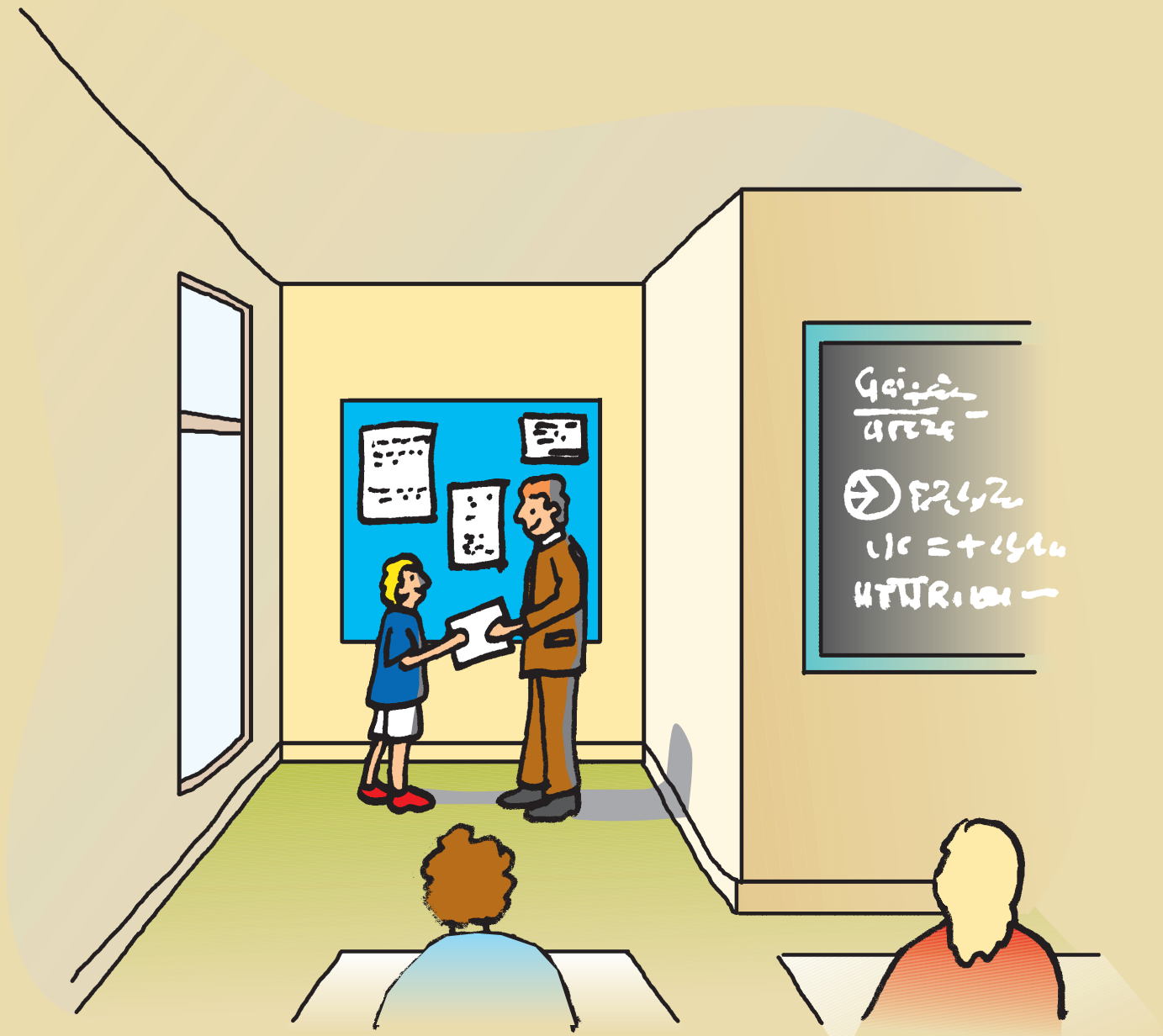


# Designing Quality Learning Spaces: Lighting

Developed by BRANZ Ltd  
for the Ministry of Education





## Editorial Note

This guideline for lighting is part of a series for boards of trustees, principals and teachers to help them understand the importance the internal environment plays in the design of quality learning spaces. It will also help boards of trustees brief consultants and tradespeople on their schools' requirements when planning new buildings, alterations or maintenance.

Other topics in the series include acoustics, ventilation and indoor air quality, heating and insulation, and interior design. The series is designed to help boards assess teaching spaces and includes practical steps to improve the quality of lighting.

The design of lighting systems is significant for two reasons: the large amount of energy school lighting can use and the profound effect lighting (both natural and artificial) can have on students.

Recent research shows good daylighting greatly improves student learning outcomes and is beneficial to the health of students and teachers.

Decisions on lighting should take into account the life, replacement costs and running costs of equipment and the benefits of well-designed lighting to the health, wellbeing and performance of students and teachers, as well as the overall costs of the system.

## Glossary of Terms used for Lighting

<b>Borrowed light</b>	a window to an internal room that 'borrows' light or view through an adjacent room
<b>Clerestory window</b>	a window high up in a room – often at a change in roof level
<b>Daylight factor</b>	the ratio of light received at a horizontal plane indoors compared to that received on an unobstructed plane outside
<b>Direct glare</b>	glare caused when overly bright parts of the visual field (eg, unshielded lamps) are seen directly
<b>Disability glare</b>	glare that makes it difficult to see detail without causing discomfort
<b>Discomfort glare</b>	glare that causes discomfort without necessarily preventing the ability to see detail
<b>Glare</b>	discomfort or impairment of vision caused by overly bright parts of the visual field contrasted with the general surroundings
<b>Glare index</b>	a numerical index which enables the discomfort glare from lighting to be ranked in order of severity
<b>Illuminance</b>	the level of light – the luminous flux density at a surface
<b>Luminaire</b>	the accepted term for a light fitting
<b>Maintenance illuminance</b>	the lowest value of average illuminance over the task area which should apply at any time during the life of a lighting system

<b>Reflectance</b>	the ratio of light reflected from a surface compared to the light falling on it
<b>Roof-light</b>	a purpose-built window built into the roof
<b>Task lighting</b>	a luminaire that provides a high level of localised light for a visually demanding task
<b>Ultra violet (UV)</b>	an invisible component of sunlight which can cause damage to the skin and eyes
<b>Veiling reflections</b>	reflections of bright objects, usually on a computer screen, which make it difficult to read
<b>Working plane</b>	the height at which a visual task is carried out – for classrooms this is between 600 and 800 mm above the floor

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# > SECTION 1

## – Lighting in Schools

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## Overview

### What teachers and students think

In a survey commissioned by the Ministry of Education the quality of light was, from teachers' perspectives, one of the top three most important factors in classroom design.

Students rated being able to see the board clearly as important as being able to hear the teacher easily. They also rated having natural light at the same level.

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***“The best classroom in our school is room 10. I like it because at one side of the classroom are huge windows which let in a lot of natural light, and you can see all the peacefulness around you, which makes me feel comfortable.”***

**Year 6 female**

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Students and teachers prefer natural lighting over artificial. They also actively dislike fluorescent lighting because of glare and flicker, although teachers acknowledge artificial light enables them to have lighting control<sup>1</sup>. Teachers feel that having adequate ways to control light within the classroom is critical, particularly:

- having separate lighting for whiteboards
- the ability to darken the room for projection, especially in secondary schools
- having task lighting in specialised teaching areas
- eliminating glare.

The main aims of daylighting are:

- functional – so tasks can be carried out:
  - accurately
  - comfortably
  - safely
- amenity – to provide a pleasant, stimulating environment.

There are several benefits of good daylighting in schools including:

- energy savings
- improved teaching and learning performance
- better quality light
- health and wellbeing.

### Defining quality lighting

Natural daylighting should always be the main source of lighting in schools, supplemented by electric light when light fades later in the day or during overcast weather.



### Energy savings

Good daylighting can save electricity as long as electric lights are turned off or dimmed when natural light is adequate. Much of a school's energy budget is for lighting. This can be greatly reduced with well-designed natural lighting provided it is designed to avoid overheating through solar gain and has automatic controls so the lights are off when not needed.

### Lighting and learning outcomes

Research in the USA has linked daylighting in classrooms to a 20% improvement in student performance<sup>2</sup>. Similar research is being carried out in New Zealand<sup>3</sup>. Good natural light helps to create a sense of physical and mental comfort, and its benefits seem to be more far-reaching than merely being a source of light. This may be owing in part to the softer, more diffused, quality of natural light and its subtle changing value and colour which electric lighting does not have. Daylight provides a high quality of light for most visual tasks and is more accurate for viewing colours.

### Health and wellbeing

Lively and pleasant interiors sometimes have a quality that is difficult to define, but which is usually owing to careful use of light. Interior environments with good lighting design help to promote the wellbeing of students and teachers. Good natural lighting not only plays a major role in learning outcomes, but can also have an impact on health and attendance rates<sup>4</sup>.

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**Natural daylighting should always be the main source of lighting in schools, supplemented by electric light when light fades.**

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## > SECTION 2

### – Understanding Daylighting

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## The level of light

The accurate calculation of illuminance (the level of light) is a specialised skill. This section does not attempt to explain this science, but gives a basic background of the principles involved.

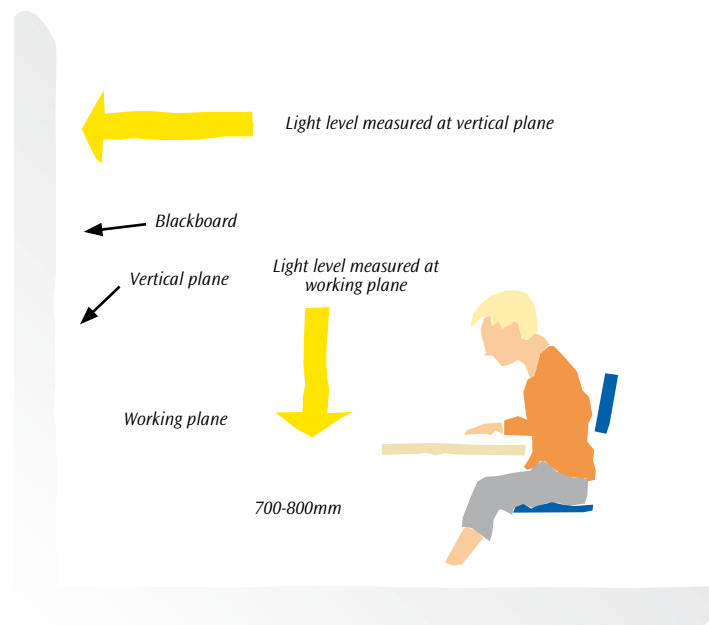
Illuminance is the luminous flux density at a surface expressed as lumens per square metre ( $\text{lm}/\text{m}^2$ ) or lux. The light of the full moon may give approximately 0.1 lux and a bright daytime sky 30,000 lux.

For classrooms, suitable illumination levels are between 300 to 500 lux at the working plane.

Good illumination is most important at desktop height.

Illumination levels for most school spaces are assessed at a working plane about 800 mm above floor (700 mm for desks and 850 mm for benches – Figure 1).

