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Natural Daylight, Visual Comfort, and Emotional Wellbeing in Educational Buildings: A Structured Literature Review

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Abstract. Natural daylight in educational buildings should be understood not only as a source of illumination but also as a spatial, physiological, and psychological condition that shapes how learning environments are experienced. Yet the literature remains dispersed across building science, lighting engineering, environmental psychology, and architectural theory, making it difficult to derive coherent architectural guidance. This paper offers a structured narrative review of research on daylight, visual comfort, and emotional wellbeing in educational buildings. The review synthesises peer-reviewed scholarship published primarily between 2000 and 2025, with emphasis on classroom- and student-oriented studies and selective use of office-based research where the underlying mechanisms are transferable. The findings suggest that daylight contributes most positively to learning environments when it is sufficient, evenly distributed, temporally dynamic, and responsive to user control. Visual comfort emerges as the key mediating condition: benefits associated with daylight are weakened when glare, excessive contrast, blackboard reflections, or lack of shading compromise task visibility. The literature also indicates that emotional wellbeing is influenced not simply by daylight quantity but by a broader assemblage of luminous conditions, exterior views, circadian support, and perceived environmental control. The paper concludes by proposing design principles for educational architecture and identifying research gaps in child-specific evidence, longitudinal post-occupancy evaluation, and integrated architectural-psychological methods.

Keywords: Daylighting, Visual comfort, Educational buildings, Emotional wellbeing, architecture, Learning environments

1. Introduction

Daylight has long occupied a privileged position in architectural discourse because it is simultaneously an environmental resource and a medium of spatial expression. In educational buildings, this dual status becomes particularly important. Students and teachers spend prolonged periods indoors undertaking visually demanding tasks such as reading, writing, screen-based work, and collective attention to boards or projection surfaces. Under these conditions, daylight is not merely an energy-saving substitute for electric lighting; it is part of the sensory infrastructure through which attention, comfort, and atmosphere are organised.

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A substantial body of scholarship links indoor lighting conditions to visual performance, eye health, alertness, mood, and perceived wellbeing [1, 2]. At the same time, architectural literature emphasises the qualitative and temporal character of daylight: its movement across surfaces, its capacity to reveal material depth, and its role in connecting occupants to the outdoor environment [1]. These two strands of literature are often treated separately. Building-performance research tends to privilege measurable indices such as illuminance, daylight autonomy, or glare probability, whereas architectural accounts frequently foreground atmosphere, perception, and spatial experience. For educational settings, however, both perspectives are necessary.

The problem addressed in this paper is therefore one of fragmentation. Research on daylight, visual comfort, and wellbeing is distributed across different disciplines and frequently extrapolates from office settings to classrooms without adequately considering the particular visual tasks, age groups, schedules, and pedagogical arrangements found in educational environments. In response, this paper reviews the literature through three questions: (1) How is daylight conceptualised in relation to educational architecture? (2) What evidence links daylight to visual comfort and emotional wellbeing? and (3) Which architectural variables most strongly mediate these outcomes? The paper argues that the most meaningful relationship is not between daylight and wellbeing in the abstract, but between carefully moderated daylight and forms of visual comfort, spatial legibility, and environmental agency that support learning.

2. Methodology

The review drew primarily on keyword-based searches using Google Scholar and journal publisher platforms. Search combinations included "daylight", "daylighting", "visual comfort", "emotional wellbeing", "lighting impression", "classroom", "educational buildings", and related terms. Priority was given to English-language, peer-reviewed journal articles published between 2000 and 2025. Foundational texts were retained selectively where they clarified definitions or conceptual frameworks. Studies undertaken in office environments were included only when they addressed mechanisms, such as glare, luminance distribution, mood, alertness, or user control, that are plausibly transferable to educational settings. The analysis proceeded through thematic synthesis. First, the literature was reviewed to clarify how daylight and visual comfort are defined. Second, empirical studies were examined for evidence linking luminous conditions to visual comfort and emotional wellbeing. Third, the findings were reorganised around architectural variables, including orientation, glazing, shading, room depth, interior reflectance, view, and user control. This method allows the discussion to move from isolated findings toward a more integrated architectural interpretation of the evidence.

3. Daylight as environmental performance and spatial experience

In building-performance literature, daylight is often defined through its measurable behaviour inside rooms: illuminance on a task plane, luminance distribution within the visual field, exposure duration, glare risk, and spectral composition. This quantitative orientation is indispensable, yet it is incomplete. Daylight in architecture is also temporal and spatial. It varies with season, time of day, weather, and orientation; it renders surfaces differently as it moves; and it mediates occupants' perceptual relationship to both interior and exterior space. Hafiz characterises this variability as a "living" quality of daylight, one that introduces movement and atmospheric richness into architecture [1].

