The Value of Daylighting Children's Health and Well-Being in School Buildings

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Abstract:- Daylight is one of the most important aspects of sustainable building. Well-integrated devices can improve daylighting in classrooms and minimize energy usage by limiting artificial lights. In western countries, the analysis of daylight settings inside educational institutions been a focus of interest since the 19th century. Even though it's been argued that to provide a interpretation somewhere else even utilizing daylight rather than more steady and controllable artificial light could decrease students' performance while failing to provide a comfortable and healthy environment, it appears that there is now widespread agreement on the need to design well-daylit space. (Vincenzo, 2017) Studies commissioned in 1999 have shown daylight enhancing elements, such as-shading devices, light shelves, and clerestories made students perform better in daylit classrooms as well as indicate the health benefits of daylighting (Heschong Mahone Group, 1999) Researchers and architects have recently focused on building performance, particularly in educational settings, due to its direct and indirect impact on space consumption and comfort. (Abdulqadir, 2019) This paper will review on daylight's impact on student performance and building performance and achievement by presenting two case studies of schools that have implemented technologies to enhance daylight and reduce artificial lighting cost effectively into the buildings. Those are- Kensington High School for the Creative and Performing Arts and Clackamas High School in Clackamas, Oregon. These case studies presented in this paper will be studied and utilized as a guideline for improving daylight educational environment in school buildings in the future. It's been visible from the comparison of the case studies of Kensington and Clackamas that solar orientation impacts on the direction of buildings on the amount of daylight in classrooms and architectural features such as- Light shelves, solar tubes, skylight can efficiently increase and distribute daylight for both good visual and low energy performance. The research methodology is done by comparing many passive and active daylight control devices. These cases reveal some advantages and disadvantages were found out and could be implemented for further design in school settings. This paper can be used as a resource for daylight design in school settings with cost effective devices in future. It's not a stretch to believe that if daylighting improves children's performance in schools, it might likewise improve adults' performance in other educational buildings.

Keywords:- *Daylight, School Building, Sustainability, Energy, Children Performance.*

I. INTRODUCTION

Almost every school building in the United States was lit during the day. from the 1950s through the early 1960s, i.e., they were purposefully constructed to offer adequate interior daylight for regular visual work. By the mid-1960s, however, a variety of factors were working against the notion of daylit classrooms. Daylight is the major light source, and it has the ability to produce nice and comfortable indoor spaces in addition to being indispensable. (Yacan, 2014) Daylighting helps in the formation of a comfortable indoor environment while also increasing the ability to save energy in buildings. Inside a classroom, daylighting improves cognitive and social abilities, supports in the learning process, and improves psychological wellness. (Yacan, 2014) Several studies have shown that when students have access to natural light in their classrooms, their performance improves. Skylights provide a simple symbolic role in that they let light to enter while preventing people from seeing the outside landscape, while windows have a far more complicated impact on humans. (Demir, World 3, no.1: 1-7, 2013) Pupils under full spectrum daylit conditions had less days of absence in a year than other students, according to a study (Mirrahimi, Ibrahim, and Surat, 2013). We may better isolate the impacts of daylight by adding educational buildings with skylights instead of natural illumination from windows, according to one theory. Skylights often have a straightforward illumination function, while window may have a significantly more complicated impact on humans. The most essential physical aspects of the classroom setting, according to Philips (1997), is lighting. This includes infrared light, student desk lighting, screen illumination, and window projection for light (Sanaz, 2012; Hussain and Suleman, 2014) Only when the classroom lighting is well-planned can students benefit from appropriate illumination in their learning environment. (Pulay, 2010) Daylighting will differ from one school building to the next dependent on the orientation, location, temperature, and latitude of the structure, therefore a conventional building design will rarely provide optimal illumination. This may transform south-faced walls towards an excellent source of subsidiary light in Northern Hemisphere. These "windows direction" is controlled by the position of the rooms, resulting in direct sunshine and daytime effects. (Yacan, 2014) Design experts must give exceptional design leadership by the usage of natural daylighting and modeling of daylight, The utilization of studies regarding natural daylight's health and productivity advantages, as well as daylighting models, must be addressed. (Yacan, 2014) **This paper aims to research on daylighting and student performance and development including two case studies of schools by implementing low-cost daylighting control devices in their settings.**

The two case studies: SMP designed, Kensington High School for the Creative and Performing Arts (2010) focused on making the structure as open and welcoming as possible. Local families would be encouraged to send their children here to observe their achievements, with the aim that the views will urge them to do so. Views out the windows encourage pupils to think about urban agriculture, green roofs, and mural painting. Daylighting, as well as other green building characteristics like operable windows, natural ventilation, and visual connection to the outdoors, has been demonstrated to minimize sick days, enhance productivity, and boost retail sales. Clackamas High School was developed by Portland-based BOORA Architects to offer an enlarged education institution for a developing Portland suburb while also improving the students' well-being and academic achievement.

II. NATURAL LIGHT BENEFITS

According to recent research, daylighting in schools can help pupils improve their test results as well as their health and physical development all without increasing school construction or maintenance expenditures.

- *Health Benefits*

From two studies, daylighting in classrooms can benefit students' health and psychological development. Many researchers examined health, human behavior and cortisol (a hormone of stress) levels in 90 elementary school pupils of Sweden in four classrooms for a year with various levels of daylighting. "The findings suggest that working in classrooms without natural light may disrupt the basic hormone pattern, which could affect children's capacity to concentrate or collaborate, as well as annual body growth and absenteeism." (Kuller R. 1992) Shishegar and Boubekri (2016) indicate that natural light creates Vitamin D, which aids in bone formation. Also, sunshine enhances learning space awareness. "Indoor sunlight is connected with increased levels of positive feelings including joy, curiosity, and alertness for the residents. (Mach, 2014:42) As a result, having enough daylight will offer a healthy environment for the physical human body as well as phycological requirements.

- *Students' Performance*

In a case study in Washington, kids having the highest daylight provision in classrooms fared up to 20% higher in arithmetic exams and up to 26% better on English assessments, according to a study of 21,000 children in 3 U.S. school systems (including Seattle Public School's students). "Students in classrooms with the most daylighting was found to have 7 percent–18 percent higher scores than those in the least" in the other two school districts. (Heschong, 1999) A different research compared exam results from students at three North Carolina daylight schools to those from the entire area school system for new schools in the area. The marks of approximately 1200 children in daylit schools were compared to the region. The analysis from the research discovered that daylit school students' outstripped students of non-daylit schools by 4%–13%. (Heschong, 1999).