FIGURE 1 Light is measured at the appropriate plane



## Daylight factor

- Outside daylight levels vary over a large range, even on a cloudy day. Our eyes quickly accommodate these changes – we can read by candlelight or in sunlight (which is 20,000 times brighter).
- What we perceive is the contrast between internal and external light levels. For this reason, indoor daylight is measured as a percentage of outdoor levels.
- The amount of daylight available to light a room is expressed as a ratio between it and the illuminance present in the sky called the 'daylight factor'.
- Data of outdoor illuminance from measurements taken throughout New Zealand is used as the basis for daylight factor calculations<sup>5</sup>.
- Calculating daylight factors is laborious, except by computer, so it's a job for experts.
- A space is considered well lit if the average daylight factor is 4-5% dependent on the level of sky illumination (at least 300 lux).
- With 25,000 lux outdoors on a bright cloudy day, a 2% daylight factor indoors would give 500 lux at that point.

### How does daylight work for classrooms?

The daylight factor, which is the percentage of the illuminance outdoors received at a point indoors, has three components (Figure 2):

- the *sky component* received directly from the brightness of the sky
- the *externally reflected component* received by reflection from external surfaces
- the *internally reflected component*.

### Sky component

Being able to see part of the sky is important for classroom occupants. Those who are in a part of a room without a sky view tend to think the natural light they are getting is unsatisfactory. Extra electric light may be needed to overcome this (Figure 3).

### Externally reflected component

Light reflected from external surfaces forms a great proportion of the light available inside a room, especially if a large portion of the sky is obstructed by nearby buildings. The reflected light component will be higher if the obstructing building is light coloured.

FIGURE 2 The main components of daylight

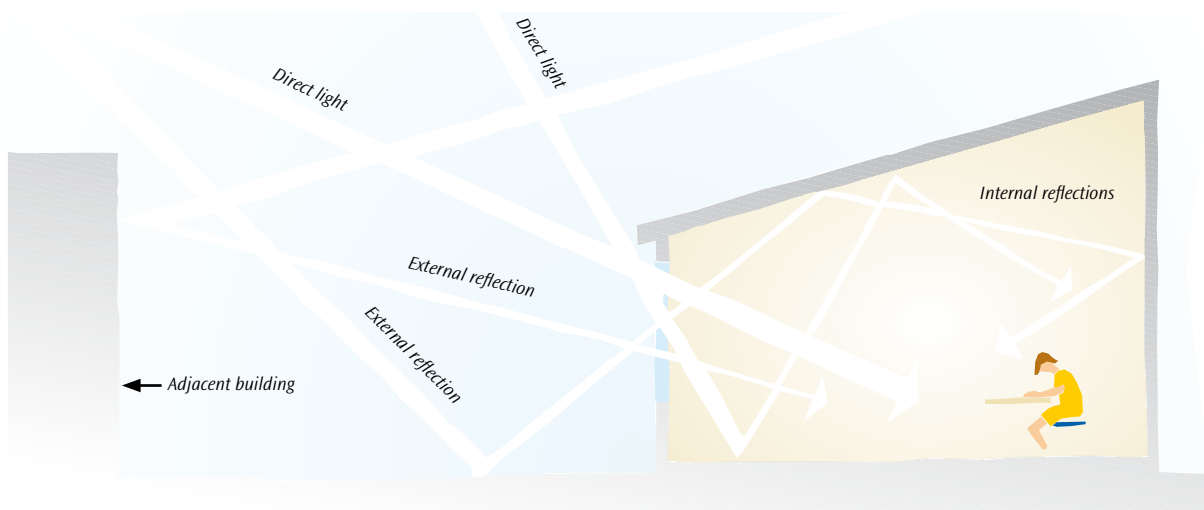


FIGURE 3 The no-sky factor



## Internally reflected component

Light reflected by the ceiling, walls and floor helps to spread daylight to the darker areas of a room which are furthest away from a light source. Using surfaces with more reflectance (lighter coloured) can greatly improve lighting efficiency (Figures 4 and 5). A lighter coloured room also provides better daylight distribution, improves brightness ratios and is visually more comfortable.

Dark coloured pinboards or fabric wall coverings can reduce internal daylight levels because they absorb light.

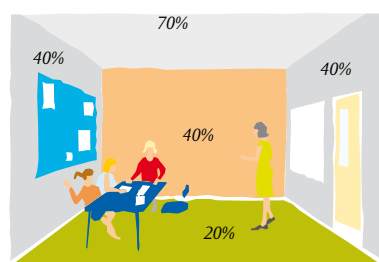
## Room shape

Daylight illumination weakens with distance from the opening so that the parts of the room furthest from the window are the most dimly lit. The deeper the room, the poorer the uniformity of daylighting, and people furthest from the window wall will feel the need for supplementary electric lighting (Figure 6).

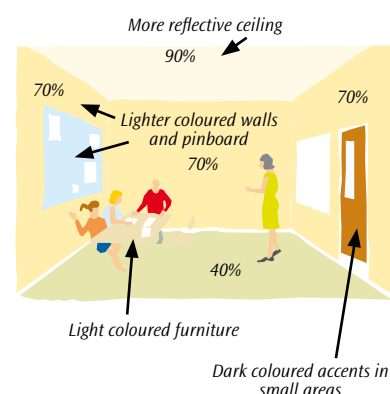
Rooms will have more satisfactory daylight if:

- the depth is no greater than the width
- the depth does not exceed twice the height of the window head
- the surface of the back wall is light coloured (Figure 7).

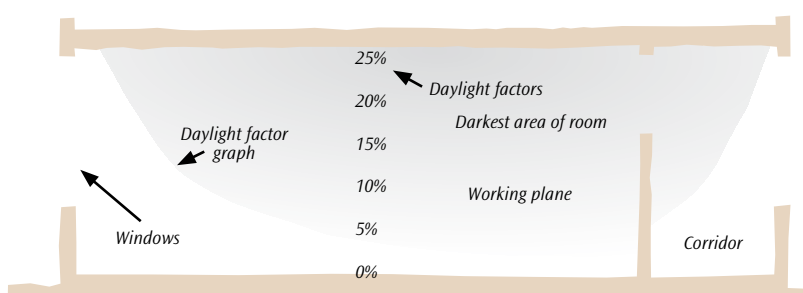
**FIGURE 4** Room with darker coloured surfaces which reflect less light



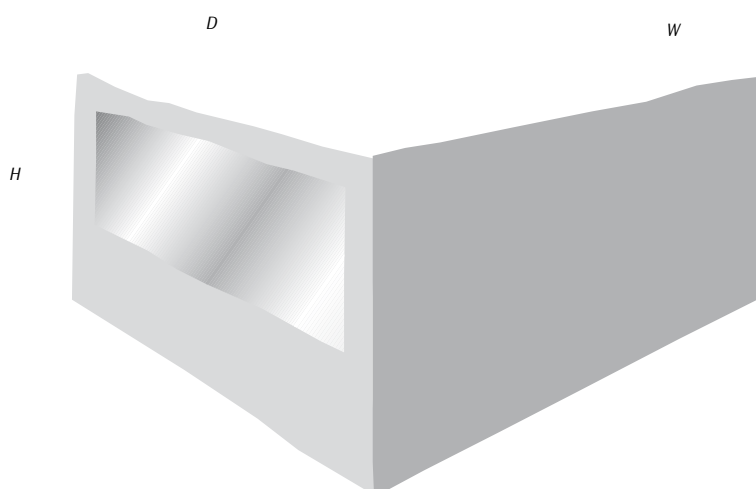
**FIGURE 5** Lighter coloured surfaces improve lighting efficiency



**FIGURE 6** Diagram showing typical daylight factor curve in classroom



**FIGURE 7** Limiting the depth of the room



- Depth should not be much greater than width
- Depth should not be much greater than height x 2
- The interior surfaces should be light coloured

**Dark coloured pinboards absorb light and coverings can reduce internal daylight.**

## > SECTION 3

### – Good Daylight

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The main principles to follow for daylighting for classrooms are:

- avoid direct sunlight
- avoid over-glazing which can create excessive solar heat gain in summer and major heat loss in winter
- ensure light sources are balanced to give even but interesting lighting
- provide windows with a view
- eliminate glare
- give users control when needed.

### Avoiding direct sunlight

Direct sunlight is an extremely strong source of light and heat. It has no place in classroom daylighting design and should be avoided because it can cause:

- visual discomfort
- solar heat gain that can cause thermal discomfort
- glare
- deterioration and fading of carpets, fabrics and equipment because of its high UV light content.

Practical methods of excluding direct sunlight include:

- correct window orientation
- fixed solid overhang for shading
- overhead sunshades
- horizontal or vertical louvres, depending on orientation
- landscaping
- interior blinds.

See *Designing Quality Learning Spaces – Heating and Insulation* in this series.

### Avoiding over-glazing

For new buildings careful expert design for daylighting will ensure windows are the right size and in the right place. The amount of light and heat can be controlled by:

- methods described above for excluding direct sunlight
- correct window placement
- correct window size
- solar control glass
- solar films or coatings.

See *Designing Quality Learning Spaces – Heating and Insulation* in this series.

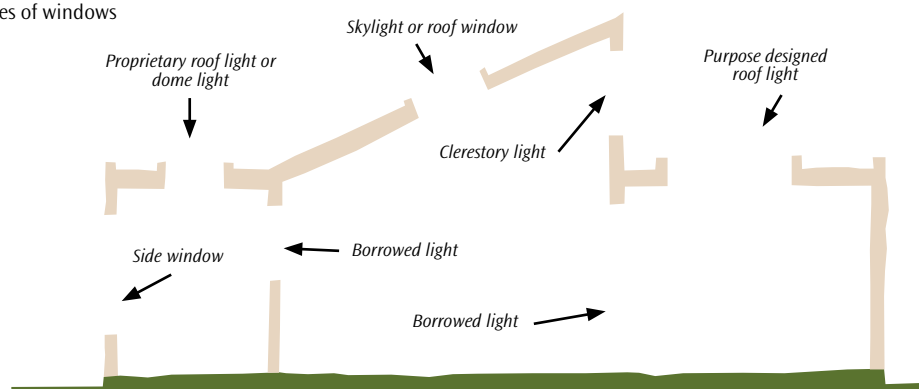
### Even balanced natural light

Ways to ensure even daylighting include careful placement and proportion of sidelight windows supplemented by:

- top-lighting using roof lights
- additional windows on opposite sides of the room
- clerestory windows
- borrowed lights
- light shelves
- a combination of these.

Because daylight illumination falls off with distance from the windows, adding clerestories, roof lights or borrowed lights (Figure 8) can improve the level and distribution of daylight. Additional sources of natural light also enhance and enliven the room.

