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Impact of Courtyard on the Classroom Luminous Environment in the Primary Schools in Dhaka

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Abstract: In Dhaka, the design of many primary school buildings places considerable emphasis on classroom layout and functional use, yet often overlooks the importance of courtyards in providing adequate natural daylight. Only a limited number of schools acknowledge the role of courtyards in enhancing daylight penetration and ensuring balanced light distribution within classrooms. Proper daylight conditions are essential for children's visual comfort, health, and overall well-being, as students spend a significant portion of their day indoors. Therefore, creating a learning environment with sufficient and comfortable daylight is crucial for both physical and psychological development. The aim of this research is to identify the necessity of courtyards in primary schools and to evaluate their benefits in improving classroom daylight conditions. The primary objective is to examine the impact of courtyards on daylight availability within classrooms. A quantitative approach was adopted using Dialux Evo software to simulate daylight levels and assess indoor lighting performance. Additionally, a qualitative method was applied through a questionnaire survey conducted among 96 students from two selected primary schools. The survey compared students' perceptions of daylight conditions in classrooms with and without courtyards. The findings reveal that courtyards act as the "heart" of school buildings by significantly improving daylight access and visual comfort. Schools with courtyards showed higher student Satisfaction, while classrooms without courtyards were often perceived as dim and uncomfortable. Incorporating courtyards in school design can reduce reliance on artificial lighting and promote healthier, child-friendly learning environments.

Keywords: *Courtyards, Primary Classroom, Luminous Environment, Day Light, Student Comfort.*

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I. INTRODUCTION

Courtyards in schools support outdoor activities and improve classroom daylight by acting as natural light wells, enhancing visual comfort and reducing dependence on artificial lighting. Studies show that optimal courtyard width proportions (H–3H) maximize sunlight penetration while controlling excessive solar gain [1] [2] [3]. Due to limited urban land and high building density, many schools in Dhaka lack adequate open spaces, which negatively affects classroom daylight availability. Since students spend long hours inside classrooms, insufficient natural light can cause visual discomfort, eye strain, and reduced concentration. Previous studies indicate that schools with courtyards achieve better indoor environmental quality by providing more uniform daylight distribution within classrooms, which supports students' visual comfort and learning performance [2] [3]. Research consistently shows that courtyards enhance the availability and effective distribution of natural daylight, allowing light to penetrate deeper into interior spaces and reducing reliance on artificial lighting [1] [4]. Improved day lighting conditions contribute to better visual comfort and create a more conducive learning environment for students. Therefore, the incorporation of courtyards in primary school design can be considered a sustainable architectural strategy for enhancing daylight performance in classrooms, particularly in densely populated urban contexts such as Dhaka. This research compared schools with and without courtyards, measured daylight levels, and analyzed how courtyards influence classroom lighting. The findings indicate that classrooms located adjacent to courtyards receive higher levels of natural daylight, which positively contributes to students' learning experience and overall well-being.

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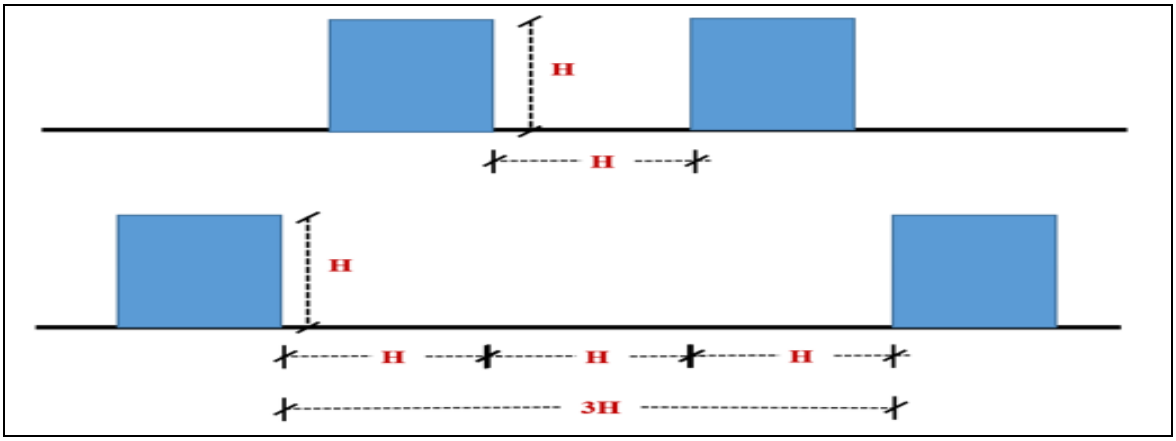

Fig 1 The Courtyard Standard Proportions According to Koch-Nielsen Studies.