- *Energy Savings- Daylight Harvesting*

Sufficient daylight reduces the need for artificial light in space, resulting in energy savings and reduced consumption. For example, Phillips stated that Artificial light demand can be replaced by the use of natural light in the right way that can help you save money. (Philips, 2004)

- *Concept of Daylighting in School: The Evolution*

In several cases, the design of public structures, such as places of worship, may depart from the above-mentioned general criteria. According to Baker et al, the Second Industrial Revolution enabled particular requirements for daylighting design for various building uses to be satisfied. (Baker, N. 1993) New teaching methods resulted in open floor plan layouts that required more energy to heat or cool. They were the first to overlook the importance of natural light and air, resulting in the construction of structures with few or no windows. (Vincenzo, 2017) The second oil crisis, as well as the increasing usage of fluorescent lamps in the United States, exacerbated the problem. A role was also played by the emergence of educational theories arguing that windows distracted children. (Wu, W.; Ng, E. 2003, 35, 111-125) Beginning in the early 1980s, as architectural flavors shifted away from Modernist suggestions, architects began to adopt a more traditional and climate-based approach to school design, resulting in the construction of a number of passive-solar schools with a spread-out shape and extensive south-facing windows to maximize solar gains in the United States. (Vincenzo, 2017) Despite these hopeful attempts, the majority of architects and engineers treat the minimum standard of the design process as something that might provide some extra value to a project rather than as a must.

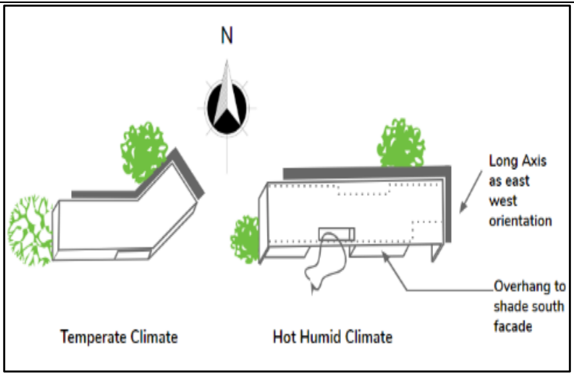
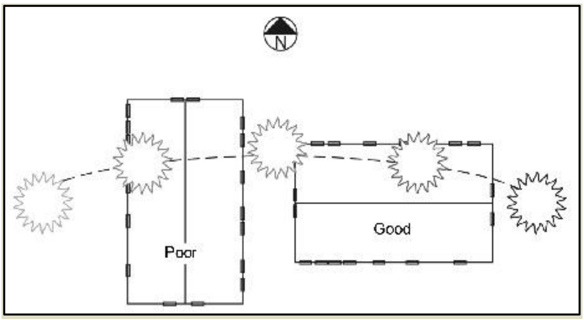
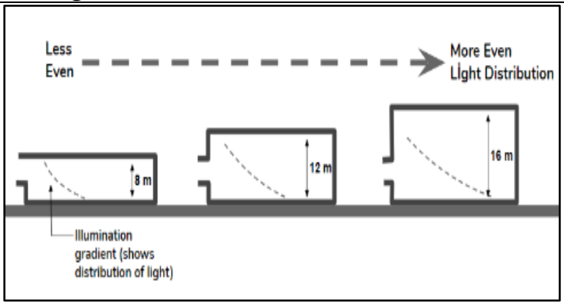
- *Passive Daylight Strategies*

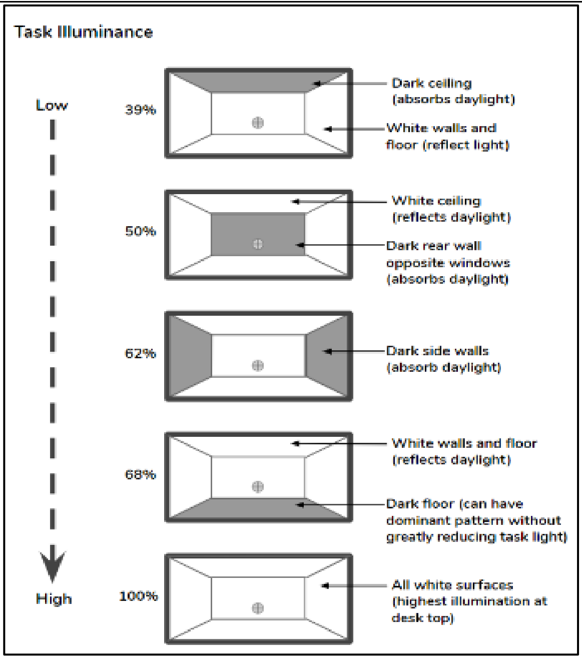
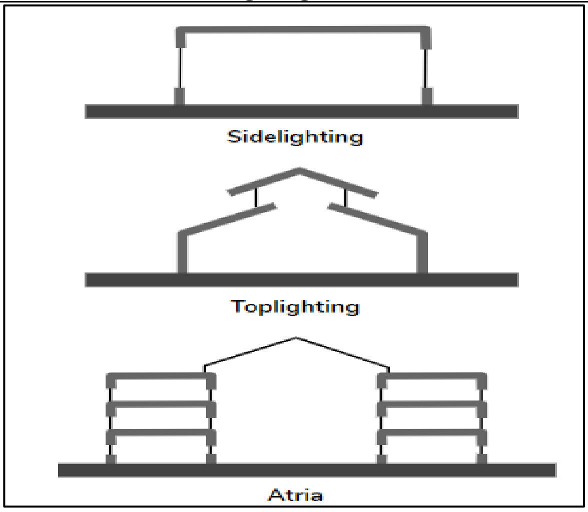
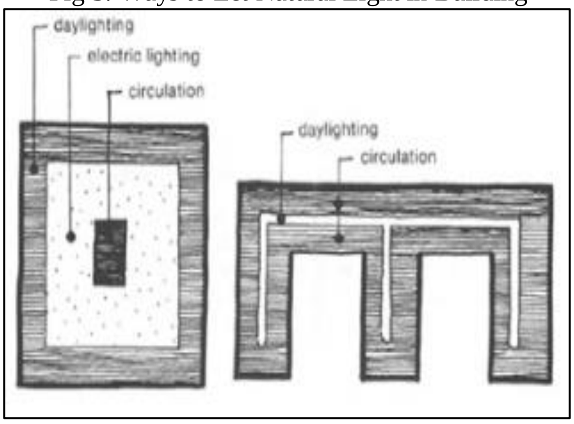
The sun in the Passive solar energy generator. After reaching the Earth's surface, solar rays can be absorbed, reflected, or transmitted. There are three sorts of passive solar gain strategies: direct gain, indirect gain, and isolated gain.