**FIGURE 8** Types of windows



**Evenly diffused daylighting (through windows) will provide the most energy savings and the best visual quality.**

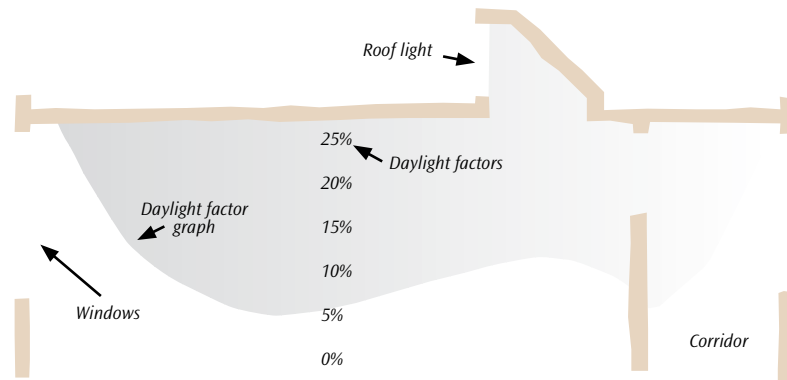
## Roof lights

Roof lights:

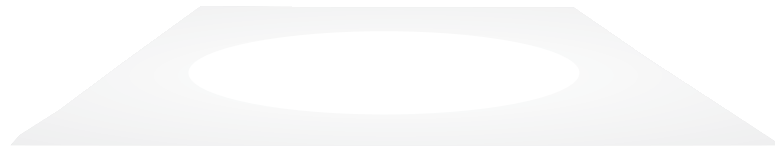
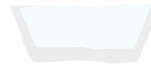
- admit light from the brightest part of the sky
- can provide a more even distribution of additional light across a space
- allow you to see the sky
- need careful design to avoid glare
- need careful design if black out is required
- require careful design to avoid direct sunlight and solar heat gain
- need regular cleaning and maintenance (see page 17)
- need careful design to prevent accidents with maintenance workers or students accessing the roof.

Figure 9 shows how adding roof lights can improve the level and distribution of natural lighting. Figures 10 and 11 show the lighting distribution effects of roof lights.

**FIGURE 9** Diagram showing improvement in daylight at the back of the room with the addition of a roof light



**FIGURE 10** Roof light concentrates light on the horizontal plane



**FIGURE 11** Roof light adjacent to a wall highlights that wall





## Additional sidelight windows

Lighting from supplementary sidelight windows, especially on the opposite wall to the main source of light, can greatly improve the quality and distribution of light. They can also look good from the outside. Figures 12, 13, 14 and 15 show the lighting effect of various types of windows.

## Clerestory windows

The advantages of clerestory windows are they:

- are high up and so let in light from a bright part of the sky
- are unlikely to be obstructed by trees or other buildings
- can provide light to the darker part of a room
- give you some idea of what it's like outside
- can provide extra ventilation (see *Designing Quality Learning Spaces – Ventilation and Indoor Air Quality* in this series).

However, they:

- need careful design to avoid glare
- can be difficult to black out
- may require shading to avoid direct sunlight and solar heat gain.

FIGURE 12 Wide distribution



FIGURE 13 Deep distribution

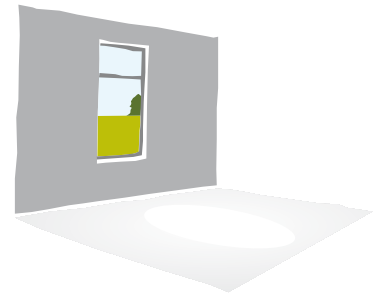


FIGURE 14 Wide distribution away from the window

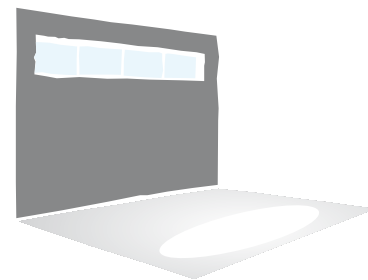
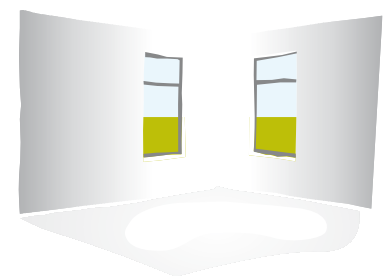


FIGURE 15 Corner windows also light the walls and reduce contrast



## Borrowed lights

Windows between interior spaces can:

- allow you to see between spaces
- improve lighting levels where light is borrowed from a well-lit space eg, a top-lit corridor or an atrium
- provide a pathway for sound to travel between rooms (see *Designing Quality Learning Spaces – Acoustics* in this series).

The supplementary light contribution of most borrowed lights is quite small. However, internal windows low down can add visual interest and serve a useful administrative purpose of seeing where people are.

## Windows with a view

It is essential that people can see out of the buildings they spend much of their day in. Windows with a view allow us to keep in touch with changing weather and the time of day – this avoids a feeling of being shut in. A view allows us to break from close work, this is important for students and teachers especially when working on computer or doing fine art, and can be good for relaxation and learning.

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**Windows with a view  
keep us in touch with  
changing weather  
and we don't feel  
shut in.**

---

With traditional windows (Figure 16) in the long wall of a classroom care must be taken to:

- position the sill at a suitable height
- exclude direct sunlight to avoid unwanted solar heat gain (see *Designing Quality Learning Spaces – Heating and Insulation*)
- ensure satisfactory ventilation.

### Light shelves

A light shelf is a single large horizontal louvre which cuts out direct sun and reflects light from its top surface deeper into the room, improving light distribution. Light shelves are suitable for north-facing windows in rooms with high ceilings. Ideally, a light shelf should project through the window plane so there is a small clerestory window above. The top surface of the shelf should have a high light reflectance and be kept clean and clear (Figure 17).

Light shelves are suitable for new buildings, but can be installed as part of a major refit.

### Glare elimination

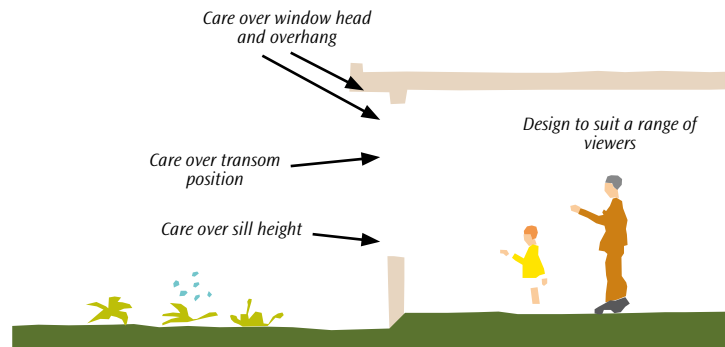
Glare is caused by overly high light contrast. Some variance in lighting intensity provides interest, but too much contrast can create:

- disability glare – where the contrast is so strong it reduces the ability of students to work
- discomfort glare – which causes distraction.

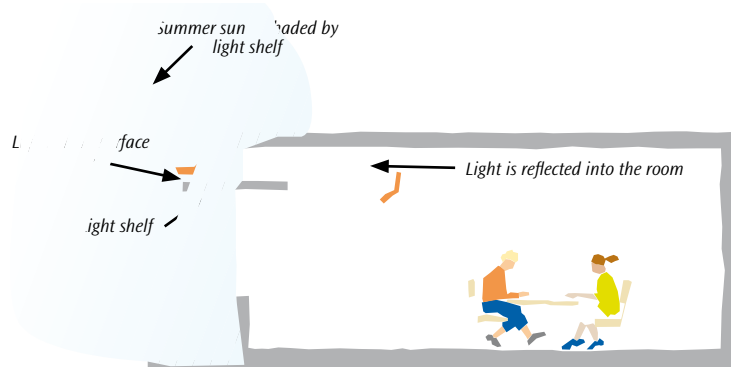
Typical situations to avoid include where:

- direct sunlight falls on or near task areas

**FIGURE 16** Care with window design



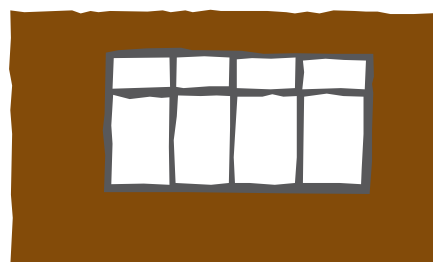
**FIGURE 17** A light shelf helps to spread light evenly into the room



- there is high contrast between windows and the window frame or adjacent walls (Figure 18)
- sky can be seen through roof lights at a viewing angle of less than about 35° (Figure 19 over)
- there is a large window at the end of a long narrow room, particularly a corridor (Figures 20 and 20A over)
- light strikes a reflective surface eg, a whiteboard
- light reflects on a computer screen.

A light coloured surface outside, such as concrete paving, can lead to glare entering windows. Consider planting or low-level screens to modify this.

**FIGURE 18** A dark wall and dark window frames can create glare



## Window light transmittance

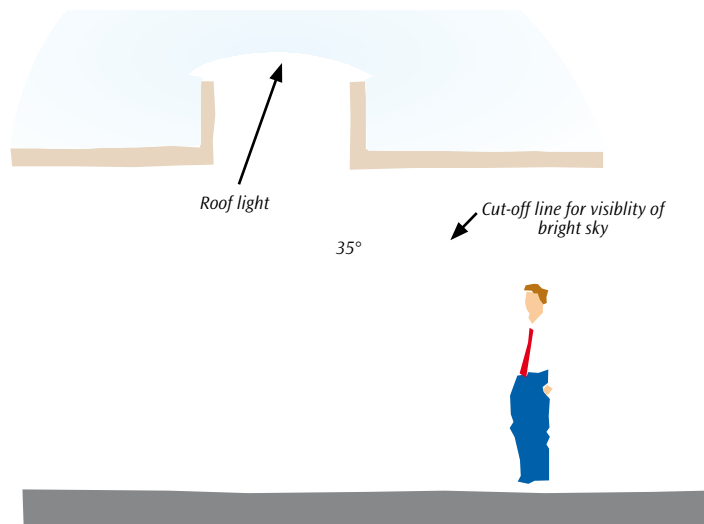
Different types of glass transmit a different proportion of the available light. Glass used to limit heat gain or provide insulation will also transmit less light.

Sometimes it is better, and costs less, to use clear glass in a smaller window that will transmit the same amount of light as tinted or reflective glass in a larger window.

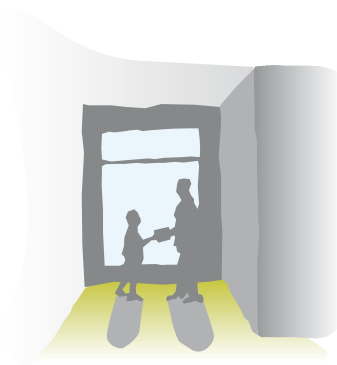
Table 1 shows the transmittance and insulation values of some types of glass (see also *Designing Quality Learning Spaces – Heating and Insulation*).

## Windows should be cleaned regularly.

**FIGURE 19** Roof light glazing should not be visible below a 35° cut-off line to avoid glare



**FIGURE 20** A large end window in a narrow room or corridor creates glare and confusing reflections



**FIGURE 20A** Side lighting of long narrow rooms reduces glare



**TABLE 1: LIGHT TRANSMITTANCE**

Type of glass	Light transmittance
No glazing	1.0
Single-glazing	0.87
Double-glazing	
• clear glass	0.75
• low-e glass	0.65
• tinted glass	0.30

Other factors affecting light transmission include:

- dirt
- things being stuck to the glass.