➢ *Aim and Objectives:*

The study aims to analyze the impact of school courtyards on students, particularly focusing on how courtyards influence daylight availability in classrooms and its subsequent effects on students' comfort and learning environment. The objectives of the research is- To identify the effect of courtyards on classroom daylight levels.

II. METHODOLOGY

The study adopts a quantitative methodology based on a comparative analysis of several primary schools. The research focuses on assessing the impact of school courtyards on children's comfort, with particular emphasis on daylight availability in classrooms.

Daylight distribution and quality in classrooms were analyzed using daylight simulations conducted in Dialux Evo software. Classrooms with and without courtyards were compared to evaluate how courtyard design influences daylight penetration and its subsequent effect on students' comfort. Selected school are: Sunbeam school (With courtyard) and Cosmopolitan laboratory school & college (Without courtyard). This study focuses on Sunbeam School, designed by Architect Bashirul Haq, and Cosmopolitan Laboratory School & College. It examines how courtyards influence classroom daylight, comparing spaces with and without courtyards to assess their effect on students' visual comfort.

III. RESULTS AND DISCUSSIONS

➢ *Questionnaire Survey of Luminous Environment of School Design:*

A questionnaire survey was conducted with 96 students from two schools to assess classroom daylight conditions. Analysis showed that students in schools with courtyards reported better daylight availability and visual comfort, while those in schools without courtyards noted insufficient natural light. The findings indicate that courtyards significantly enhance daylight penetration in school buildings.

➢ *Analysis of Questionnaire Survey, without Courtyard School Design:*

- *How do you Feel About Day Light in your Classroom is Enough or Not?*

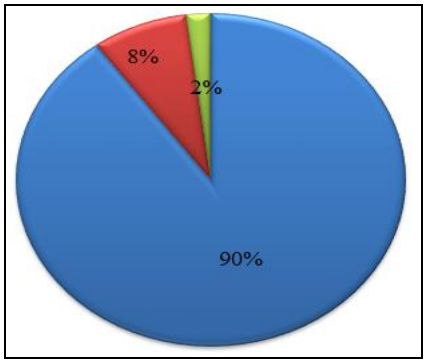

Fig 2 Students Response on Daylight, without Courtyard School

Figure 1 shows that 90% of students found their classrooms too dark, 8% slightly uncomfortable, and 2% neutral. This indicates that the absence of a courtyard reduces daylight, increasing reliance on artificial lighting, causing eye strain, lower concentration, and a less pleasant environment.

➢ *Analysis of Questionnaire Survey, with Courtyard School Design:*

- *How do you Feel About Day Light in your Classroom is Enough or Not?*

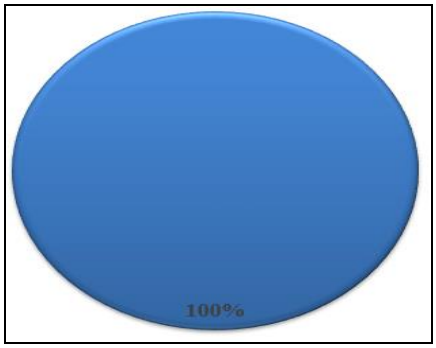

Fig 3 Comfort Voting of Daylight in Schools with Courtyard.

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Figure 2 shows that 100% of students felt comfortable with classroom daylight in schools with courtyards. This indicates that courtyards enhance day light, reduce dependence on artificial lighting, and create a pleasant, well-lit environment, improving students' comfort and overall learning experience.

Comparative Analysis of Classroom Comfort Based on Questionnaire Survey: Schools with and without Courtyards: Comparison of student's perception of daylight in classrooms schools with and without courtyard.