- **Direct heat gain:** When direct sun-light reaches the project's surface (for example, through a south-facing glass façade), it heats and energizes it.
- **Indirect heat gain:** When sunlight strikes a different surface, it is reflected back into space (For example, a masonry wall grips the sunlight and transfers the heat absorbed into the interior space). Greenhouses that have been assembled are a mix of direct and indirect gain systems.
- **Isolated gain:** using substitute substance to absorb energy is a "natural collective loop". Water, air, rock, and a heat storage tank are examples of these materials. A natural current occurs as warm water caught by the container rises and enters the storage tank's top.

➢ *The Daylight Strategies are Described as a Guideline for Future Research in Below Chart:*

Table 1: Daylighting Strategies, Credit: Author

Daylight Strategies	Description	Diagrams
Building orientation	**Building is oriented towards East-west:** The long axis running east-west normally receives the most sunshine from the south. In the northern hemisphere, this is the preferred building orientation during the winter. With optimal illumination, however, this orientation can provide the most consistent results throughout the day. (M. David Egan, Victor Olgyay, 2001) **Building is oriented towards North and South:** Buildings with a long axis that runs north-south receive the most sunlight in the morning and afternoon. During the summer, the east and west façade receive more sunlight than during the winter. (M. David Egan, Victor Olgyay, 2001)	 Fig 1: Building Orientation, Source: M. David Egan, Victor Olgyay, Architectural Lighting 2nd Edition, 2001.  Fig 2: Plan of a House with a Long Axis East-West is More Energy Efficient. Credit: UF/IFAS Program for communities of Resource Efficient
Proportion of height of room and daylight	The light distribution for both top lighting and side lighting gets more even as the ceiling height rises. As seen in the side lighting sections below, the ratio of typical light levels to lowest light levels drops by a factor of six (6) as, the ceiling height rises from 8 to 16 ft.	 Fig 3: Side Lighting Section Source: M. David Egan, Victor Olgyay, Architectural Lighting 2nd Edition, 2001.

Room Reflectance	The reflectance of the room has a significant impact on light dispersion. The ceiling is, generally, the most significant light-reflecting element. Different amalgamations of matte black and white exteriors are shown opposite a window surface in diagrams. (M. David Egan, Victor Olgyay, 2001)	 Fig 4: Room Reflectance Source: M. David Egan, Victor Olgyay, Architectural Lighting 2nd Edition, 2001.
Building massing and shape	The effectiveness of light distribution is determined by the building's massing. Natural light will be simplest to lighting small forms with the most access to exterior openings. - Side lighting, top lighting, and atria are the three most common ways (Fig 5) to let natural light into a space. - Top lighting is excellent for light penetration - Atria is good for light penetration in multistoried building - Narrow floor plans (Fig 6). ensure that work spaces are well-lit in multistory buildings. If a regular plan is not possible, "finger" plans are preferred. (M. David Egan, Victor Olgyay, 2001)	 Fig 5: Ways to Let Natural Light in Building  Fig 6: Massing of Buildings to Maximize Daylight

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<table>
<tr>
<td>Side lighting</td>
<td>
The entrance is described as side seeing.

Increase ceiling height allows more light in rear of space
Increase the distance between light source and ceiling to distribute light more evenly across the ceiling.
Shape ceiling (Fig 7) for minimum surface area and best distribution by using ceiling sloped upward from openings. (M. David Egan, Victor Olgyay, 2001)