Windows should be regularly cleaned so the light can get in. This includes roof lights, which get dirty and grow lichen more easily than vertical windows, and can be forgotten.

## > SECTION 4

### – Achieving Good Daylight

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# How to improve daylighting in your school.

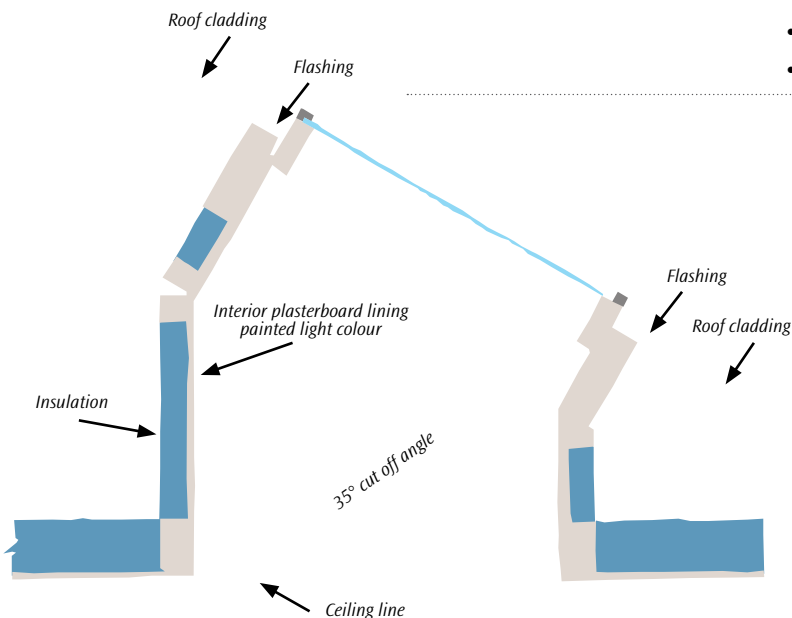
## Increasing daylight in classrooms

Where nearby buildings limit the visible sky – paint the wall facing the classroom a light reflective colour (see Figure 3)	<ul style="list-style-type: none"> <li>• effective way to increase reflected light</li> <li>• inexpensive</li> <li>• care is needed to avoid glare</li> </ul>
Paint the underside of overhangs a light reflective colour	<ul style="list-style-type: none"> <li>• moderately effective way to increase reflected light</li> <li>• inexpensive</li> </ul>
Paint the inside surfaces of the room with light reflective colours (see Table 2, page 21)	<ul style="list-style-type: none"> <li>• effective way to increase internally reflected light</li> <li>• inexpensive</li> </ul>
Have light-coloured flooring	
Avoid dark fabrics and pin up space	
Trim back vegetation outside the windows	<ul style="list-style-type: none"> <li>• effective way to increase reflected light</li> </ul>
Plant deciduous trees	<ul style="list-style-type: none"> <li>• inexpensive</li> <li>• will allow more light in winter when the leaves fall</li> </ul>
Install roof lights at the back of the room	<ul style="list-style-type: none"> <li>• only applies to single-storey buildings</li> <li>• can be retrofitted</li> <li>• very effective</li> <li>• expensive</li> </ul>
Install proprietary skylights	<ul style="list-style-type: none"> <li>• may be retrofitted into skillion roofs (Figure 21)</li> <li>• may be double-glazed</li> <li>• may be opened for ventilation operate manually or by remote control</li> <li>• may be fitted with blinds operated manually or by remote control</li> <li>• very effective</li> <li>• expensive</li> </ul>

**FIGURE 21** Proprietary type skylight

### OPTIONS FOR SKYLIGHT

- Opening
  - Manual
  - Remote Control
- Ventilated – with trickle vent
- Fixed
- Double-glazed
- Tinted glass
- Blinds
  - Venetian or rolled
  - Manual or remote control



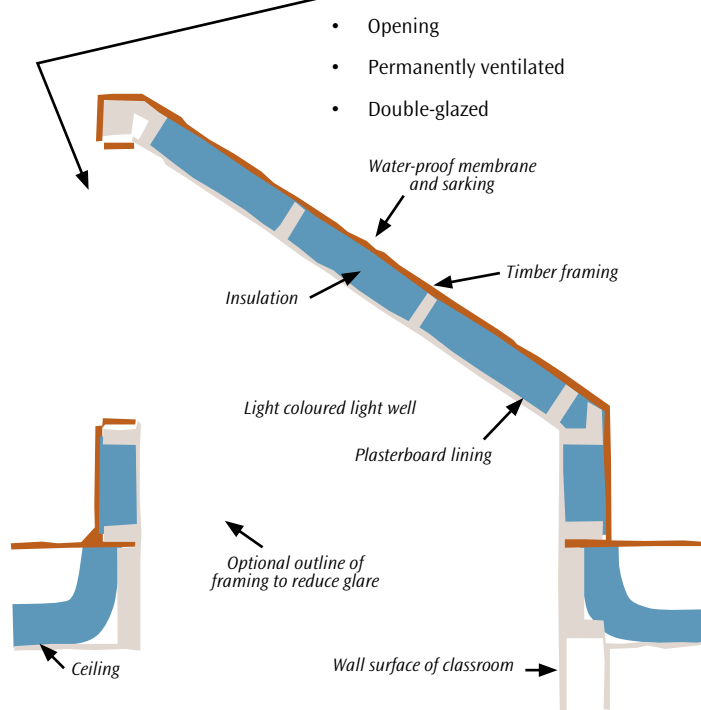
Install purpose-designed and built clerestory lights (Figure 22)

- more appropriate in new buildings
- many design options
- very effective
- expensive

**FIGURE 22** Purpose-designed clerestory light

**Clerestory light window may be:**

- Opening
- Permanently ventilated
- Double-glazed



Install proprietary tube lights (Figure 23)

- can be retrofitted in most situations
- effective
- some may also be used for ventilation
- lower-cost option for top-light

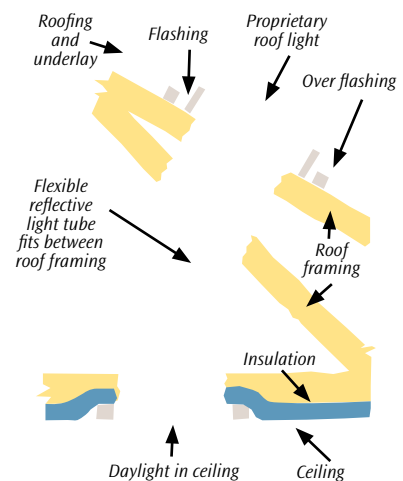
Install additional external side windows

- only possible if there is a suitable wall and outlook
- windows on the back wall will give the most effective supplementary light
- may give an additional view
- effective supplementary light, depending on the window placement
- may assist with natural ventilation (see *Designing Quality Learning Spaces – Ventilation and Indoor Air Quality*)
- expensive

Install internal borrowed lights to adjoining room or corridor

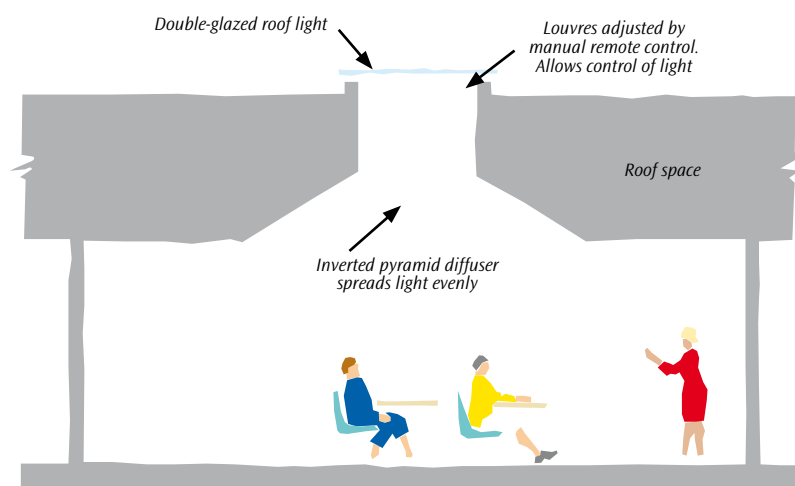
- moderately effective if the adjoining room is well lit
- low-level windows may let you see where people are

**FIGURE 23** Tube-type proprietary roof light



	<ul style="list-style-type: none"> <li>• may introduce acoustic problems (see <i>Designing Quality Learning Spaces – Acoustics</i> for details of suitable borrowed lights)</li> </ul>
In new buildings or major refurbishment, design for light shelves on north-facing windows (see Figure 17, Section 3)	<ul style="list-style-type: none"> <li>• distributes light more evenly into the room</li> <li>• provides shading to reduce direct sunlight</li> <li>• reduces glare</li> <li>• expensive</li> </ul>
Use innovative design (Figure 24)	<ul style="list-style-type: none"> <li>• very effective in new buildings</li> </ul>

**FIGURE 24** Innovative daylighting design in California. Capistrano School – see Case Study 2, the Collaborative for High Performance Schools (CHPS), Best Practices Manual Volume 1



**TABLE 2: APPROXIMATE REFLECTANCE OF VARIOUS SURFACE FINISHES**

	%
White gloss tiles	0.85
White semi-gloss paint on smooth plaster	0.8
Light grey paint	0.7
White acoustic ceiling tiles	0.7
Natural radiata pine plywood	0.55
Mid grey paint	0.45
Varnished pine plywood	0.45
Varnished pinus radiata boards	0.3
Varnished particleboard	0.25
Dark grey paint	0.15
Carpet	0.1 to 0.45
Quarry tiles	0.1
Black paint	0.05

### Preventing glare from daylighting

Avoid dark colours for walls and window frames against a bright window (see Figure 18, Section 3)	<ul style="list-style-type: none"> <li>• effective way to reduce contrast</li> <li>• repainting is inexpensive</li> </ul>
Avoid low-angled view of the sky through roof lights (see Figure 19, Section 3)	<ul style="list-style-type: none"> <li>• effective way of reducing glare</li> <li>• not expensive if part of the original design</li> </ul>
Avoid low-angled view of the sky through roof lights by fitting louvres or coffers which cut off a direct view of the sky	<ul style="list-style-type: none"> <li>• effective way of reducing glare</li> <li>• can be retrofitted</li> <li>• moderately expensive</li> <li>• may reduce daylight to some extent</li> </ul>
Avoid small windows on large walls – fit louvres or blinds to existing windows causing glare	<ul style="list-style-type: none"> <li>• inexpensive</li> </ul>
Avoid large windows on the short wall of a long narrow room – fit louvres or blinds to existing windows causing glare (Figure 20)	<ul style="list-style-type: none"> <li>• inexpensive</li> </ul>
Eliminate direct summer sunlight with louvres or blinds	<ul style="list-style-type: none"> <li>• see <i>Designing Quality Learning Spaces – Heating and Insulation</i></li> </ul>
Place whiteboards and blackboards where the reflection of windows or roof lights will not be seen	<ul style="list-style-type: none"> <li>• use a mirror to predict where glare will occur</li> </ul>
Provide outside planting or low-level screens if bright exterior surfaces cause glare problems inside	<ul style="list-style-type: none"> <li>• inexpensive</li> </ul>

### Ensuring quality daylighting and promoting wellbeing

Get expert assistance to ensure adequate daylight levels for various activities	<ul style="list-style-type: none"> <li>• an average daylight factor of 3 to 4% ensures good daylight for most tasks depending on the regional location</li> </ul>
Provide daylight from more than one source such as: <ul style="list-style-type: none"> <li>• side windows on more than one wall</li> <li>• roof lights</li> <li>• clerestories</li> <li>• borrowed lights</li> </ul>	<ul style="list-style-type: none"> <li>• a mixture of sources gives more even light and more visual interest</li> </ul>
Provide windows with a varied view	<ul style="list-style-type: none"> <li>• allows visual contact with the outside</li> <li>• provides a distant focus to rest eyes</li> </ul>





## > SECTION 5

### – Electric Lighting

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## Electric lighting design

The main aims of artificial lighting (as for daylighting) are:

- functional – so tasks can be carried out:
  - accurately
  - comfortably
  - safely
- amenity – to provide a pleasant, stimulating environment.