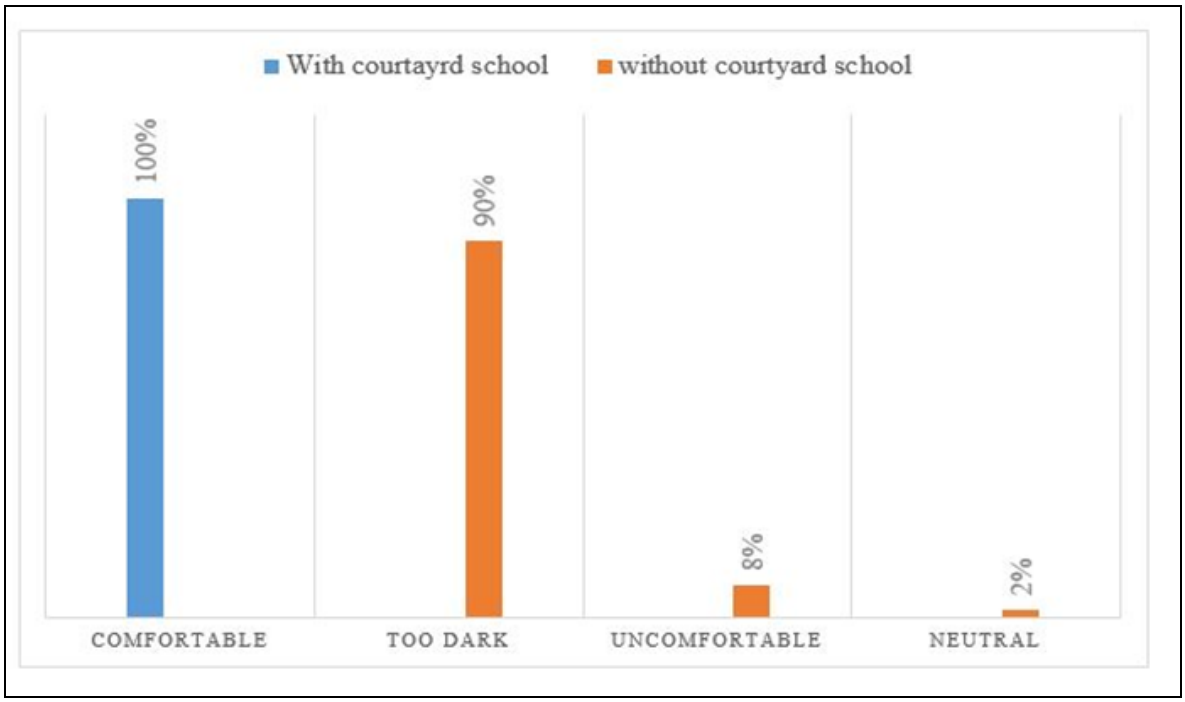

Chart 1: Comparative Analysis of Classroom

Chart 1 shows students' perceptions of daylight in classrooms. In the school with a courtyard, 100% of students felt comfortable with the lighting. In contrast, in the school without a courtyard, 90% reported classrooms were too dark, 8% felt uncomfortable, and 2% were neutral.

These findings indicate that the absence of a courtyard limits daylight, often requiring artificial lighting, which can cause eye strain, fatigue, reduced concentration, lower academic performance, and higher energy use. Courtyards, therefore, are essential for adequate daylight, visual comfort, and students' health and productivity.

➢ *Simulation Analysis of Luminous Environment*

A simulation-based analysis was conducted using DIALux Evo to evaluate daylight in Class 1 classrooms of Sun Beam School (with courtyard) and Cosmopolitan Laboratory School (without courtyard). The study assessed daylight availability at 9:00 AM and 12:00 PM, with measurements at 1 m above the floor, in line with BNBC standards (300 lux for general activities, 450 lux for detailed tasks).

Results show that classrooms with courtyards have better daylight penetration and more uniform light distribution, providing a visually comfortable environment. In contrast, classrooms without courtyards exhibit lower daylight levels, highlighting limited natural light access. These findings emphasize that courtyards significantly enhance classroom luminous quality, supporting their role as an effective passive day lighting strategy.