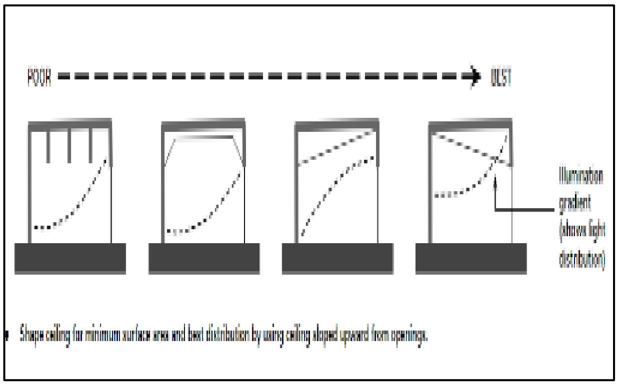


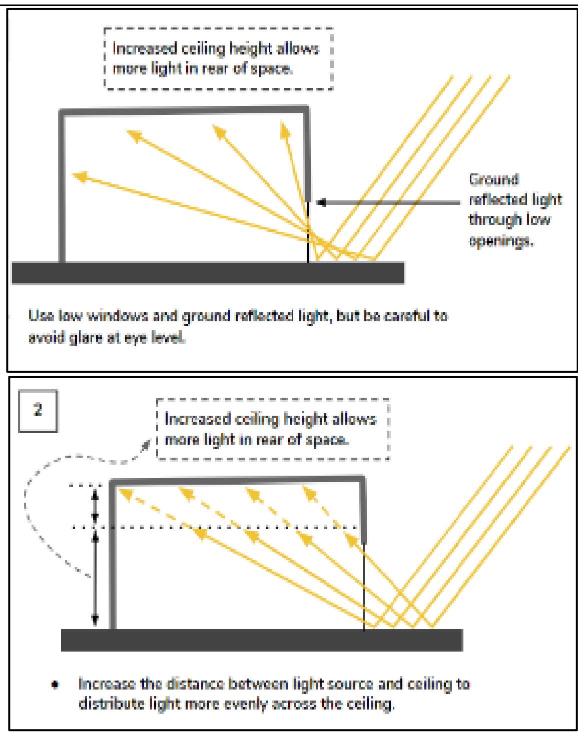
Fig 7: Shape Ceiling
</td>
<td>


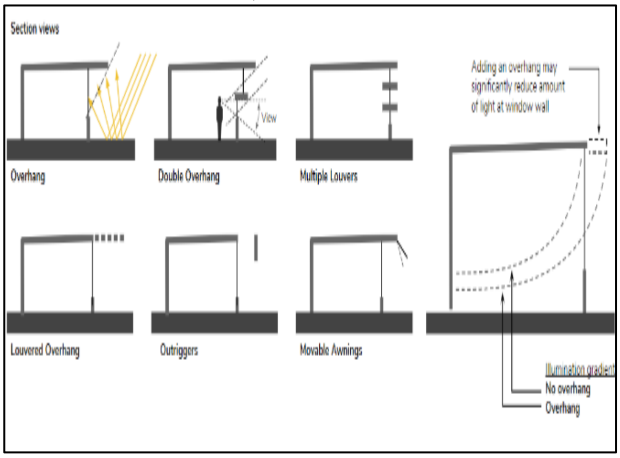
Fig 8: Increasing Ceiling Height Allows More Light in Space
</td>
</tr>
<tr>
<td>Openings</td>
<td>Carefully place openings to optimize light dispersion and perception. A window surface can be divided into three sections: upper, middle, and bottom.</td>
<td></td>
</tr>
<tr>
<td>Parametric modeling, daylight simulation, and artificial intelligence (ai)</td>
<td>The software analyzes a building's architecture and estimates the expected levels of daylighting throughout the structure at any given time of year. It can synthesize huge data sets in seconds, then learn from that solution to develop a much more efficient solution.</td>
<td></td>
</tr>
<tr>
<td>Sunlight Shading devices</td>
<td>
Shading devices can be categorized as horizontal, vertical, or a combination


Fig 9: Different Types of Shading Devices
Source: (M. David Egan, Victor Olgyay, 2001)
</td>
<td></td>
</tr>
</table>

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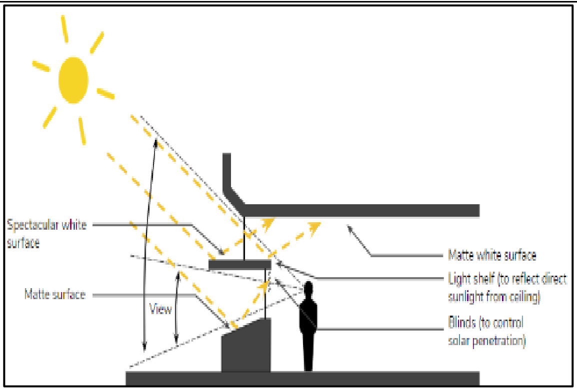
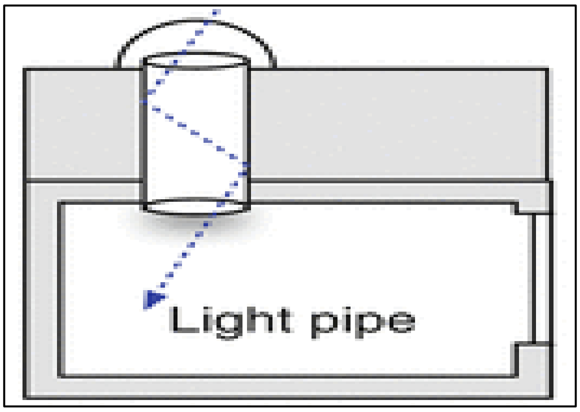
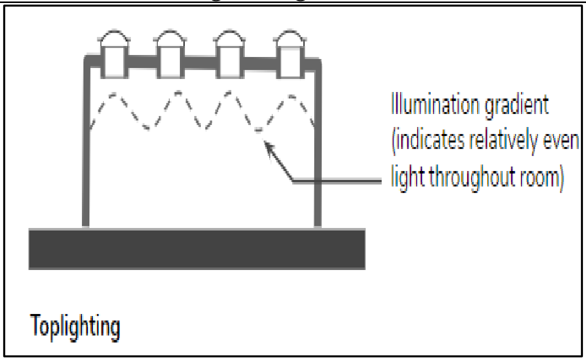
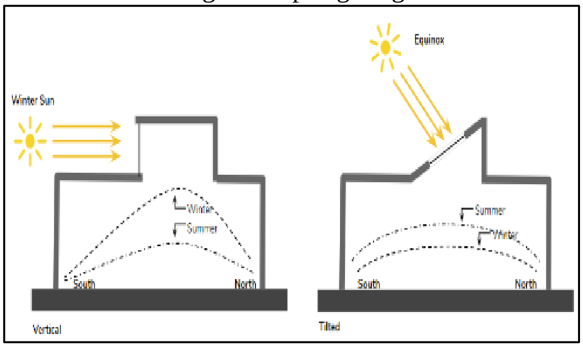
Sunlight Redirecting Devices	These devices share the same geometric patterns as shading devices. (M. David Egan, Victor Olgyay, 2001) - Light shelves work well on the south side of building. - Solar tubes, which are powered by the sun rather than electricity, allow sunlight to enter through a thin hole from the roof. (M. David Egan, Victor Olgyay, 2001)	 Fig 10: Light Shelf Mechanism Source: (M. David Egan, Victor Olgyay, 2001)  Fig 11: Light Tubes
Top lighting	Roof apertures, for example, may offer three times the amount of light as side lighting openings of same size. The optimum distribution may be obtained by placing the apertures where they are required. -Tilt: Set the glass tilt to correspond to the season's illumination requirements. (M. David Egan, Victor Olgyay, 2001)	 Fig 12: Top Lighting  Fig 13: Clerestory, Tilt Opening Source: (M. David Egan, Victor Olgyay, 2001)

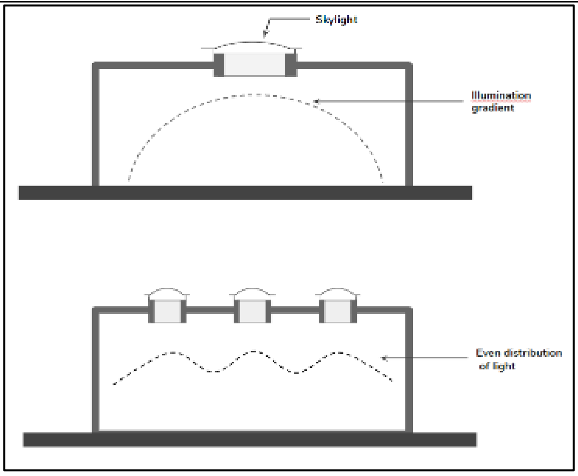
<table>
<tr><td>Sky lights</td><td>Skylights work best in cloudy skies. Vertical clerestories operate best with low sun angles and reflected light. (M. David Egan, Victor Olgyay, 2001)</td><td>

