Introduction

Lighting in schools has long been regarded primarily as a matter of visual comfort — ensuring that students can read, write, and see the board without strain, while also meeting energy efficiency requirements. Yet in recent decades, research in neuroscience, endocrinology, and chronobiology has demonstrated that light is not only a visual input but also a biological signal. The eye contains specialized photoreceptors (intrinsically photosensitive retinal ganglion cells, or ipRGCs) that project to the brain’s master circadian clock in the suprachiasmatic nucleus (SCN). Through this pathway, light regulates hormone secretion, sleep–wake timing, mood, and cognitive performance.

The Problem

Traditional classroom lighting systems are optimized only for brightness and visibility, ignoring the non-visual biological effects of light. As a result, students are often exposed to lighting that is visually adequate but biologically disruptive. Key issues include:

• Circadian disruption: high CCT or blue-rich light late in the day delays melatonin secretion.

• Hormonal imbalance: insufficient vertical illuminance in the morning weakens cortisol amplitude.

• Cognitive fatigue: poor uniformity, low CRI, and flicker induce strain and impaired attention.

• Mood instability: inadequate melanopic stimulus reduces serotonin turnover.

• Long-term risks: chronic disruption linked to metabolic, immune, and psychological disorders.

The Idea

The central idea of this framework is that light can be described and controlled through measurable parameters — CCT, CRI, flicker, glare, horizontal and vertical illuminance, melanopic EDI, uniformity, and exposure duration. By aligning these parameters with their biological, hormonal, skin, nervous system, and biochemical effects, lighting can be designed not just for seeing but for learning and wellbeing.

Side Effects of Poor Lighting

Ignoring biological effects produces consequences beyond discomfort, including disrupted circadian alignment, abnormal melatonin suppression, cortisol flattening, headaches, reduced serotonin synthesis, and lower classroom engagement.

Our Solution

This booklet provides a parameter-based framework that integrates biology with classroom lighting design. For each parameter, we present definitions, recommended ranges, biological effects, biochemical pathways, recommendations, and checklists. By shifting from a purely visual model to a biological + visual model, schools can create environments that enhance attention, stabilize circadian rhythms, protect long-term health, and ultimately improve educational outcomes.