Table 1 Daylight Data Analysis

School Name	**Class 1**	
	9.00 am	**12.00 pm**
Sun beam School (with courtyard)	403 lx	506 lx
Cosmopolitan laboratory school and college (without courtyard)	112 lx	294 lx

Comparing schools with and without courtyards shows the significant impact of courtyard design on classroom daylight. Classrooms with courtyards generally meet or exceed recommended luminance standards, while those without courtyards often fall below them, relying heavily on artificial lighting. This highlights the role of courtyards in improving daylight, visual comfort, and reducing energy use in schools.

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Fig 4 Cosmopolitan Laboratory School, without Courtyard

Fig 5 Sun Beam School, with Courtyard

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Classroom Daylight Simulation at 9:00 AM: A Comparative Analysis of Sun Beam School (With Courtyard) and Cosmopolitan Laboratory School (Without Courtyard)

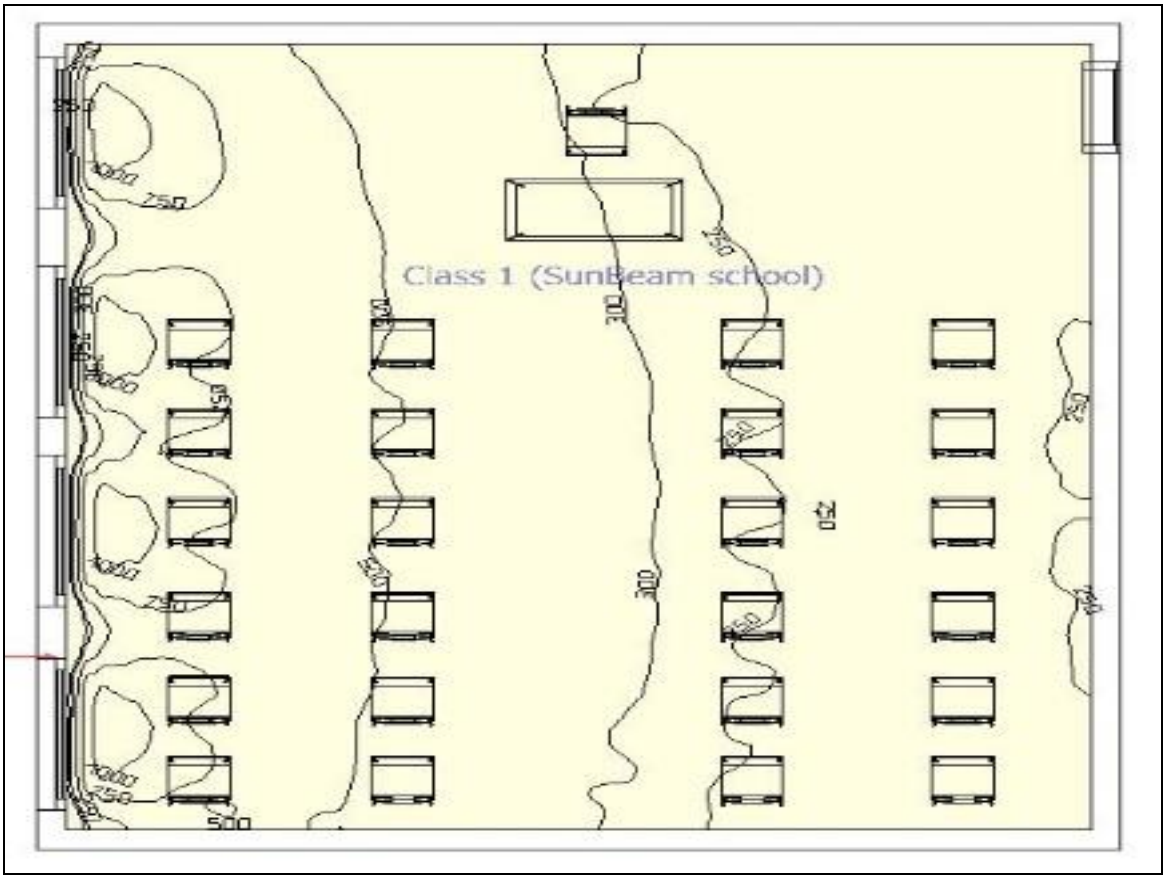

Fig 6 Sun Beam Plan with Lux Level

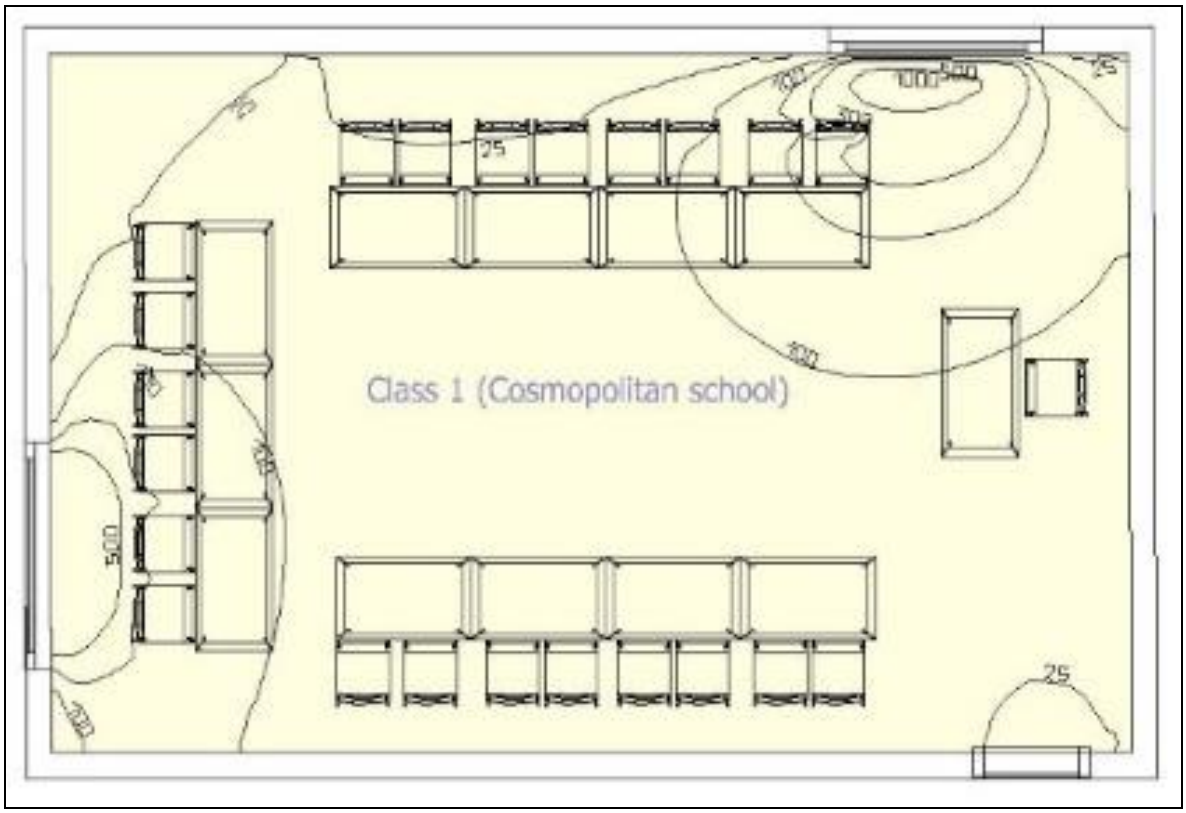

Fig 7 Cosmopolitan School Plan with Lux Level

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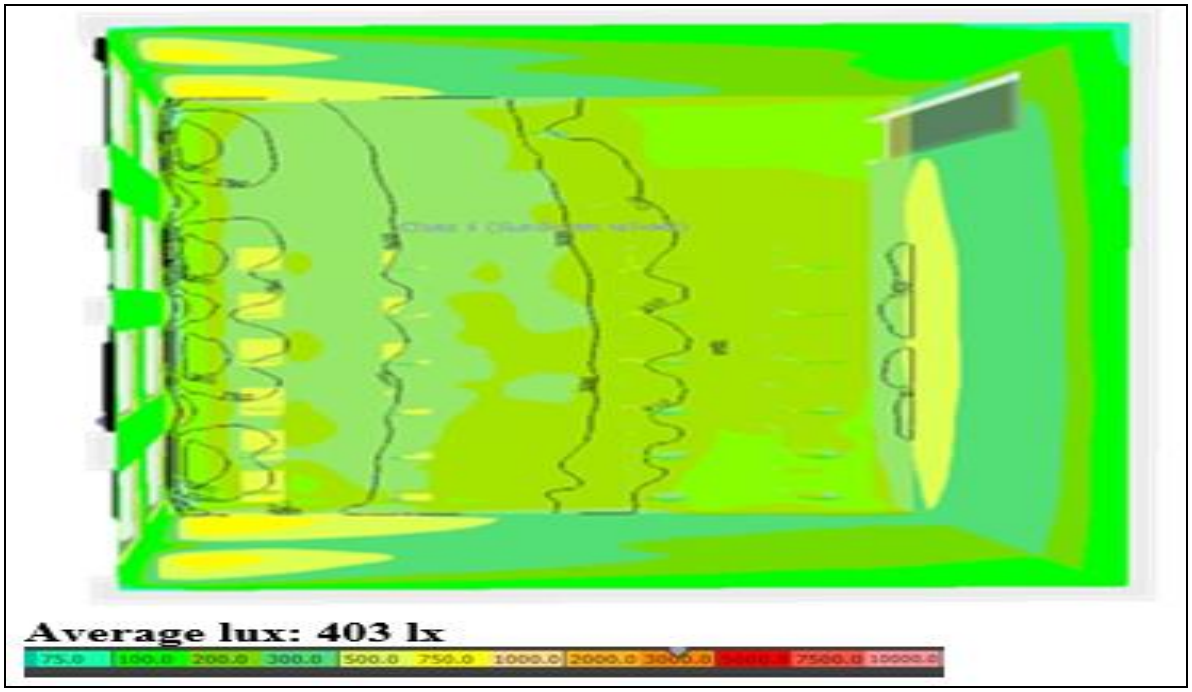