Fig 14: Skylight Openings</td></tr>
<tr><td>Light wall colors</td><td>Light-reflective paint bounces light about the area, making the room feel brighter.</td><td></td></tr>
</table>

III. CASE STUDY 1

Project Name	**Kensington High School for the Creative and Performing Arts**
The architect	SMP SRK Architects, a joint venture
Lighting Design	David Nelson & Associates
The date of completion:	September, 2010
Location of the project	1901 North Front Street, Philadelphia, Pennsylvania, United States
Project Site Context/Setting:	Urban settings, Brownfield Site
Client	AP / BSI Construction, a joint venture
Project Area	90,000 square feet
Completion Date	2010
LEED Certification	Platinum
Link to a website of this case	https://www.aiatopten.org/node/48

Fig 15: KCAPA Birdseye View with Sustainable Strategies - Photo Credit: SMP Architects

➢ *Important Features:*

An urban adolescent activist group called Youth United for Change helped the School District of Philadelphia (SDP) build a smaller high school that would encourage pupils to graduate rather than drop out with no future. In contrast to their home living conditions, they desired “a green school” that would create a bright, healthy learning atmosphere.

Because students spend the majority of their time in classrooms, the design team focused on orienting them for best daylighting, **decreasing artificial lighting and HVAC loads.** The high-performance characteristic of classrooms is also aided by **multiple level switching and occupancy controls**. When a room is empty, **lighting controls are integrated with HVAC**, allowing ventilation air to be reduced and heating and cooling set points to be adjusted to the **unoccupied** mode. The windows are primarily positioned away from the train tracks, skylights help to bring in natural light, and **Sunshades, window shades, and fritted glass** are used to reduce glare and heat gain in challenging solar orientations. The principal axis of the school building is north-south, which is not optimal for daylighting. The scale of the glass openings, which normally span the length of the classroom and have a head height of 10 feet, however, ensures that the classrooms receive enough daylighting. The building's **circulation is a mix of double- and single-loaded hallways**, and classrooms are placed for best daylighting. All **single-loaded corridors** look out into the garden, lobby, or green roof area, while the double-loaded corridors get their light from classroom doors, corridor ends, and skylights. Daylighting At least a 2% glazing factor is present in 96% of classrooms and 90% of non-classroom area. The view requirements of LEED are met in 96% of regularly used rooms. **Sunshades, window shades, and fritted glass** are used to reduce glare and heat gain in challenging solar orientations. (https://www.aiatopten.org/node/48)

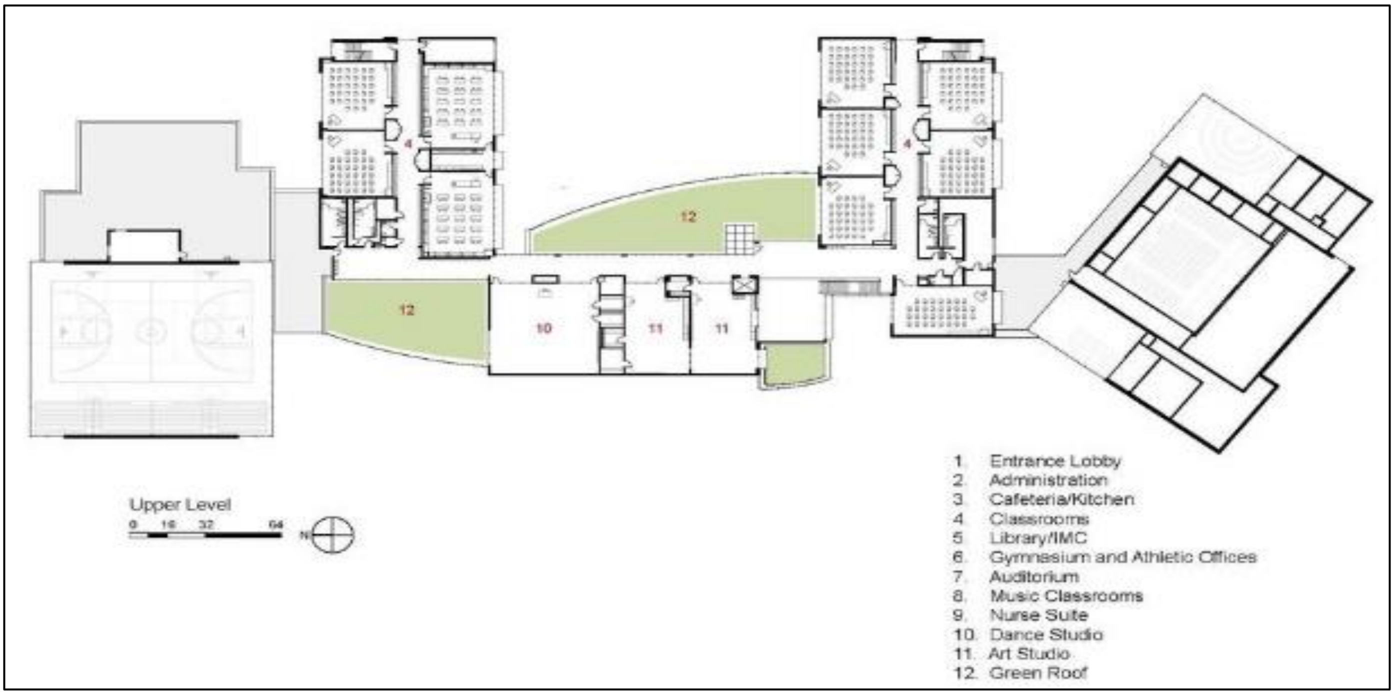


Fig 16: U- Shaped Plan of the Campus Enhance Daylight in Buildings - Credit: Second Floor Plan - Photo Credit: SMP Architects

Fig 17: Naturally Ventilated and Daylit (Clerestory) Student Cafeteria - Photo Credit: Barry Halkin, Halkin Photography