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The concept that most directly links measurable daylight conditions to user experience is visual comfort. Visual comfort is usually understood as a condition in which light supports visual tasks without causing strain, distraction, or physiological cost. Reviews by Carlucci et al., Shafavi et al., and Tabadkani et al. show that visual comfort cannot be reduced to a single threshold value. It is shaped by a constellation of factors including illuminance level, glare sensation, luminance contrast, daylight uniformity, view content, adaptation state, and personal expectations [3, 4, 5]. In other words, visual comfort is both objective and subjective: it depends on physical conditions, but it is experienced through situated human perception.

This distinction is particularly important for educational buildings. A classroom may satisfy a numerical daylight target and still fail to provide visual comfort if strong contrast, direct sun penetration, or reflections on boards and screens interfere with learning tasks. Conversely, a space with moderate rather than maximal daylight levels may be perceived positively if it offers balanced luminance, stable working conditions, and a meaningful connection to the outside. The design problem is therefore not to maximise daylight indiscriminately but to produce appropriate daylight conditions for specific educational activities.

4. Daylight, visual comfort, and emotional wellbeing

Evidence linking daylight to emotional wellbeing is significant but methodologically uneven. Much of the foundational empirical literature comes from offices rather than schools. Hwang and Kim, in a large study of a green office building, found that daylighting and improved shading management were associated with better visual comfort, reduced annoyance glare, and improved psychological health and productivity [2]. Borisuit et al., using realistic daylighting and electric-lighting scenarios, reported that participants generally preferred daylighting conditions and associated them with more positive ratings of visual acceptance, alertness, and mood [6]. These studies do not directly model classrooms, but they establish mechanisms that remain relevant to educational architecture: glare reduction, luminous balance, and subjective preference matter as much as absolute light levels.

More recent work brings the discussion closer to educational settings. Fakhari et al. developed a structural equation model of classroom visual comfort and showed that multiple architectural, environmental, and individual variables act simultaneously rather than independently. Their results suggest that perceived lighting level and glare sensation are among the strongest determinants of overall visual comfort [7]. In higher educational buildings, Kong et al. similarly found that subjective visual comfort is entangled with broader "lighting impressions", including affective and distributional dimensions [8]. These findings reinforce an important point: students respond not only to how much light is present, but to how that light is organised, distributed, and felt.

Classroom-specific studies also expose problems that office-based metrics may understate. Bian et al. show that reflections on blackboards can be a major source of discomfort and reduced task visibility, demonstrating that classroom visual comfort cannot be evaluated solely through generic glare metrics developed for office scenes [9]. Mahgoub et al. likewise argue that daylighting performance, classroom design, and occupant preferences are interdependent. The implication is that educational spaces have distinctive visual ecologies. Students repeatedly alternate between desk work, looking toward teaching walls, and attending to peers or screens [10]. The luminous environment must therefore support multiple directions of gaze and multiple visual tasks within the same room.

The wellbeing dimension extends beyond task visibility alone. Daylight is associated in the literature with reduced visual fatigue, better alertness, enhanced mood, and stronger subjective satisfaction with the indoor environment [6, 11]. In educational settings, these outcomes should be

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understood as proximal indicators of emotional wellbeing rather than as a single universal construct. The evidence supports an association between good daylighting and positive affective states, but it does not justify a simplistic claim that more daylight always produces better wellbeing. Excessive brightness, poor shading, unstable luminance, or lack of user control can reverse the expected benefit and produce stress, distraction, and dissatisfaction.

A more defensible interpretation is that daylight supports emotional wellbeing when it operates through mediating conditions: visual comfort, circadian appropriateness, exterior connection, and a sense of environmental control. This position also helps explain why the literature sometimes appears contradictory. Studies that treat daylight merely as quantity often report mixed outcomes, whereas studies that attend to the quality, distribution, and controllability of daylight tend to produce more consistent design insights.

5. Architectural variables shaping daylight outcomes in educational buildings

5.1. Orientation, solar exposure, and façade design

Orientation strongly influences both daylight availability and glare risk. In many climates, north- and south-facing façades are easier to moderate than east- and west-facing façades, where low-angle sun more frequently produces direct penetration, high contrast, and discomfort. Michael and Heracleous, for example, found that Cypriot classrooms in all orientations could achieve sufficient lighting levels, but glare problems were most pronounced in east- and west-oriented spaces [12]. Their work is instructive because it shows that adequate daylight quantity does not guarantee acceptable visual quality.

