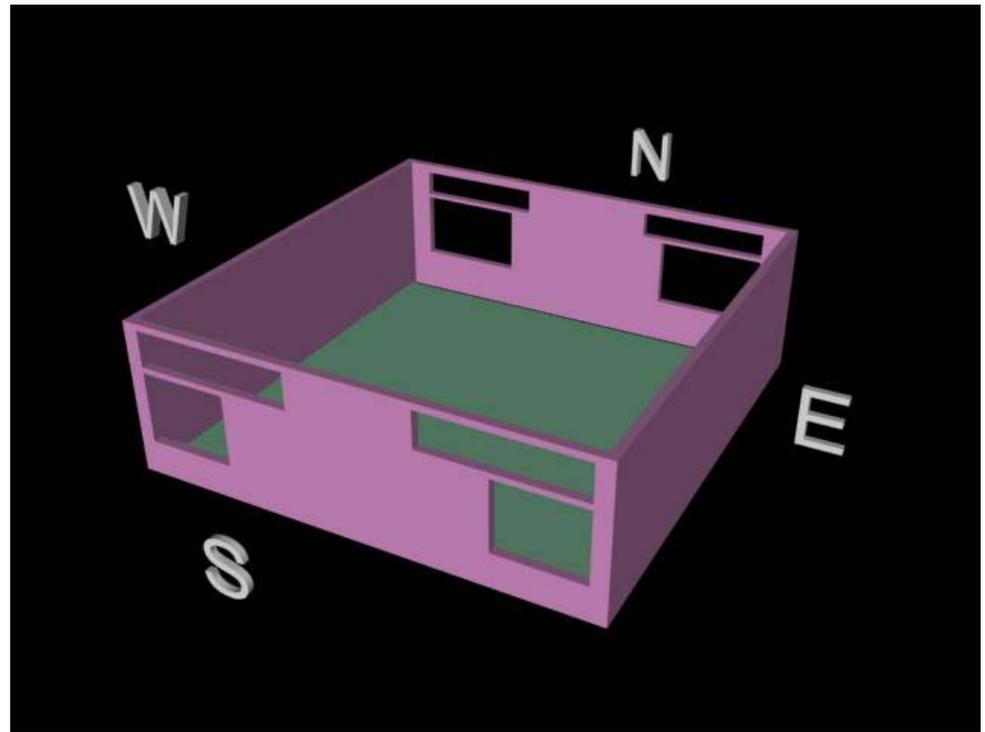
- Average classroom is 30' x 30'.
- High ceilings enhance space and provide better illumination, ventilation, and acoustics.
- Floor-to-ceiling height should be at least 10'.





Orient Windows North/South

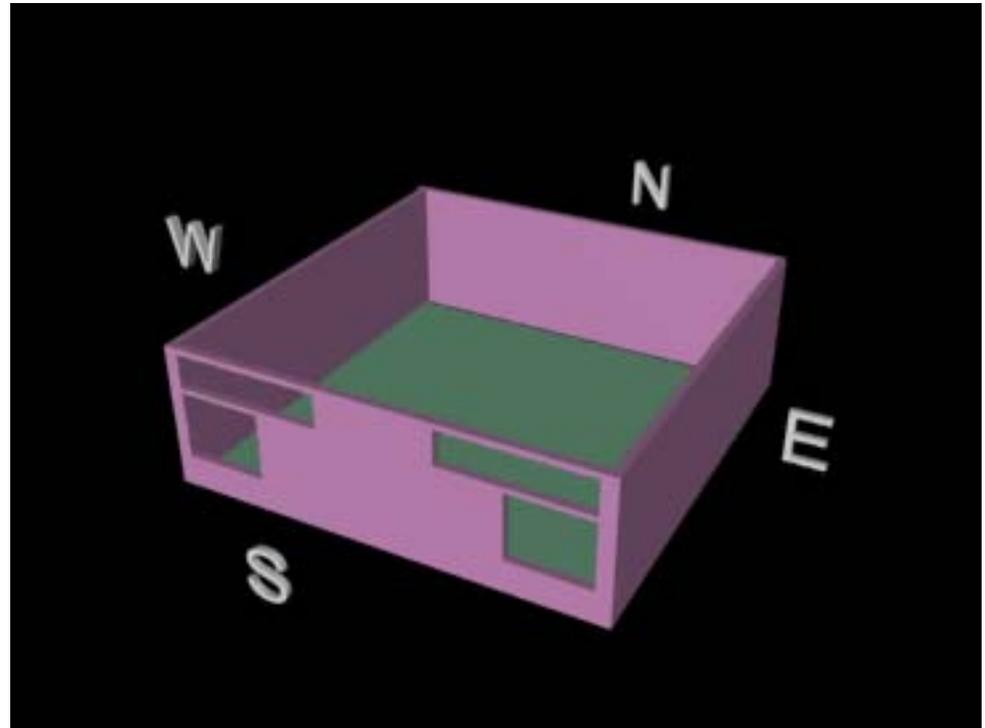
- Windows should be oriented either north or south.
- Locate windows at edges of room.
- If possible, increase the amount of window glazing. This will increase visual comfort and indoor environmental quality - but may cost more.