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Fig 18: Recycled Content Steel, Masonry, Glass and Drywall from PA - Photo Credit: Barry Halkin, Halkin Photography

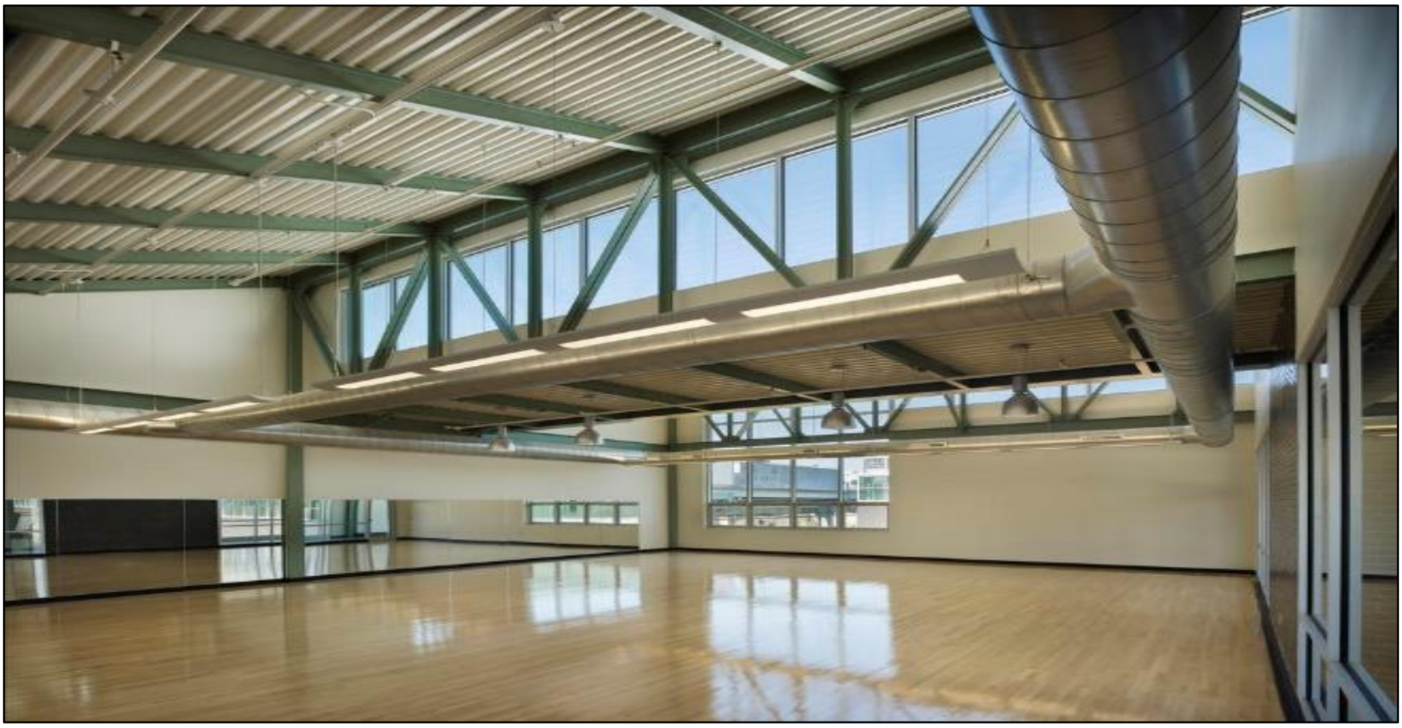

Fig 19: Dance Studio Lit from Above, Windows, Clerestory and Corridor - Photo Credit: Barry Halkin, Halkin Photography

➢ *Daylight Strategies Used in this Project:*

- The principal **axis of the school building runs north-south**, **which is not optimal** for daylighting. However, the size of the glass apertures, which often run the length of the classroom and also have a head height of 10 feet, ensures that the classrooms are well-lit.
- Though the entire complex is on a north-south axis due to th proportion of the site; however, **classrooms are oriented on an east-west axis**, with most having a southern orientation.
- The building plan layout of **U- shape** is shown in the Fig 16 is upright for daylight provision.
- There are **two types of fixtures** in most classrooms. A **linear pendant fixture** with up and downlight parts provides general lighting. T8 bulbs are used.
- **Energy-efficient recessed fluorescent T8 fixtures** light the corridors.
- The light fixtures on the upper floor are placed differently to allow for **solar light tube "fixtures"** to be used for lighting.

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Fig 20: Fritted Glass, Sunshades, Wheatboard were Specified Throughout - Photo Credit: Barry Halkin, Halkin Photography

- The architectural design of the lobbies is reflected in the **decorative pendants**. In the theater, there is a sophisticated theater lighting kit.
- **Double-loaded corridors** are lit from borrowed lights at classroom entrances, corridor ends and through **skylights** above. (Fig 20)