When daylight fades later in the day, on overcast days, or when additional lighting is needed for specific tasks, electric lighting supplements or takes over. This is a staged process.

To perform well and be cost-effective under changing circumstances, electric lighting design must be carefully integrated with daylighting design and be flexible. The installation must provide for:

- close work lighting – often supplementary to daylighting so specific tasks can be carried out accurately and comfortably
- combined lighting – daylighting complemented by artificial lighting where the daylighting is reduced eg, in deep rooms or as daylight fades
- full electric lighting – when daylight is insufficient eg, in the evening or at night.

## Electric lighting design should only be undertaken by an experienced lighting engineer.

### Artificial lighting quality

Basic electric lighting quality will depend on the:

- amount of light
- colour appearance of the light
- ability of the light to make colour look correct
- amount of glare.

### Amount of light

As lighting installations age and collect dirt they give less illuminance. To compensate, illuminance levels are specified as the minimum the installation is designed to give during its lifetime. This is called the 'maintenance illumination' and is expressed in lux.

**TABLE 3: LAMP COLOUR RENDERING GROUPS**

Group	Colour rendering index (Ra approx)	Typical applications
1A	90 and over	where high accuracy colour matching is necessary
1B	80-90	where accurate colour judgement is required
2	60-80	where moderate colour rendering is adequate

## Colour appearance and colour rendering

The colour of the light given out by different artificial light sources appears to have varying degrees of warmth or coolness. The colours (called the correlated colour temperature or CCT) needed for different functions are simplified into three groups:

- warm
- intermediate
- cold.

The ability of the light to make colour look correct (compared to daylight) is expressed as the colour rendering index (Ra). Lamps are arranged in groups according to their Ra. Table 3 shows those groups appropriate for use in teaching spaces.

## Glare

Glare causes visual discomfort when parts of the room are overly bright. Glare index is a numerical index which enables the discomfort glare from lighting installations to be ranked in order of severity. The maximum glare index can be given for lighting installations so they can be designed accordingly.

## Lighting requirements for schools

Table 4 quantifies the factors discussed above and is adapted from AS 1680.2.3: 1994.



**TABLE 4: SPECIFIC RECOMMENDATIONS FOR TEACHING SPACES**

Type of space	Maintenance illumination lux	Lamp appearance group	Lamp colour rendering group	Maximum glare index	Comments
Multi-purpose halls					
• general use	160	warm or intermediate	1B or 2	19	
• social use	80	warm or intermediate	1B or 2	19	
• examinations	240	warm or intermediate	1B or 2	19	
• theatre use					special requirements
General classrooms	240	warm or intermediate	1B or 2	19	
Workshops	240				with task lighting
Art rooms	400 to 800	warm or intermediate	1A	16	see <i>Specialist Teaching Spaces</i>
Laboratories	320	warm or intermediate	1A or 1B	19	
Music rooms	320	warm or intermediate	1B or 2	19	
Textile craft rooms	320	warm or intermediate	1B or 2	19	task lighting
Gyms	320	warm or intermediate	1B or 2	19	see <i>Specialist Teaching Spaces</i>
Libraries	240	warm or intermediate	1B or 2	19	see <i>Specialist Teaching Spaces</i>

## Even electric lighting

Most teaching spaces should have uniform illumination to eliminate deep shadows and strong contrasting patterns of light and dark. Students spend a lot of time working at their desks, which means constant change between the 'head up' and 'head down' positions. The eye needs to adjust rapidly for distance, angle and lighting. Avoiding strong contrasts reduces fatigue.

The lighting can still be in sympathy with the architecture and have features, such as wall washing lights (where the bulbs face the wall, thus 'washing' the wall with light, to add interest).

Using surfaces with a high reflectance will help with even light distribution. Suitable levels are:

- walls not less than 0.6
- ceilings not less than 0.7
- floor coverings with as high a reflectance as possible.

## Task lighting

A luminaire which illuminates only a limited area can be used to supplement background ambient light where:

- there is a task requiring close work
- increased illuminance is only needed over a small area
- strong directional lighting is required
- the general lighting is obstructed
- higher light levels are needed by a student with vision impairment

- there is a need to overcome reflections of bright objects causing problems in computer screens.

For maximum effect install lighting luminaires for close work which:

- are adjustable if needed
- have a heavy base or are clamped to the desk
- have compact fluorescent lamps which have:
  - a long life
  - low energy consumption
  - low heat output.

## Flicker

Older types of discharge lamps and fluorescent lamps sometimes develop a flicker which:

- causes discomfort and annoyance
- can be dangerous with rotating machinery in workshops.

The use of high frequency controls overcomes this problem by raising the oscillation rate to a non-perceivable high frequency.

## Selecting lamps

Fluorescent lamps are suitable to light all teaching spaces.

### Selecting lamps for teaching spaces

Use fluorescent lamps for general lighting (Type T8 or T5)

- long life
- high efficacy
- good colour rendering
- low installation costs
- can be dimmed

Fluorescent lamp Type T8

- good energy efficiency
- low-cost lamps and controls
- lower mercury content
- will run off standard or high frequency control gear

Fluorescent lamp Type T5

- more compact than T8
- highest efficacy
- will run off high frequency control gear (which is more expensive but recommended)

Use compact fluorescent lamps in task lighting luminaires and in place of tungsten lamps

- longer lasting
- lower energy use

## Selecting luminaires

Luminaires are the total light delivery unit including lamps, lamp holders, reflectors, diffusers and control gear. There are three basic types of luminaires suitable for general teaching spaces:

- recessed box (or trough) type – for use in suspended ceilings (Figure 25)
- surface mounted box type (Figure 26)
- suspended (pendant) type (Figure 27).

These are available with various types of diffusers, such as:

- prismatic – which scatters the light
- louvred – which shields and directs the light.

One of the critical factors affecting the choice of luminaire is the way light is distributed (how much is directed downwards, outwards and upwards).

The light distribution of luminaires may be:

- direct – all the light is directed down to the working plane as it is with recessed luminaires (Figure 28)
- semi-direct – some light is directed down and some is allowed to reflect off the ceiling and walls to light the working plane (Figure 29)
- indirect – all the light is reflected from walls and ceiling to the working plane (Figure 30).

Pendant luminaires are able to provide a good balance between direct and indirect lighting and are the most suitable for teaching spaces in general.

FIGURE 25 Recessed luminaire

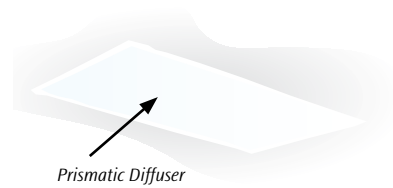


FIGURE 26 Surface mounted luminaire

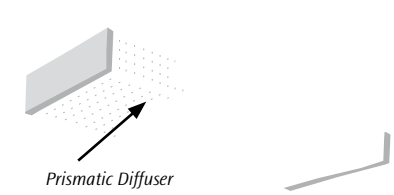


FIGURE 27 Pendant Luminaire

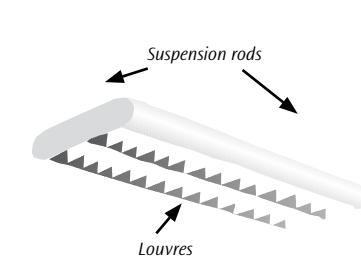


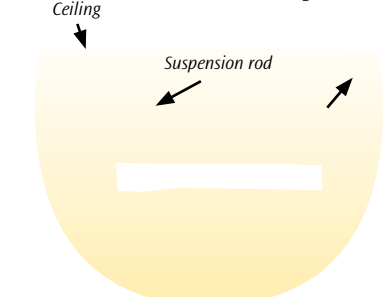
FIGURE 28 Recessed luminaire delivers directional light



FIGURE 29 Surface mounted luminaire can deliver direct/semi-indirect light



FIGURE 30 Pendant luminaire can deliver direct and indirect light



## Selecting luminaires for classroom lighting

### Recessed

- generally only suitable for suspended ceilings
- generally give direct light
- may be fitted with a range of diffusers
- may have a high degree of glare
- do not light the ceiling

### Surface mounted

- suitable for most ceilings
- may give direct light and some indirect light, depending on the design and type of diffuser used
- may throw some light on the ceiling
- glare is reduced by some indirect lighting

### Pendant

- suitable for most teaching spaces
- may give direct light and a high proportion of indirect light, depending on design
- can light the ceiling
- minimum glare and even spread of light

## Lighting controls

Controlling the level of electric lighting can make large power savings.

The simplest, cheapest type of control is manual switching. There is a tendency, though, for lights to be left on when they are not needed.

### Selecting lighting controls

Initiate a power-saving regime and educate all users	<ul style="list-style-type: none"> <li>• may only work for a short time</li> <li>• subject to misunderstanding and forgetfulness</li> </ul>
Switching lights in groups	<ul style="list-style-type: none"> <li>• allows lights to be turned off, or dimmed, in part of a room that has sufficient daylight</li> <li>• a bit more expensive to wire groups of lights to separate switches</li> </ul>
Manual control switches	<ul style="list-style-type: none"> <li>• education about saving power may lead to savings</li> <li>• lights are likely to be left on even when there is sufficient daylight</li> </ul>
Dimming – ability to reduce the light output from the system	<ul style="list-style-type: none"> <li>• allows illuminance level to be integrated with daylighting</li> <li>• dimmed lighting uses less power</li> <li>• useful to minimise glare in specialist rooms such as computer rooms</li> <li>• useful in audio visual presentation rooms</li> <li>• moderately expensive</li> </ul>
Occupancy sensors – turns off lights in unoccupied rooms	<ul style="list-style-type: none"> <li>• cost-effective</li> <li>• suitable for most general teaching spaces</li> <li>• should be coupled with manual switches to prevent activation when daylight is adequate</li> <li>• ultrasonic sensors are more sensitive, but more expensive, than infra-red</li> </ul>
Daylight sensor controls – automatically control lighting levels to integrate with available daylight	<ul style="list-style-type: none"> <li>• effective at controlling power use</li> <li>• expensive to install</li> <li>• unlikely to be cost-effective</li> </ul>

**Controlling electric lighting can make large power savings.**

## Maintenance

Levels of illuminance fall because of:

- the age of the lamps
- dirt build-up on lamps and luminaires
- dirt build-up on walls and ceilings.

