

## ILLUMINATING THE CLASSROOM ENVIRONMENT

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Lighting needs to be carefully addressed in new construction and modernization projects because controlled daylight and appropriate artificial illumination are critical to the quality of student performance.

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What can we do to help teachers teach and help students learn? One critical area that deserves the attention of educators, administrators, designers and maintenance teams is illumination. A term that describes aspects much broader than the standard overhead electric lighting system, illumination also includes direct natural light, indirect natural light, indirect artificial light and reflected light, as well as the control of all light sources.

There is a distinct and proven link between illumination and student achievement, as indicated in the National Clearinghouse for Education (NCEF) study, "Do School Facilities Affect Academic Outcomes?" NCEF's report states that, in terms of lighting, there are seven independent studies indicating that classroom lighting affects student performance. These reports also document that there are optimal lighting levels for learning, that appropriate lighting improves test scores and reduces poor behavior, and that daylight fosters higher student achievement. Clearly, correct illumination is a critical component of teaching and learning.

"Controlled illumination" is another critical component of the learning environment. Inadequate lighting controls can produce negative results, including glare, eye strain, fatigue, decreased attention span, increased body temperature and, consequently, poor student/teacher performance.

### Revisiting the Past

Before the use of electricity became widespread, school environments depended entirely on uncontrolled natural daylight as the only source of illumination. With the advent of electricity, lighting design moved away from natural light and classrooms came to depend primarily on electric lighting sources.

Window areas were then reduced to conserve energy, and classroom environments became disconnected from the outdoor environment and psychologically stifling. Today, the school design profession is moving forward in improving learning environments by moving backwards a little. We are reintroducing natural daylight, while providing illumination control features that produce optimum light levels.

Through the past few years, with the publication of breakthrough research documenting the impact of daylight on student performance, school districts and their architects and engineers have explored many beneficial and cost-efficient ways to bring natural light into buildings. Daylight is available, it's free and we now know how important it is to learning, but the challenge of optimizing light in the academic environment clearly requires careful planning and design.

Daylight is now promoted as an energy-saver and an amenity in the classroom environment. Incorporated effectively, daylight can yield a lighter electric load and reduce heating and cooling loads to some extent, and classrooms filled with sunlight and attractive views to the outside are typically more popular with students and teachers. But districts today are recognizing that the educational benefit far surpasses even these important attributes, necessitating the development of design strategies for new and modernized buildings that ensure an adequate amount of controlled daylight to enhance the instructional setting.

Recent studies in California, Washington, Colorado and North Carolina have all pointed to improved student test scores in facilities with higher levels of controlled daylight. Studies in Sweden and Canada have also noted improved student behavior and health, including fewer days of absence per year. The Canadian study pointed out that daylighting allowed for downsizing in heating, ventilating and air conditioning systems, which improved classroom noise levels — another plus for the learning environment.

## Controlled Daylight

When Heschong Mahone published its landmark report for Pacific Gas and Electric, “Daylighting in Schools,” in 1999, they were careful to note the importance of moderating daylight within classrooms. The report cites, for example, that “the relationship between daylight and human performance shows that students in a classroom that had a well designed adjustable skylight that diffused daylight throughout the room and reduced glare improved their learning faster than students in more traditional classrooms.”

It’s important for districts and their communities to recognize that it requires more than the addition of larger windows and a few skylights to adequately address daylight needs in schools. Early on, districts may need to commit to a slightly higher capital budget to allow for additional glass and design components. For example, ceiling configurations that include clerestory windows and pyramidal coffers, creating an even distribution of light within a room, may require additional detailing during the design phase.

The use of electric lighting controls and the potential for reduced electrical and HVAC operating costs through the long-term, however, may offset the increase in initial capital costs. More importantly, the investment in daylight may yield even greater benefit in terms of student performance through many years than the more traditionally accepted investments in technology and furnishings.

Students perform best in classrooms that feature uniform, diffused daylight. Daylight levels should be ample enough to reduce the initial number of fixtures in classrooms and enable electric lights to be turned off during the day, even on overcast days. Determining those optimal levels of light requires a meticulous review of building orientation and appropriate window configuration, and a recognition that classrooms need less light for evening use than in the daytime.

At the same time, designers need to assess options for use of high-performance glass, exterior shading devices and the latest in glazing systems, which allows districts to use expansive windows while minimizing heat loss in colder regions. Ideally, light levels in a classroom should reflect the characteristics of natural light, with subtle variations that keep the brain engaged and active. These variations in lighting may break with traditional engineering concepts, but they are vital ingredients in creating the optimum setting for learning.

## Lighting Basics

In the design of artificial illumination, the most important consideration should always be use of the space. Elementary school classrooms with potentially modest use of computers, for example, may be well served by the use of prismatic troffers, a standard classroom fixture that provides ample vertical illumination. Classrooms that accommodate extensive use of computers, especially at the higher grade levels, may be better served by parabolic troffers, which provide a higher level of light control and typically result in reduced glare.

Glare is also a factor with whiteboards and video monitors. Good lighting design takes into account the location of these components within the room, and their positions to avoid reflected glare from highly contrasting sources.

One attractive option for classrooms at all levels is the installation of fluorescent cove lighting around the perimeter of the room. This can make the space seem much brighter. Although the strip lighting itself is not expensive, it does require detailing that affects the construction budget. However, the perception of an all-around high level of illumination, rather than lighting that is primarily focused on desktops, can be a psychological plus for students and teachers working within the room.

Flexibility is always important in standard classroom lighting design. Many districts still opt for a multilevel switching system as a simple and cost-effective solution. Multilevel switching typically works with three series of lamps to create low, medium and high levels of illumination. The cost for fluorescent dimming systems, which provide the most flexibility in the integration of daylighting and electric lighting, is becoming more affordable.

Maintenance is also a critical factor in effective lighting. Maintenance staff should plan to perform group lamp replacements on a regular schedule. Even if lamps have not burned out, they often become very dim after lengthy periods. Just as windows work better clean, lamps need regular cleaning, as dirt and dust can minimize the output of illumination.

Many states have adopted the ASHRAE 90.1 2003 standards in terms of energy codes, which require a higher level of energy efficiency. One key area that the standards address is the use of automatic controls. At a minimum, schools should be incorporating occupancy sensors into areas such as corridors, restrooms and other public spaces. Ultimately, codes will require some sort of automatic lighting controls in classrooms and throughout the academic environment.

### Shedding Light on Classroom Design

Lighting has long been overlooked by administrators as a secondary consideration in school design — both in terms of budget and the focus that this aspect is given during the planning process. With studies now proving that, without question, both controlled daylight and appropriate artificial illumination are critical to the quality of student performance, lighting should be carefully addressed in new construction and modernization projects.