Fig 8 Sun Beam False Color Rendering

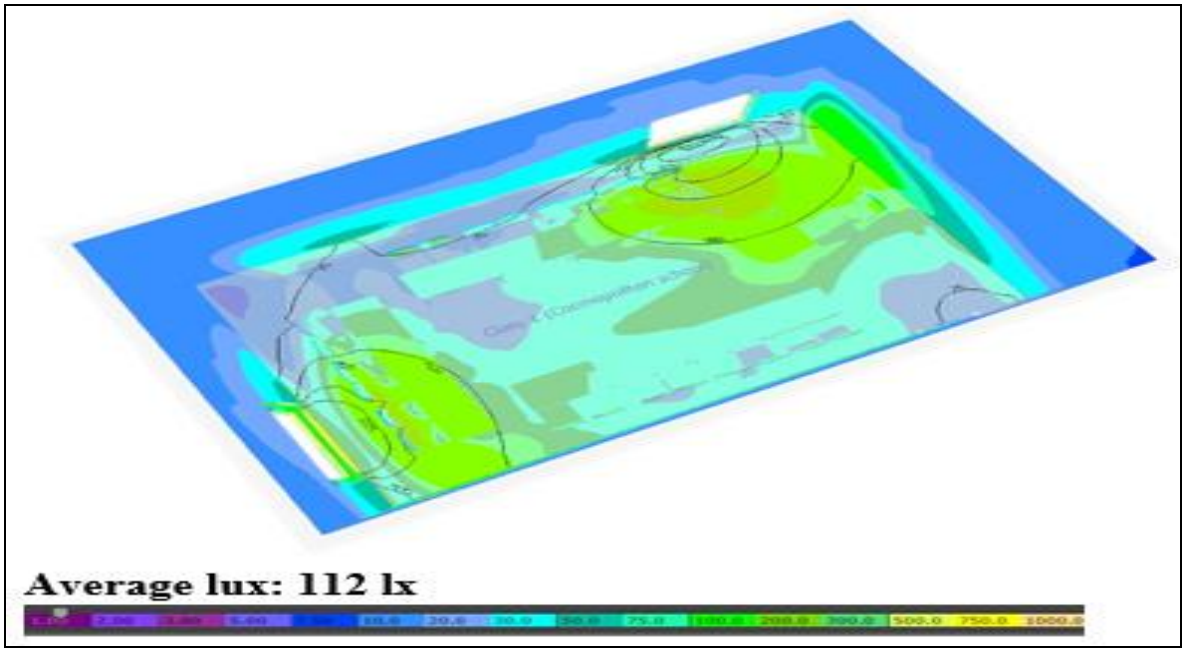

Fig 9 Cosmopolitan School False Color Rendering

Based on the daylight simulation results, an analysis of Class 1 classroom data at 9:00 AM indicates that Sunbeam School, which incorporates a courtyard, achieves an average daylight illumination level of 403 lux (lx). According to internationally accepted standards, the recommended illumination level for classrooms ranges between 300 and 500 lux. Therefore, the daylight level observed in the Sunbeam School classroom falls well within the acceptable and comfortable range for learning activities.

In contrast, at the same time (9:00 AM, Class 1 data), Cosmopolitan School, which does not include a courtyard, records an average daylight illumination of only 112 lux in its Class 1 classroom. This value is significantly below the recommended standard, indicating insufficient daylight penetration due to the absence of a courtyard.

As a result, classrooms in schools without courtyards remain heavily dependent on artificial lighting throughout the day, even during morning hours. This increased reliance on artificial lighting leads to higher energy consumption and may adversely affect students' visual comfort and overall learning environment. Conversely, the presence of a courtyard enhances daylight availability, reduces dependence on artificial lighting, and supports a healthier and more energy-efficient classroom environment.

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Classroom Daylight Simulation at 12:00 PM: A Comparative Analysis of Sun Beam School (With Courtyard) and Cosmopolitan Laboratory School (Without Courtyard)