Poor maintenance will reduce illuminance levels and waste energy. To ensure light levels are maintained and running costs are minimised:

- clean all luminaires at least once a year
- ensure the correct lamps are used – keep the number of types used to a minimum to reduce the chance of error
- have lighting levels checked annually by a lighting expert using a light meter
- change lamps as soon as they start to fail or lighting levels fall
- keep walls and ceiling clean and well painted.

### Safe disposal of used lamps

Mercury lighting is generally three to four times more efficient than non-mercury lamps. But even small amounts of mercury are an environmental hazard (as published by the Ministry for the Environment), and it is important used lamps are disposed of correctly.

The tubes should be removed by an approved operator before disposal in a land fill.

Lamps can be recycled by specialist companies that provide and collect storage bins and dispose of the mercury<sup>6</sup>.

## > SECTION 6

### – Classroom Lighting Layouts

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Here are three possible layouts for typical classrooms or similar teaching spaces. They are not to scale and not lighting designs. Lighting design should only be carried out by an experienced designer.

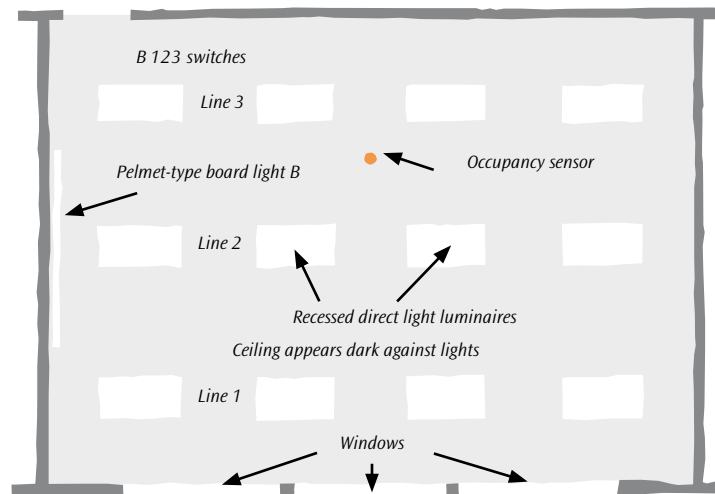
**Scheme A** (Figure 31) is an acceptable lighting installation because:

- the recessed lighting fixtures are arranged parallel to the windows to give good integration with daylight
- three rows of recessed directional luminaires will give a good spread of light at the working plane
- the rows of lights are switched separately so artificial lighting levels can be adjusted in zones to suit the level of daylight available
- the board is separately lit by a pelmet-type luminaire
- occupancy sensor with manual on-switches will save power.

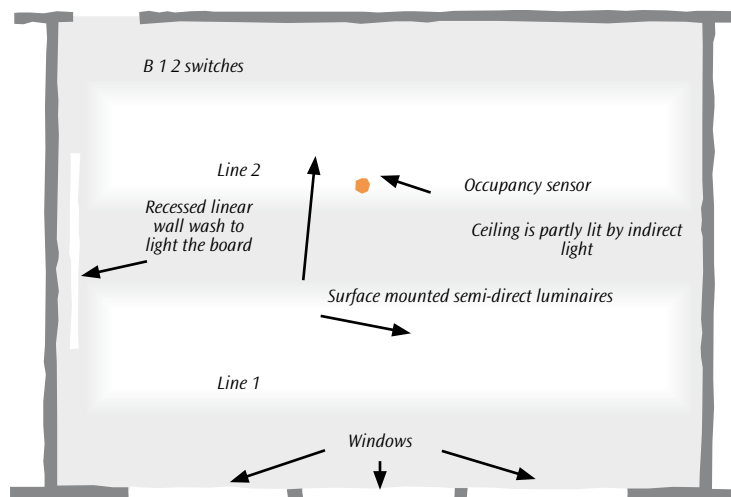
**Scheme B** (Figure 32) is a better lighting installation than Scheme A because:

- surface mounted semi-direct luminaires will give a wider, more even, spread of light
- wider distribution of light will throw some light on the ceiling and walls, reducing glare
- wider distribution of light allows the economy of two rows of fixtures
- continuous luminaires reduce contrast and improve light distribution
- the board is separately lit by a wall washer-type luminaire
- occupancy sensor with manual on-switches will save power.

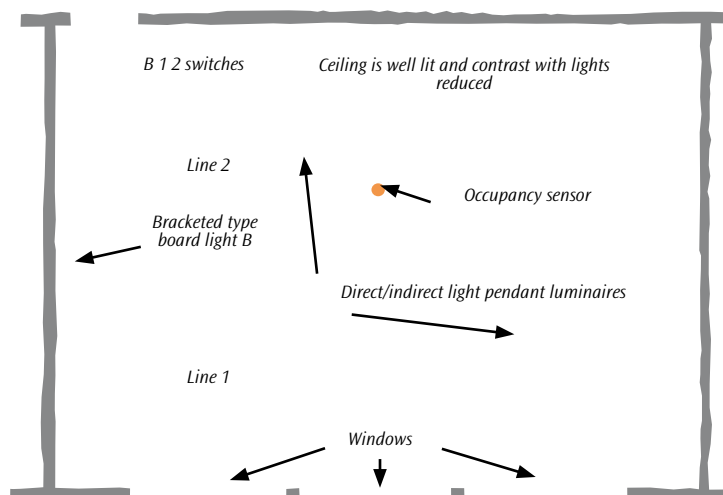
**FIGURE 31** Classroom lighting system Scheme A plan



**FIGURE 32** Classroom lighting system Scheme B plan



**FIGURE 33** Classroom lighting system Scheme C plan



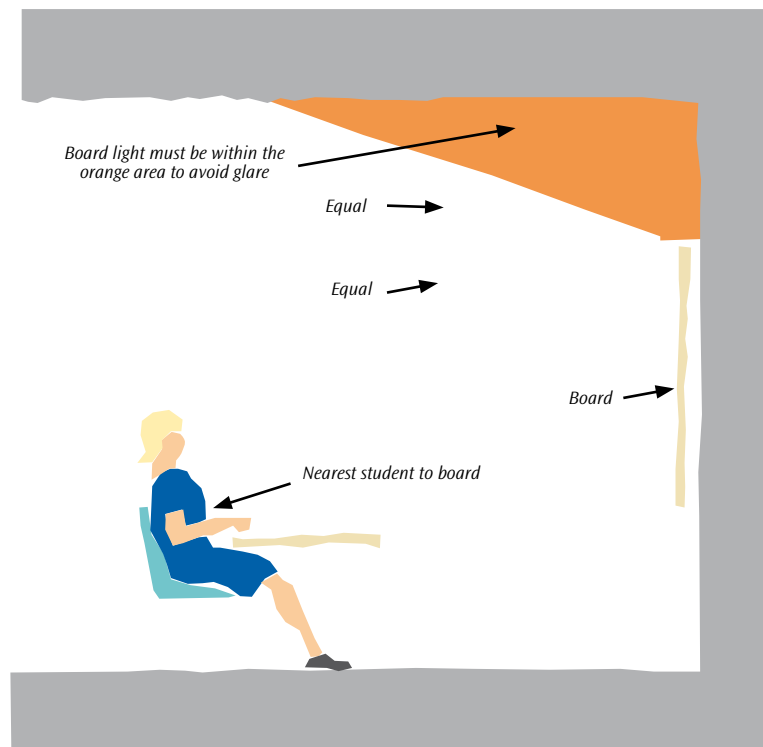


**Scheme C** (Figure 33, page 30) is better than Scheme B because:

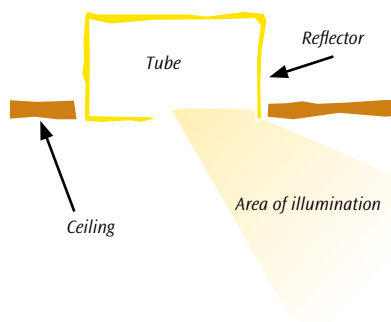
- indirect/direct pendant luminaires give a more comfortable, more even, spread of light
- the indirect light component lights the ceiling, reducing glare to a minimum
- the board is separately lit by a bracket-type luminaire
- it is the most cost-effective scheme
- occupancy sensor with manual on-switches will save power

Flexibility should be a key priority when considering lighting layouts. Planning should allow for future changes in teaching style and the continued development of support technologies such as computers and audio/visual equipment.

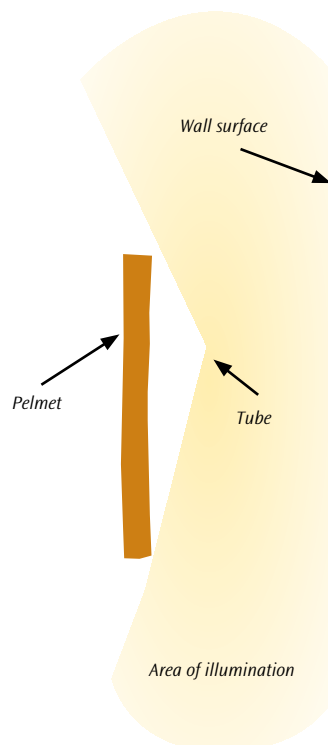
**FIGURE 34** Board lighting to avoid glare



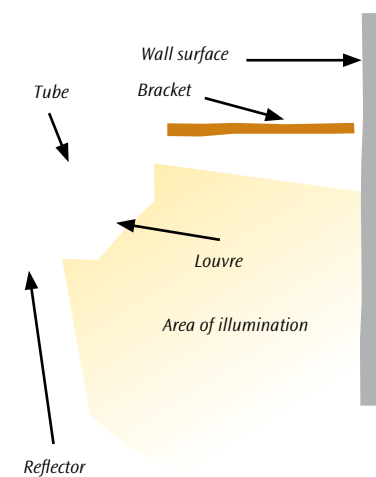
**FIGURE 35** Recessed linear wall-wash luminaire



**FIGURE 36** Pelmet-type wall-wash fixture



**FIGURE 37** Bracket-mounted board light



## > SECTION 7

### – Specialist Teaching Spaces

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## Specialist help

All areas in this section have special requirements and it is important to seek advice from an experienced lighting expert.

## Multi-purpose halls

Lighting requirements will depend on the activities in the room. Factors affecting the type of lighting used include:

- the high ceiling – spread of light and maintenance of luminaires becomes an issue
- need for black-out
- possible uses such as:
  - drama or dance
  - social events
  - meetings, assemblies or exams
  - gymnastics or games.

All or any combination of these possible uses needs a high degree of flexibility in the lighting design.