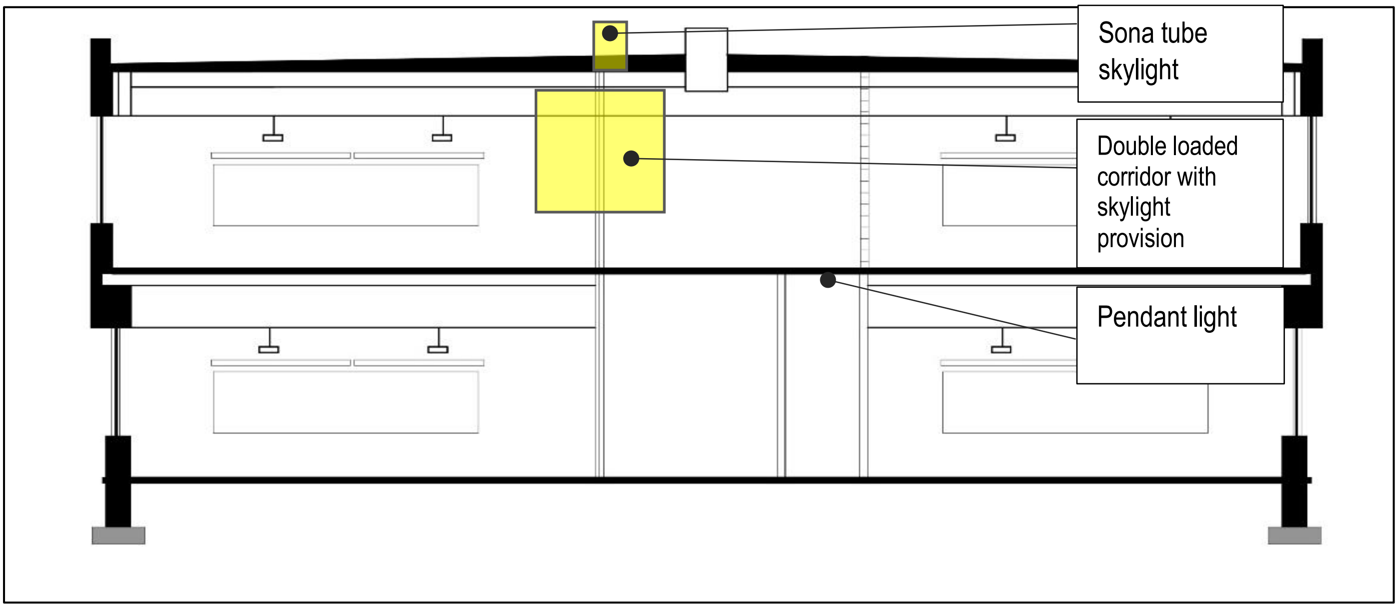

Fig 21: N/S Section Through Typical Classroom Wing

- **Perable windows** provide fresh air throughout the school
- Side lighting with **Light shelves** increase the daylight where needed.
- Vertical **slat shading devices** in the window reduce the glare in the classrooms.
- **Fritted glass, sunshades, wheatboard** are specified throughout the building mitigate the glare and heat gain
- **Energy performance:** This school is renowned as energy efficient school in the district. The low EUI is a result of high-efficiency HVAC and lighting systems, low flow plumbing fixtures reducing domestic hot water consumption, and high-performance glazing and insulation.

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IV. CASE STUDY 2

Project Name	**Kensington High School for the Creative and Performing Arts**
The architect	Boora Architects
The date of completion:	2000
Location of the project	Clackamas, Oregon, United States
Project Site Context/Setting:	Urban settings
Owner	North Clackamas School District
Project Area	265,400sft
LEED Certification	Silver
Link to a website of this case	https://www.djc.com/news/co/11136438.html

Fig 22: The School Campus - Credit: Courtesy of Better Bricks

➢ *Important Features*

Clackamas High School in Clackamas, Oregon, (Fig 22) has been recognized as a **national model for energy performance** by the Rocky Mountain Institute and the Energy Foundation. Clackamas High was thoughtfully **placed in a valley with spectacular views of Mount Hood to take advantage of sunshine** and wind patterns. The school has 1,800 students and is housed in a 265,355-square-foot structure with four 2-story academic houses that connect the Library, Administration, Counseling Services, and the Student Commons. The project was created with the goal of achieving **energy efficiency**, **creating healthy indoor conditions, conserving resources, and demonstrating environmental stewardship**.

➢ *Effective Design features:*

The structure was designed to **maximize natural light** and solar access. (David H, 2002) The light is channeled down to the first-floor halls through round, mirrored solar tubes. (Joetta L, 2002) To precisely integrate daylighting with the electric lighting system, **sensors that measure the amount of light** in each room were used. However, it is sometimes confusing and not user friendly as they were not used to these systems. **Small plants are strategically planted** across the school's vast **courtyard** (Fig 25) to provide shade in the future. The courtyard is the first indication that this is a unique institution. The **two-story entryway is flooded with light from floor-to-ceiling windows** on both sides as you pass through the vestibule's two sets of doors. (Joetta L, 2002) In the back of the classroom, a shelf extends from the window to reflect more natural light into the room. (Joetta L, 2002) Whenever possible, low-maintenance, long-lasting building materials were chosen. Their selection was influenced by the **reduced toxicity of alternative building materials**. Future green additions were addressed during the development and construction of Clackamas High School.

Energy savings measures and positive impacts of daylight on users' health and energy savings of the building:

Energy-saving measures like as daylighting, natural ventilation, operable windows, and efficient electric lighting are important not only because they **save money on energy bills**, but also because they improve the performance of the occupants. This translates to better exam results for students. (David H, 2002) Daylighting has been shown to reduce sick days, increase productivity, and boost sales, just like other green building features like natural ventilation, moveable windows, and outdoor visual access. For example, using

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natural sunshine instead of fluorescent lighting in the classroom has been related to enhanced academic attainment and health. With this information in mind, BOORA architects developed Clackamas High School to provide extended facility of education for a developing Portland suburb and improving the kids' health and academic performance. (David H, 2002)

Fig 23: The Cafeteria Area Fully Daylit, Credit: Courtesy of Better Bricks

Future plans **include solar photovoltaic panels on the roof and electric vehicle charging** stations in the parking area. "The most essential thing is to bring these kinds of issues up early in the process," he said. "Having a design team that understands and has **expertise designing structures** of this type is the second most critical element." **The school's building cost per square foot was $117, which was significantly less than the median high school construction cost of $135 to $145 per square foot.** (David H, 2002).

Fig 24: The Clerestory Enhance Daylight in Classrooms - Credit: Courtesy of Better Bricks

Fig 25: Top View of the Clackamas School
Source: Google map

➢ *Daylight Strategies used in this Project:*

- The ceilings in the classrooms slope downward to reflect sunlight from the hall windows and the enormous windows that face outer surface, some of which have **light shelves** to reflect the light even more.
- In the classrooms are two lines of T-5 low-voltage lights which may or may not be used throughout the day. (Joetta L, 2002)
- **"Light scoops"** catch daylight through translucent windows and skylights and transport it to adjacent spaces through clerestory windows (Fig 24) and light is channeled downward to the first-floor halls through round, **mirrored solar tubes**.
- The school's lighting is controlled by a **main computer,** which monitors **the activity and outside light in each classroom**, which is supposed to turn off lights when people leave a room. (Joetta L, 2002)
- To lighten the areas, the school's lockers, halls, and classrooms are all painted white.

