



# Healthy Schools Network, Inc.

## DAYLIGHTING

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### PROBLEM

Studies show that **poor or inappropriate lighting in schools can adversely affect children's health and their ability to learn.** Sunlight is the most important source of light and energy for humans. Its benefits can be gained through direct exposure outdoors, or skylights in buildings. People spend over 90% of their time indoors. Children spend up to 40 hours per week in school buildings, especially when they participate in after-school activities. Much of this time is spent under artificial lighting.

### SOLUTION

Studies conducted on schools have reported that the use of “**daylight**” or “**full-spectrum lighting**” is associated with healthier students.

### BENEFITS

- These studies reported that students had **fewer cavities, gained weight and grew in height** more than students in non-daylit classrooms.
- The students demonstrated **better work habits, improved academic performance**, resistance to fatigue, and more positive attitudes
- Studies also reported that schools had **greater energy efficiency, significant cost savings and reduced environmental impact.**

## DAYLIGHTING AND FULL-SPECTRUM LIGHTING DESIGN

“Daylighting” design uses skylights and appropriately placed windows to capture daylight in a room or building. “full-spectrum lighting” design uses full-spectrum florescent lamps (light bulbs) that are strategically placed to mimic daylight. These lighting options can be part of the design of a new building or can be incorporated into an existing building during renovation. Improved lighting in schools is part of a larger effort to promote “high performance” schools that provide a healthy and productive learning environment.

### CASE STUDIES

#### Johnson County, NC

A two-year study of six schools in Johnston County, North Carolina compared children attending schools with full-spectrum light with

children attending similar schools with conventional lighting conditions. The study found that children who were exposed to full-spectrum lighting became healthier over time.

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## Reported Results:

- **Health and Performance:** Students in full-spectrum light were healthier and attended school 3.2 to 3.8 days more per year. Because of the additional Vitamin D received by students in full-spectrum light, they had 9 times less dental decay and grew in height an average of 2.1 cm.
- **Behavior:** Full-spectrum light induced more positive moods in students. Libraries with superior light resulted in significantly lower noise levels.

## Wake County, NC

The Durant Middle School in Wake County Public School System is a particularly impressive example of one of the North Carolina Schools using daylighting. The school's goal was to design the best possible learning environment for its students and staff and to cut energy use and costs.

### Strategies:

- Floor plan with an east-west axis, and south-facing windows; roof monitors and skylights for daylighting
- Light colors for surfaces and finishes, and light-levels appropriate for different tasks
- High efficiency T-8 fluorescent lamps
- Automatic dimming high-efficiency electronic fluorescent lamps; on/off photoelectric daylight sensors
- Overhangs and interior baffles to shield direct sunlight while using daylighting.

### Reported Results:

- **Health and Performance:** Natural lighting had a positive effect on students' attitudes and performance. Students tended to be more attentive and displayed lower levels of hyperactivity in the classroom. Durant school has the highest attendance rate out of the 94 schools in the county.

- **Energy Efficiency:** A recently completed conventionally designed middle school of comparable size and construction to Durant had a typical energy load of approximately 77,000 Btu/ft<sup>2</sup>/yr, whereas Durant Middle School used only 35,000 Btu/ft<sup>2</sup>/yr, an overall reduction of more than one half.
- **Cost and Savings:** Although the extra professional time allocated to design and testing added an estimated \$115,000 to the total construction cost, the reduction in total energy use in Durant Middle School will yield a savings of \$165,000 per year; this savings could be used for educational materials.

## BRIGHT EXAMPLES:

Other studies have reported:

- **Capistrano School District in Orange County, CA** students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% faster on reading tests in one year than those with the least amount of daylighting.
- **The Poudre Schools District in Fort Collins, CO** found a 7% improvement in test scores in those classrooms that used daylighting and a 14% to 18% improvement for those students in the classrooms with the largest window areas.
- **In Seattle, WA** students in classrooms with the largest window area, or most daylight, were found to be testing 9% to 15% higher than those students in classrooms with the least window area.
- **The Bethune Elementary School in Rochester, NY** currently saves more than 119,000 Kw/hr annually in energy use. This reduction in lighting energy use corresponds to annual cost savings of about \$15,040. Using estimates developed by the US EPA, the reduction in lighting energy use from this school will result in lower annual emission of toxic chemicals and compounds that contribute to acid rain, global warming and smog.

## Harvesting Daylight: 1% Can Go a Long Way

Only a small percentage of natural daylight available outdoors needs to be harvested to serve our visual needs. Daylight intensity depends upon time of year, time of day and sky conditions (i.e., clear or overcast). A “footcandle” is the light emitted by a single candle across a square foot area. At noon on clear summer days the light’s intensity is equal to that of over 10,000 footcandles. If only 1% of that light were directed to areas exposed to sunny conditions within buildings, the lights intensity would be 100 footcandles. 100 foot-candles is two-times the minimum amount of light needed for reading, and three-times the minimum light needed to work at a computer in a typical classroom. In other words, appropriate light for a classroom might be 25 to 50 footcandles, depending upon the student activity.

Even in winter under totally overcast skies when the light’s brightness is similar to that of 1,000 foot-candles, a 1% harvest gives off light intensity of 10 footcandles in all directions. In practice, buildings can be designed to deliver 2% or more of the available daylight to most, if not all spaces. However, buildings should also be designed for proper sun and glare control. — *Bill Bobenhausen, FALA, CCS, CSI, Director, Sustainable Design, Steven Winter Associates, Inc., and Illuminating Engineering of North America, Lighting Handbook, 9th Edition, Chapter 10.*

## HELP LIGHT THE WAY IN YOUR COMMUNITY

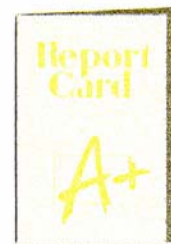
- If your school is considering *energy efficiency, undergoing a major renovation, or a new construction project*, tell your Board of Education, the Superintendent, School Facility Director, Building Principal, or school’s architect to use daylighting and full-spectrum lighting.
- The New York State Energy Research and Development Authority (NYSERDA) has technical design assistance and financial assistance for schools to help with lighting improvements. <http://www.nysERDA.ny.gov> or call 518-862-1090, *ext. 3271*. *Out of State Readers*: Call your own state or major metro area energy conservation office and ask if there are similar programs to help schools design, purchase and install better lighting.