### Lighting multi-purpose halls

Good, even daylighting from windows and roof lights will suit functions such as: <ul style="list-style-type: none"> <li>• assemblies</li> <li>• examinations</li> <li>• gymnastics and games</li> </ul>	<ul style="list-style-type: none"> <li>• roof lights, if used, should be positioned and screened to avoid glare</li> <li>• if black-out is required blinds will be needed</li> </ul>
Fit remote operated black-out blinds to roof lights	<ul style="list-style-type: none"> <li>• needs careful design to be effective</li> <li>• expensive</li> </ul>
If the hall is to be used for drama, provide two independent lighting systems	<ul style="list-style-type: none"> <li>• gives increased flexibility</li> <li>• expensive but necessary</li> </ul>
Make the lighting dimmable	<ul style="list-style-type: none"> <li>• supports audio visual presentations</li> <li>• reduces power consumption when high levels of illuminance are not needed</li> </ul>
Switch luminaires in groups	<ul style="list-style-type: none"> <li>• allows more flexibility</li> <li>• reduces power consumption when only a part of the hall is in use</li> <li>• cost-effective</li> </ul>
Install theatrical lighting rails over and across the front of the stage area	<ul style="list-style-type: none"> <li>• will allow special lighting to be set up as needed</li> <li>• requires skilled advice</li> <li>• expensive</li> </ul>
For large halls with a complex set of functions, install a control desk from which all lighting and dimmers can be controlled	<ul style="list-style-type: none"> <li>• allows for coordinated productions</li> <li>• effective control</li> <li>• expensive</li> </ul>

## Gyms

Factors affecting the type of lighting used in gyms include:

- the high ceiling – spread of light and maintenance of luminaires becomes an issue
- many sports activities require the participants to often look up – avoid glare at high level either from daylight or luminaires
- surfaces (in particular the floor) tend to be reflective – avoid glare from the floor
- ball sports are robust – luminaires must resist damage or be protected
- the room may sometimes be used for other purposes eg, exams.

### Lighting gyms

In new buildings avoid daylighting from:

- roof lights that cause glare to players looking up
- windows causing reflections on the floor

High-level windows on the side walls are the most appropriate for daylighting

In existing buildings, install screening to windows and roof lights that cause distracting reflections

- design roof lights and windows to avoid glare

- see *Designing Quality Learning Spaces – Heating and Insulation*

Select long-life luminaires

- cost-effective
- reduces maintenance required high up

Select luminaires that:

- are robust with:
  - polycarbonate diffusers
  - wire protectors
- shuttlecocks cannot get caught on
- will not cause glare
- cast some indirect light onto the ceiling

- cost-effective

If the gym is to have other uses, provide supplementary lighting

- may be the only solution
- expensive option

Think about providing lockable controls for gym lighting

- avoids lights being left on

Install occupancy sensors

- saves power

## Libraries

Windows should be sufficient to provide background natural lighting and views. In libraries daylighting must be balanced with:

- wall space for shelving
- the need to protect books from damage by UV light.

Electric lighting must provide lighting for:

- the general ambient background
- book shelves
- students and librarians doing close work.

Also avoid glare and veiling reflections (bright reflections on computer screens).

### Lighting libraries

Shade windows (see <i>Designing Quality Learning Spaces – Heating and Insulation</i> )	<ul style="list-style-type: none"> <li>• to prevent UV damage to books</li> </ul>
General electric lighting similar to classrooms	<ul style="list-style-type: none"> <li>• economic</li> </ul>
Have special wall-wash type lighting for book shelves	<ul style="list-style-type: none"> <li>• it is important to light the books well</li> </ul>
If book shelving is moveable, attach lighting to the shelf unit	<ul style="list-style-type: none"> <li>• allows flexibility because the stacks can be moved without loss of good lighting</li> </ul>
Provide dimmable lights	<ul style="list-style-type: none"> <li>• cost-effective</li> <li>• supports audio visual presentations</li> <li>• allows flexibility to suit conditions</li> <li>• reduces power consumption when high levels of illuminance are not needed</li> </ul>
Provide desk lamps	<ul style="list-style-type: none"> <li>• lighting for close working areas</li> </ul>
Provide feature lighting at the check-out desk and at displays	<ul style="list-style-type: none"> <li>• provides interest, variety and a focal point</li> </ul>

## Music rooms

The requirements for general classroom lighting will be satisfactory for music rooms. Task lighting to music stands may be needed.

## Design, Art and Technology rooms

Art rooms need good directional daylighting and a high level of electric light luminance.

### Lighting art rooms

Provide good daylighting with: <ul style="list-style-type: none"> <li>• good controls to windows so variation can be achieved</li> <li>• some south lighting</li> </ul>	<ul style="list-style-type: none"> <li>• art subjects need a range of lighting intensity and direction</li> </ul>
Provide good artificial light with: <ul style="list-style-type: none"> <li>• a luminance of 400 – 800 lux</li> <li>• good colour rendering lamps</li> </ul>	<ul style="list-style-type: none"> <li>• level of lighting needed will vary with the type of work</li> <li>• good colour matching is needed for most art work</li> </ul>
Provide task lighting for demanding work	<ul style="list-style-type: none"> <li>• some of the higher levels of lighting can be provided locally</li> </ul>
Provide some feature lighting for displays	<ul style="list-style-type: none"> <li>• provides interest and variety</li> </ul>

Technology rooms need similar lighting levels as classrooms.

### Lighting technology rooms

Provide task-light lighting for close, demanding work with good colour rendering lamps

- some machines have built-in task lights
- safety consideration

Provide low voltage task lighting for machines

- safety consideration

Avoid dangerous stroboscopic effect with machinery by using high frequency control gear for the luminaires

- small cost increase
- high frequency controls avoid flicker
- safer

Provide some feature lighting for displays

- provides interest and variety

## Computers

Computers are either in:

- classrooms
- administration areas
- staffrooms
- specialised computer suites.

Computers are susceptible to reflections that reduce the contrast on the screen making it difficult to read. Avoid reflections from windows, luminaires and shiny surfaces.



### Lighting for computers

Shade windows to avoid direct sunlight entering the room (see *Designing Quality Learning Spaces – Heating and Insulation*)

- direct sunlight is a major cause of glare
- tinted glass or solar films will not effectively control glare from direct sunlight

Position computers (Figure 38) so that:

- they are parallel to the window wall
- they face a blank wall
- there are no windows behind the students

Use luminaires with louvre-type optical control

- to shield a direct view of the lamp

Use luminaires with a large up-lighting component (pendants)

- reduces contrast and gives more even light

Minimise veiling reflections by:

- reducing luminance (Figure 39)
- using matt surfaces and materials in the task area
- using the brightness and contrast buttons to best effect
- ensuring the background screen is a colour that provides contrast to the work on screen
- fitting dimmers so the luminance of the general background lighting can be reduced as needed

FIGURE 39 Avoiding veiling reflections

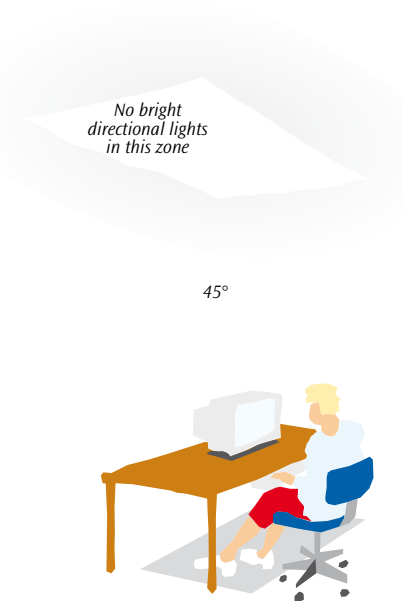
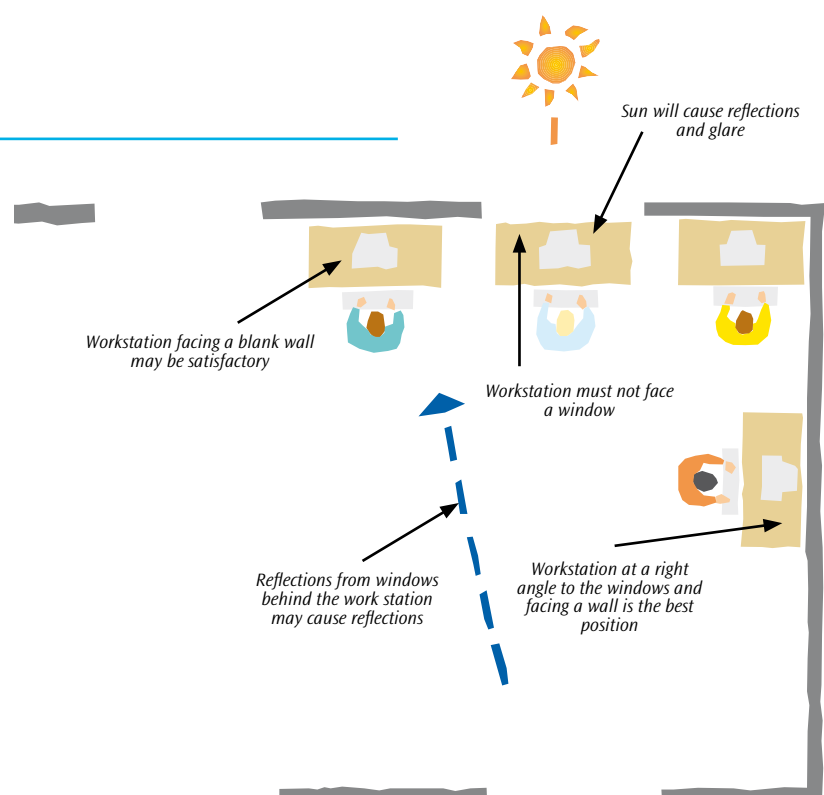


FIGURE 38 Placing of workstations for computers



## > SECTION 8

### – Students with Special Education Needs

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## Schools for all people

Schools should consider the needs of current and future students with a wide range of impairments including:

- hearing impairments
- visual impairments
- physical difficulties
- emotional and behavioural difficulties
- learning difficulties.

### Planning ahead

Making provision for students with special education needs must be an integral part of a school's policies and practices. This provision must be considered at all stages of planning and construction of new buildings and refurbishments. Schools should take account of both existing and future students likely to attend the school. Generally, planning and design which makes provision for students with disabilities benefits all students and teachers.

### Students with visual and hearing impairments

Visual impairments in students include:

- defects in the field of vision eg, tunnel vision where only the central part of the field can be seen – this can result in impaired mobility while the ability to read and do fine work may be unaffected

- loss of central vision, which does not affect mobility but makes detailed tasks such as reading very difficult
- blurring of vision (loss of acuity).

The lighting needs for students with visual impairments are complicated by individual reactions to the level and quality of light. Some students need increased illumination, but are more sensitive to glare. Others prefer reduced levels of general lighting.

Probably the best compromise is to be able to reduce general lighting levels locally and to provide supplementary task lighting as needed.

Lighting and colour must work in combination with each other. Over-bright illumination will wash out colour and for the vision impaired person reduce these to whites, greys and blacks. A well-designed lighting scheme should allow sufficient light to highlight colour differences.

Lighting in foyers and entrances also needs to take into account the increased adjustment time people with vision impairment need in moving from artificial indoor lighting to natural daylight.