Skylights

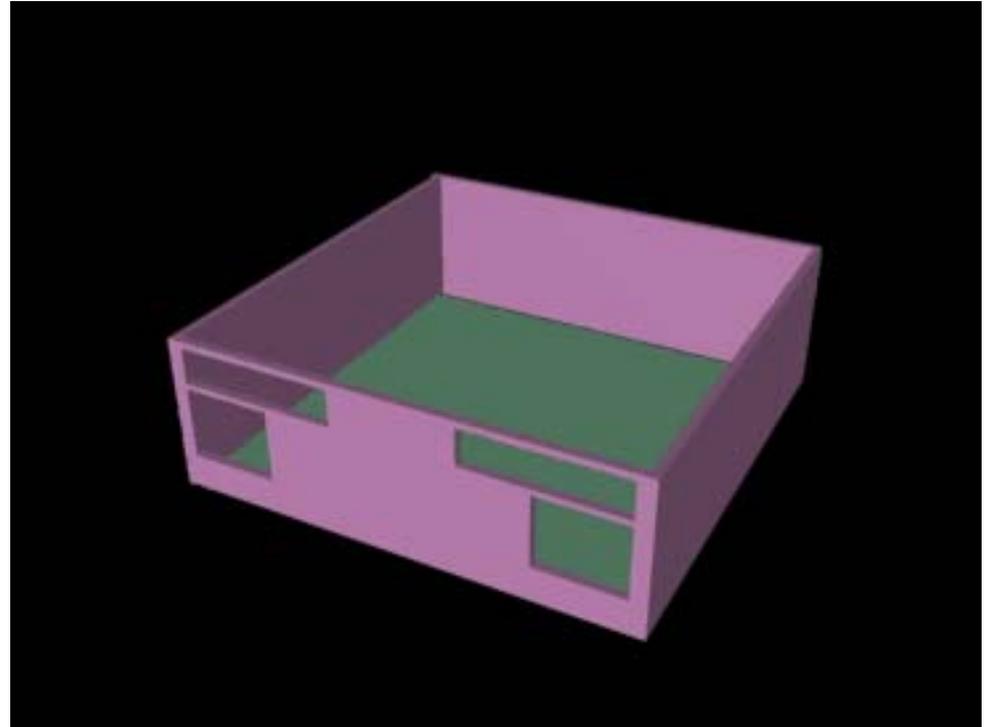
- Skylights or clearstories should illuminate the classroom's back wall.
- Treat skylights like light fixtures - one big one is a very bad idea.





Electric Lighting

- Two or three rows of pendant-mounted electric lights are positioned parallel to the window wall.
- Design connected power at around 0.9 W/sf using state of the art technology.





Lighting Control

- Occupancy sensors shut off lights if room is unoccupied.
- Separate controls for each light based on daylighting availability.