For educational design, façade strategy should therefore combine aperture size, glazing specification, and solar protection. Large glazed areas may improve daylight penetration, yet without appropriate control they can create overlit perimeter zones and visually unstable interiors. High-performance glazing and external or between-pane shading devices are valuable not because they maximise daylight, but because they render daylight more usable.

5.2. Room depth, section, and surface reflectance

The depth and section of a room determine how far daylight can penetrate before the interior falls into underlit conditions. Deep classrooms often produce a familiar imbalance: bright areas near the façade and dim, visually compressed conditions toward the rear. Reviews of daylighting strategies in schools note that shallow plans, higher ceiling reflectance, clerestories, light shelves, and carefully chosen surface reflectances can improve the diffusion of daylight and reduce contrast between front and back zones [5, 13].

Material specification is equally important. Highly absorptive finishes reduce the effective spread of daylight, while excessively glossy finishes can intensify reflected glare. In educational buildings, surfaces should therefore be selected not only for aesthetic reasons but also for their contribution to a stable luminous field. Matte finishes with moderate to high reflectance can support more balanced light distribution without introducing excessive specular reflection.

5.3. Teaching walls, views, and user control

Classrooms differ from many other building types because visual attention is repeatedly directed toward teaching surfaces. The placement of blackboards, whiteboards, and digital screens relative to

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windows is therefore a critical architectural decision. As shown in Table 1, reflections on teaching surfaces are identified as a key risk when daylight is poorly resolved, highlighting the importance of coordinating window position with interior layout and sightlines. Bian et al. demonstrate that visual discomfort in classrooms may arise from reflections on the board rather than from the window itself. This finding underscores the need to coordinate window design with interior layout, seating arrangement, and typical sightlines [9].

User control also has a strong bearing on comfort and satisfaction. Earlier reviews of daylit buildings show that occupants value the ability to modify blinds, shades, and lighting conditions in response to changing tasks and personal preferences [14]. In educational settings, such control is especially important because activities shift throughout the day—from lectures to reading to screen work—and because students may be more sensitive than adult office workers to visual fatigue. Control should not be understood narrowly as a technical add-on; it is part of the broader architectural capacity of a room to accommodate variation.

Finally, access to views deserves attention. View quality is not identical to daylight quantity, yet the two are often spatially linked. Windows can provide not only light but also visual relief, orientation, and a sense of connection to weather, vegetation, and time. Although view satisfaction may not always be the strongest predictor in visual comfort models [7], it remains an important component of the overall atmospheric and psychological experience of learning space.

Table 1. Architectural variables mediating daylight performance and wellbeing in educational buildings

Architectural variable	Risk when poorly resolved	Design implication
Orientation and solar exposure	Low-angle sun, direct penetration, and unstable contrast can increase glare, especially in east- and west-facing rooms.	Prioritise façade strategies that moderate solar gains; pair exposed orientations with effective external or adjustable shading.
Glazing and shading systems	High transmission without control can create overlit perimeter zones and user dissatisfaction.	Use glazing and shading as a combined system so daylight remains usable across seasons and changing tasks.
Room depth and section	Deep classrooms often become bright near the façade and underlit at the rear.	Limit excessive depth where possible; use clerestories, light shelves, and reflective ceiling planes to extend daylight penetration.
Teaching-wall and screen placement	Reflections on boards and screens can compromise legibility even when general daylight levels appear acceptable.	Coordinate window position, teaching surfaces, and typical sightlines at the design stage.
Interior finishes and reflectance	Dark or glossy surfaces can intensify contrast, absorb useful daylight, or create reflected glare.	Specify matte finishes with moderate-to-high reflectance to support stable luminance distribution.
User control and views	Lack of control reduces comfort when daylight changes rapidly; sealed visual environments can feel closed and fatiguing.	Provide operable blinds or responsive controls while maintaining meaningful exterior views and temporal awareness.

6. Conclusion

This paper has argued that daylight in educational buildings should be understood as a multidimensional design issue linking environmental performance, spatial experience, and human wellbeing. The literature shows that daylight can support positive emotional states, reduce visual strain, and improve satisfaction with learning environments, but only when visual comfort is

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carefully secured. Glare, excessive contrast, reflected brightness on teaching surfaces, poor distribution, and lack of user control can all negate the potential benefits of daylight.

For architecture, the implication is clear: successful daylighting is not the provision of maximum light, but the orchestration of appropriate light. Orientation, glazing, shading, room proportion, surface reflectance, view, and interior layout must be treated as interdependent variables. A PhD-level reading of the literature therefore moves beyond generic advocacy for daylight and toward a more critical design position: daylight matters because of how it is shaped, moderated, and inhabited. Educational buildings that achieve this balance are more likely to support both visual comfort and the emotional wellbeing of their users.

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