### Lighting in teaching spaces for students with special education needs

Avoid:

- all aspects of glare
- strong lighting contrasts
- direct sunlight

Avoid highly reflective finishes

- reflections on walls, and particularly on floors, can be very confusing

Ensure signs, display areas and blackboards are well lit

Accommodate students in the part of the room that best suits their impairment and make adjustments to improve their comfort

Adjustments may include:

- special task lighting
- fitting blinds to nearby windows or roof lights causing glare
- shielding general lighting causing glare
- a suitably coloured work top

Position light switches and power outlets at a regular height throughout the school

- this helps people to find what they are looking for

Cold light is not suitable for many students with special education needs

- use lamps that give warm light

**Lighting can be important for both visual and hearing impaired students, eg, a teacher's face and hands need to be well lit so students with hearing impairments can get more from facial expressions.**

## > SECTION 9

- Planning New Buildings and Extensions
  - Statutory Requirements for Lighting
- 



## Ensuring good lighting

Where new buildings or substantial alterations or extensions are planned, an architect will be appointed. Principals and boards of trustees should be aware of important lighting factors and need to have a basic understanding of design processes.

For a good outcome it is vital that:

- boards of trustees realise:
  - lighting schools is not like lighting houses
  - designing to suit the regional climate is important
  - correct orientation of the building is a prime factor
  - natural lighting should be the main source of lighting in learning spaces
  - careful consideration of windows, skylights and eaves can help ensure comfortable conditions and reduce running costs
  - achieving comfortable learning/teaching conditions is a holistic process – ventilation, air quality, heating and lighting must all be considered
- teachers and educators understand that:
  - comfortable conditions in teaching spaces are important for health and general wellbeing
  - a comfortable environment is a good learning environment
- architects and designers understand the:
  - lighting needs of schools
  - specific climate of the site

- climatic, technical and practical elements of lighting
- importance of comfortable conditions for health and wellbeing
- holistic nature of ventilation, air quality, heating and lighting
- requirements of students with special education needs.

## Monitoring the design process

### Key principles

Principles that can be applied at the appropriate stages are set out in the Ministry of Education *Property Management Handbook*.

### At the initial assessment stage

Ensure a survey is carried out to establish:

- local climatic year-round conditions
- sun angles and shading for all times of the year.

Ensure the architect is fully briefed on the:

- statutory requirements New Zealand Building Code (NZBC)
- Ministry of Education requirements
- recommendations in this publication
- need for a computer model to show the energy requirements of the proposed design.

### At the design stage

Ask the architect:

- how the local climate affects lighting and how this has been taken into account in the design

- how the advantages of natural lighting will be projected to all parts of a room
- how views to outside will be maximised
- how direct sunlight, excessive solar heat gain and glare will be avoided
- how the room will be able to be blacked out and used for projection, data shows etc
- how the lighting levels are controllable by the teacher
- how students with special education needs have been catered for
- to explain the computer model of the energy requirements of the design
- to explain the life-cycle costing of the lighting system.

Answering these questions may involve some calculations and technical explanations which you are not expected to understand. The important point is to ensure the architect has:

- given sufficient thought to these issues
- designed accordingly
- provided specific information on how a good outcome will be achieved.

### At practical completion

Require the architect to:

- demonstrate by monitoring and recording that the design requirements and those questions outlined above have been met
- show that running costs are approximate to the design model.

### The New Zealand Building Code (NZBC)

Clause G7 *Natural Light* applies only to housing, homes for the elderly and early childhood education centres. The few requirements specified in the Acceptable Solution G7/AS1 are minimum and unlikely to meet the requirements for school classrooms. Clause G7 focuses on the importance of:

- being able to see part of the sky from the inside
- an outside view for visual contact with the outside
- light-coloured reflective interior surfaces.



### New Zealand Standard 6703

NZBC Clause G7 makes reference to NZS 6703:1984 *Code of Practice for Interior Lighting Design*. This standard is under revision and is due to be replaced by a combined Australian/New Zealand standard AS/NZS 1680.

### Australian Standard 1680

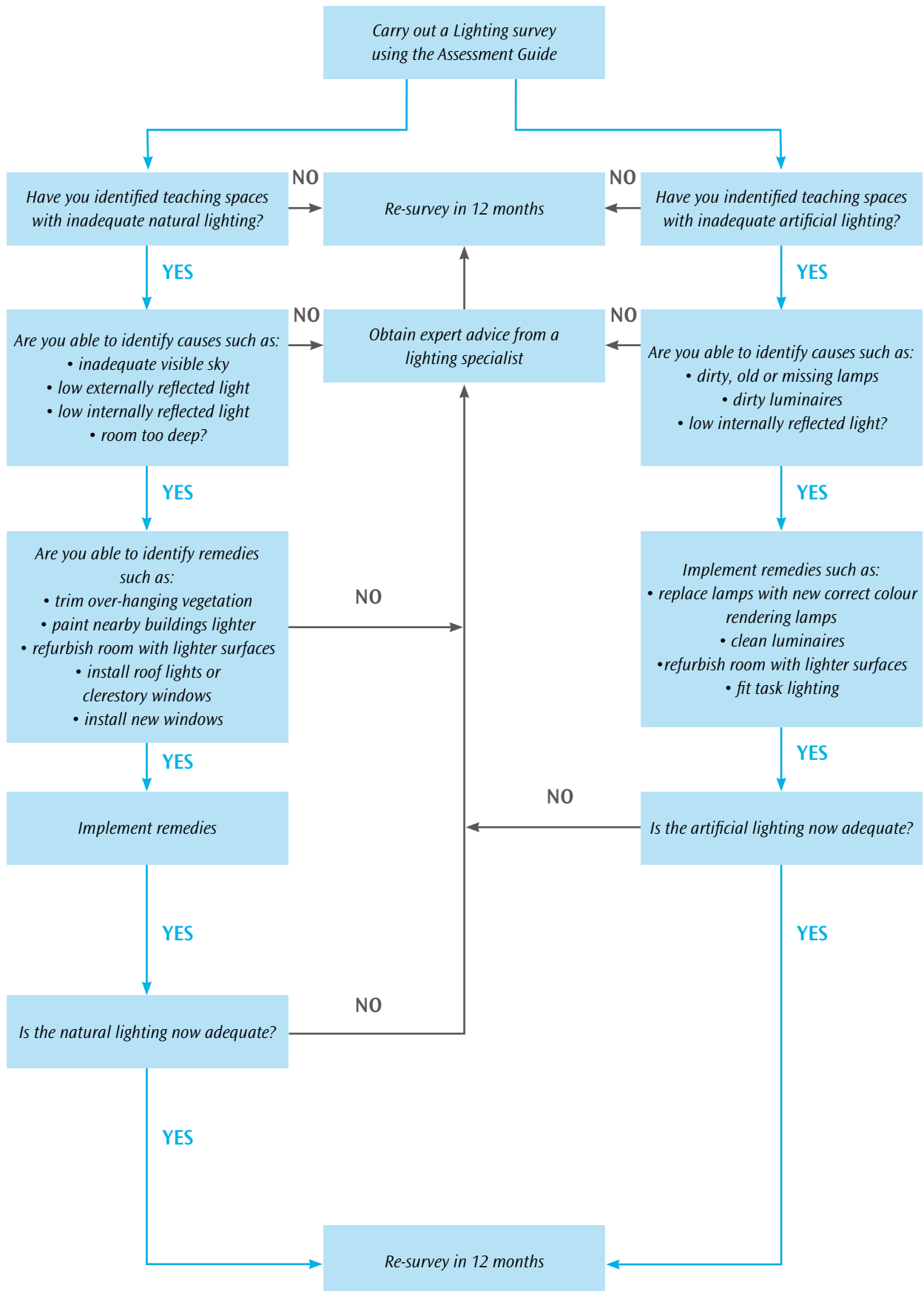
The New Zealand Ministry of Education policy statement on artificial lighting ([www.minedu.govt.nz](http://www.minedu.govt.nz)) recommends schools follow AS 1680: 1994 *Interior Lighting Part 2.3: Educational and Training Facilities*. The figures quoted in this guide are taken from this standard.

## > APPENDICES

- Flow diagram for Lighting Assessment
  - Lighting Survey Form
  - Other References
- 



## Flow diagram for Lighting Assessment



# Lighting Survey Form

Use this survey form to help you assess how suitable the lighting is in your classrooms.

## 1. Are students and teachers complaining of poor levels of daylighting?

Yes ☐ No ☐

**Comment:** Check that:

- daylight levels are adequate – if necessary have a check carried out by a lighting engineer using a light meter
- windows are clean
- the room has light-coloured surfaces
- there is adequate visible sky.

It may be necessary to supplement the daylight by installing roof lights or additional windows.

## 2. Do students and teachers complain of direct sunlight glare or overheating?

Yes ☐ No ☐

**Comment:** Check that:

- there is adequate shading
- the room is not 'over glazed'.

See *Designing Quality Learning Spaces – Heating and Insulation*.

## 3. Are the rooms suitable for projection, data shows or other activities that require control of the levels of natural light?

Yes ☐ No ☐

**Comment:** Check that:

- There are blinds/curtains to reduce the levels of natural light sufficiently.

## 4. Is lighting controllable by the teacher?

Yes ☐ No ☐

**Comment:** If not, seek advice from a lighting designer about your options.

## 5. Is there a pleasant view to look at?

Yes ☐ No ☐

**Comment:** Think about adding a 'view' window, repainting buildings blocking the view, or landscaping.

## 6. Do students and teachers complain of inadequate artificial light?

Yes ☐ No ☐

**Comment:** Check that:

- luminaires are clean
- interior surfaces are clean and finished in light colours
- lamps are the correct type and working efficiently, do they need upgrading?
- think about installing additional general lighting
- think about whether task lighting will help.

If needed have a check carried out by a lighting engineer using a light meter.

## 7. Are their complaints about glare on computer screens?

Yes ☐ No ☐

**Comment:** Check that:

- workstations are correctly placed to avoid reflections
- overhead lights are not in the reflection zone and are adequately screened (see section 7)
- surfaces that can reflect light are dark coloured with a matt finish.

Think about installing dimming to the lighting system and fitting blinds to the windows.

## 8. Is your school's lighting bill unusually high?

Yes ☐ No ☐

**Comment:**

- employ a lighting consultant to identify ways to improve lighting efficiency
- encourage teachers and students to save power
- think about installing automatic devices to switch off unnecessary lights.

## Other References

### **1 *Best Practice in Classroom Design***

Report prepared for the Ministry of Education  
AC Nielsen  
Wellington, NZ

### **2 *Day-lighting in Schools: An Investigation into the Relationship Between Day-lighting and Human Performance***

Heschong Mahone Group  
Fair Oaks  
California, USA

### **3 *Day-lighting Improves Performance in New Zealand Schools – Fact or Fiction?***

Quentin Jackson, Michael Donn  
School of Architecture  
Victoria University  
Wellington, NZ

### **4 *Journal of Environmental Psychology (1992)***

Kuller and Lindsten

### **5 *Code of Practice for Interior Lighting Design***

New Zealand Standard 6730  
Standards Association of New Zealand  
Wellington, NZ

### **6 *Mercury Lamp Recycling Initiative in New Zealand***

Brigitte Knapp, Lincoln Falconer, Mark Vinsen  
Medi-Chem Waste Services Ltd  
Auckland, NZ



## Notes

## Notes