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**Sources:**

- Hathaway, Warren E. Ph. D., *A study into the Effect of Types of Light on Children: A Case Daylight Robbery*, 1992.
- Nicklas, Michael H. and Gary B. Bailey. *Analysis of the Performance of Students in Daylit Schools*. Innovative Design, Raleigh, North Carolina.
- Healthy School Environment REPORT. IAQ Publications. Vol. 2, No. 3, March 1999.
- Thayer, Burke Miller. *A Daylit School in North Carolina. Watt Watchers of Texas, Natural Daylighting in Schools*.
- Pacific Gas and Electric Company (research conducted by the Heschong Mahone Group, Fair Oaks, CA), *Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human and Performance*, 1999.
- Reis, Michael, *Un-Glaringly Good Advice on Daylighting*, *Environmental Design and Construction*, July/August, 2000.
- Rensselaer Polytechnic Institute, School of Architecture, Lighting Research Center, Troy, NY, (518) 687-7174 or [www.lrc.rpi.edu](http://www.lrc.rpi.edu).

- Energy Center of Wisconsin, Daylighting Collaborative, (800) 864-6254 or [www.daylighting.org](http://www.daylighting.org).
- City of New York Department of Design and Construction, *High Performance Building Guidelines*, 1999.
- US Environmental Protection Agency, *Lighting Upgrade Technologies*, EPA 430-B-95-008, 1995 or see [www.us.epa.gov](http://www.us.epa.gov).
- US Dept. of Energy, energy *Smart Schools*, <http://energy.gov>

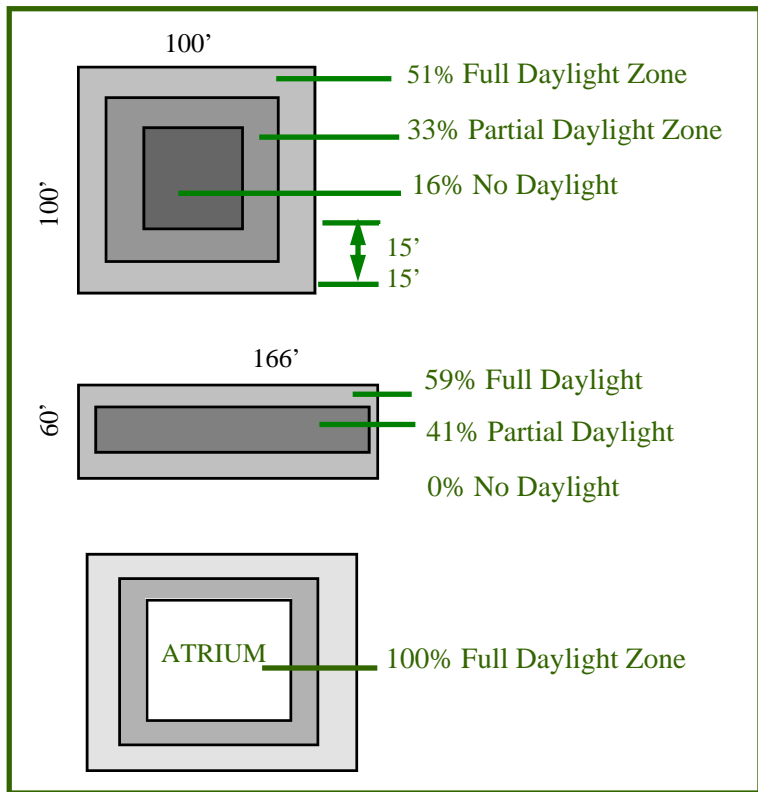
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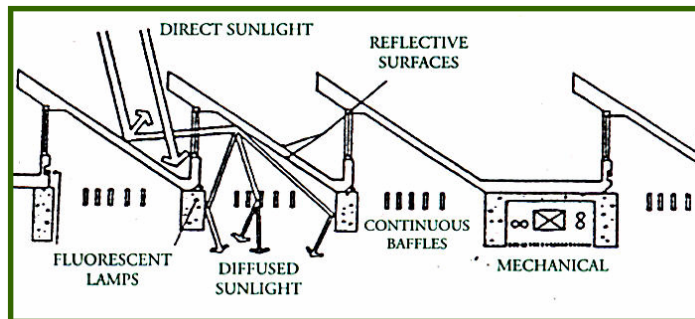
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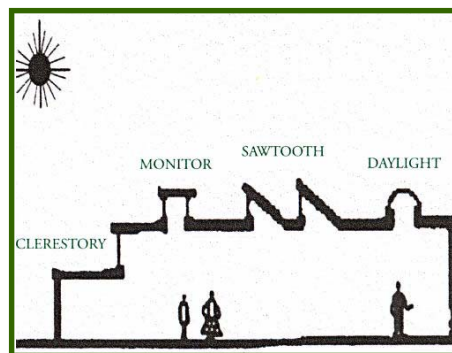
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The massing of a building can affect the portion of the floor area benefiting from natural light.



Section through a clerestory designed to admit evenly diffused sunlight into a work space.



There are many ways to bring daylight into a building including these overhead methods.