➢ *Analyzing the Case Studies:*

Several daylight strategies are followed on both of the case studies which are broadly positive and some may become negative for the occupants. The strategies are compared below:

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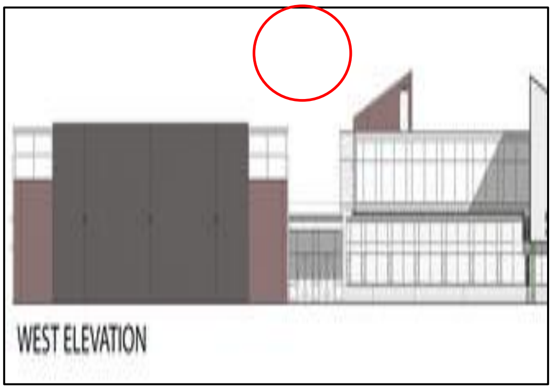
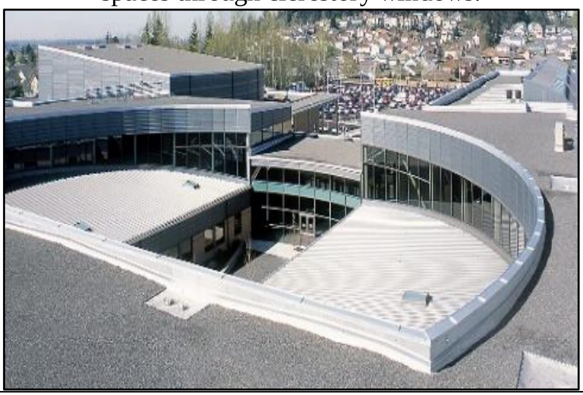
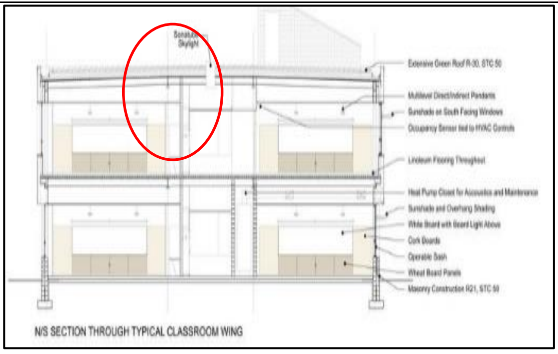
Table 2: Analyzing the Case Studies in Terms Of Daylight Strategies, Credit: Author

Daylight Strategies	**Case Study 1 (Kensington High School)**	**Case Study 2 (Clackamas High School)**
Building orientation	East- west axis Not the optimal solution for daylight 	North- South axis Best layout for optimal daylight provision 
Building massing and shape	U- shaped plan Effective layout to attract daylight more inside the building	Courtyard focused plan layout Effective for daylight.
Room Reflectance	White board and white light over that been used in classrooms to brighten up	To lighten the areas, the school's lockers, halls, and classrooms are all painted white.
Side lighting	Vertical slat shading devices in the window Light shelves used to increase sunlight.	Side lighting are prominent in this building through full height glasses. 
Top lighting	Double-loaded corridors are lit from skylights above  Fig 1: Skylight provision, Credit: SMP Architects	"Light scoops" catch daylight through translucent windows and skylights and transport it to adjacent spaces through clerestory windows. 
Skylight	Double-loaded corridors are lit from skylights above	The second-floor hallway is flooded with light from overhead skylights.

		
Sunlight Redirecting Devices	solar light tube "fixtures" Light shelves in the windows to enhance daylight Vertical slat shading devices in the window Sunshades	Light scoops Light shelves used in classrooms to increase sunlight Mirrored solar tubes are used in first floor halls.
Classroom lighting fixtures	Oriented on an east-west axis Two types of fixtures in most classrooms: A linear pendant fixture T8 bulbs are used. Energy-efficient recessed fluorescent T8 fixtures light the corridors.	The ceilings in the classrooms slope downward to reflect sunlight from the hall windows the enormous windows have light shelves to reflect the light even more.
Lighting controls	lighting controls are integrated with HVAC, allowing ventilation air to be reduced and heating and cooling set points to be adjusted to the unoccupied mode.	Lighting is controlled by the computerized programs. Each classroom's activity and the outside light are monitored, and the lighting is adjusted accordingly. However, it is sometimes confusing and not user friendly as they were not used to these systems.
Other Provisions	Operable windows Fritted glass lobbies have the decorative pendant lights. Single and double loaded corridors to provide light indoor	Solar photovoltaic panels on the roof and electric vehicle charging stations Courtyard to provide shade in the future Single and double loaded corridors to provide light indoor
Energy savings	In 2011, Kensington High School for the Creative and Performing Arts used 39.74 kBtu/ft2 of energy. This places it significantly below other high schools in the area and makes it the district's most energy-efficient school.	The structure should cut energy costs by 44%. HVAC, interior lighting, and water heating are all accountable energy.

➢ *Cutting Cost by Saving Energy:*

Due to creative and innovative design choices, school construction expenses do not represent a significant cost increase above traditionally constructed daylit school. Additionally, daylighting benefits students in these institutions in terms of enhanced academic achievement (as measured by test results) as well as overall health and well-being.

➢ *Among The Design Strategies Are:*

- Using funds for building exteriors and hallways to pay for classroom daylighting. (Heschong Mahone Group, 1999)
- Orientation is important feature to be noticed to enhance daylight and reduce energy cost.
- Reducing cooling system costs, as well as electricity and maintenance costs, offsets much or all of the higher costs associated with daylighting elements. (Heschong Mahone Group, 1999)
- Optimizing mechanical system sizing and building system coordination to improve whole-building design. (Heschong Mahone Group, 1999)
- Define passive daylighting methods early in the design process, however it is feasible to retrofit a structure with these design aspects. Architects can modify the outside envelope with windows or storefronts. Or they can light a window already there. It is not too late to add extra natural light.
- Passive daylighting technologies will hold a significant role in architecture. Embracing natural light promotes better environmental responsibility and encourages happier, healthier guests.

V. CONCLUSION

In conclusion, the daylighting efficiency has been investigated by comparing two case studies by the daylighting strategies and the proper design approaches for optimizing natural light have been identified. The energy savings issue of these case studies were prominent issue to focus for cutting the cost of construction and electric bill as well. The health and well being of children’s are the main reason for which this study has been done thoroughly to identify the meaningful prediction of school building design in future construction. The findings have revealed the positive

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and negative issues of the design which can be ignored while planning such building. The usage of light shelves, solar tubes, skylights can be increased in future designs to get more natural light inside the building. The quantity and quality of daylight parameters should be focused more to know the daylight effect on the children's performance and health.

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