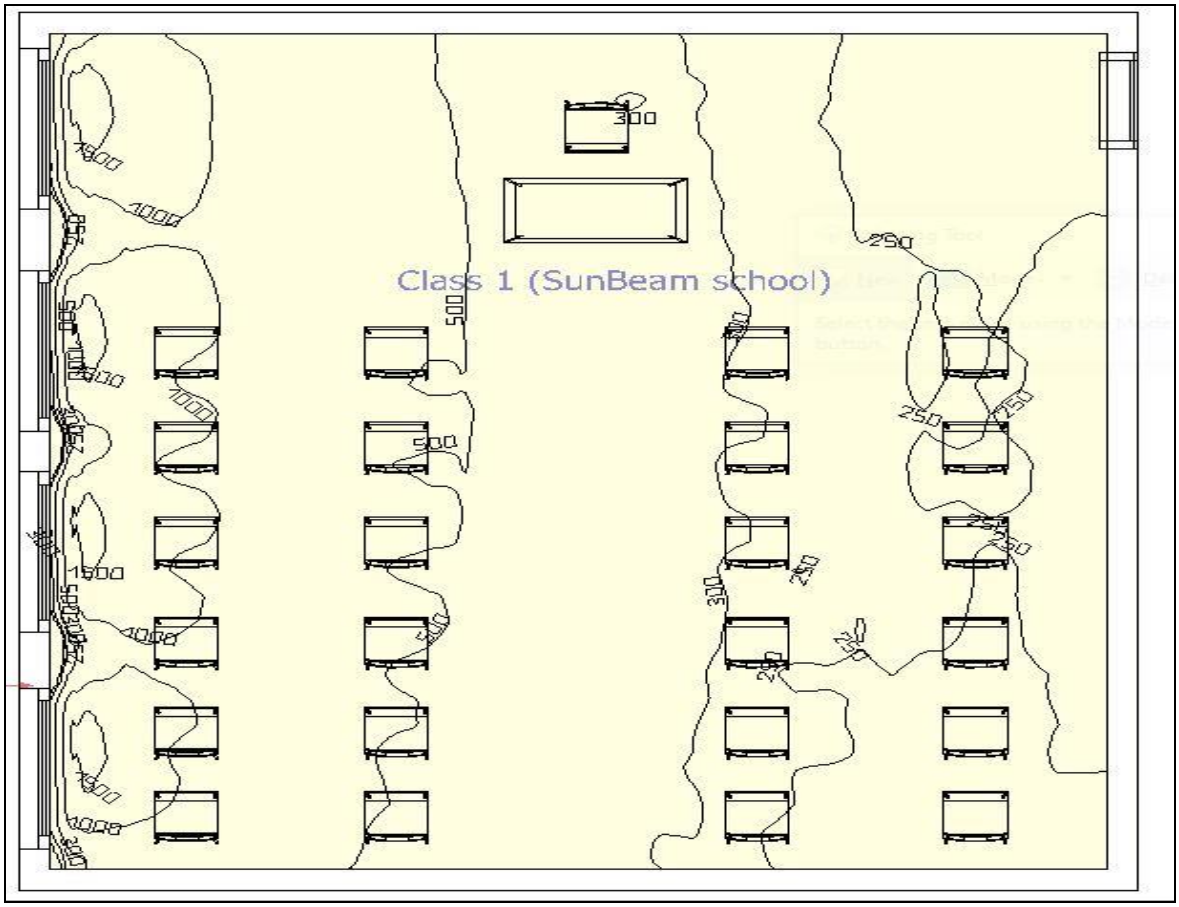

Fig 10 Class 1, Plan with Lux Level, Sun Beam School (with Courtyard)

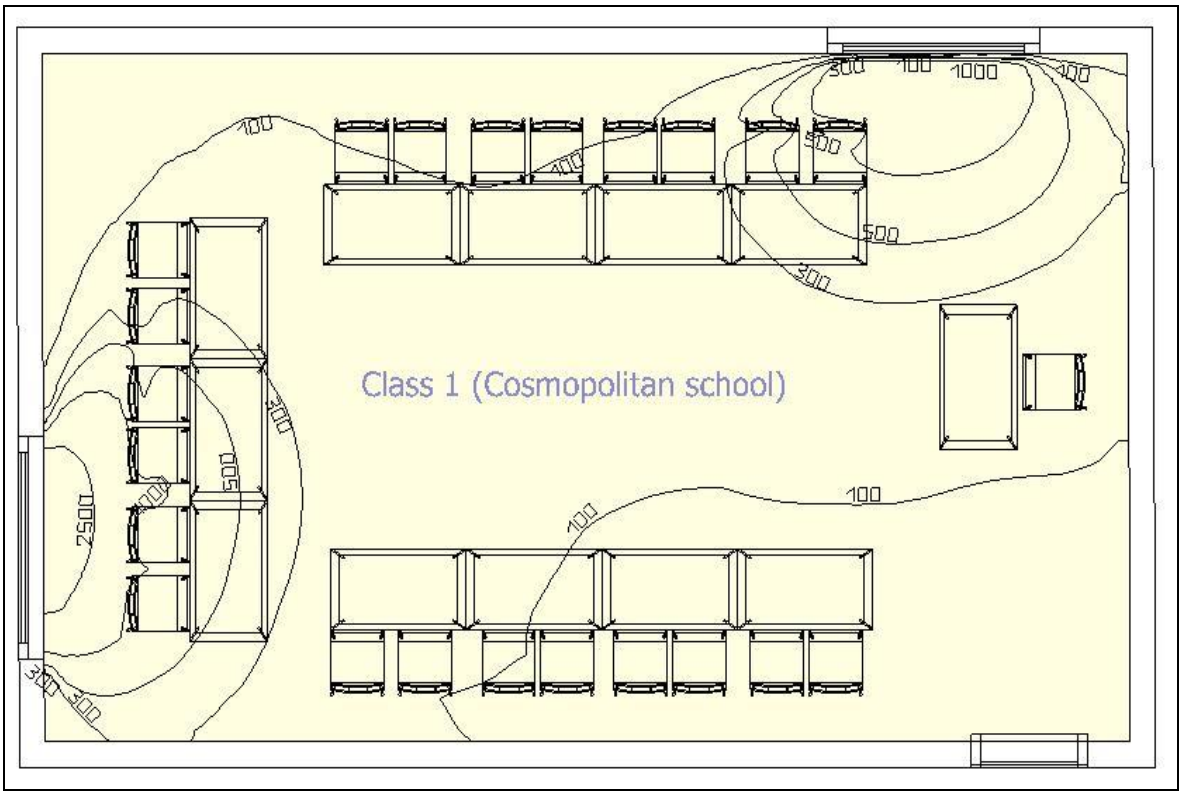

Fig 11 Class 1, Plan with Lux Level, Cosmopolitan Laboratory School (without Courtyard)

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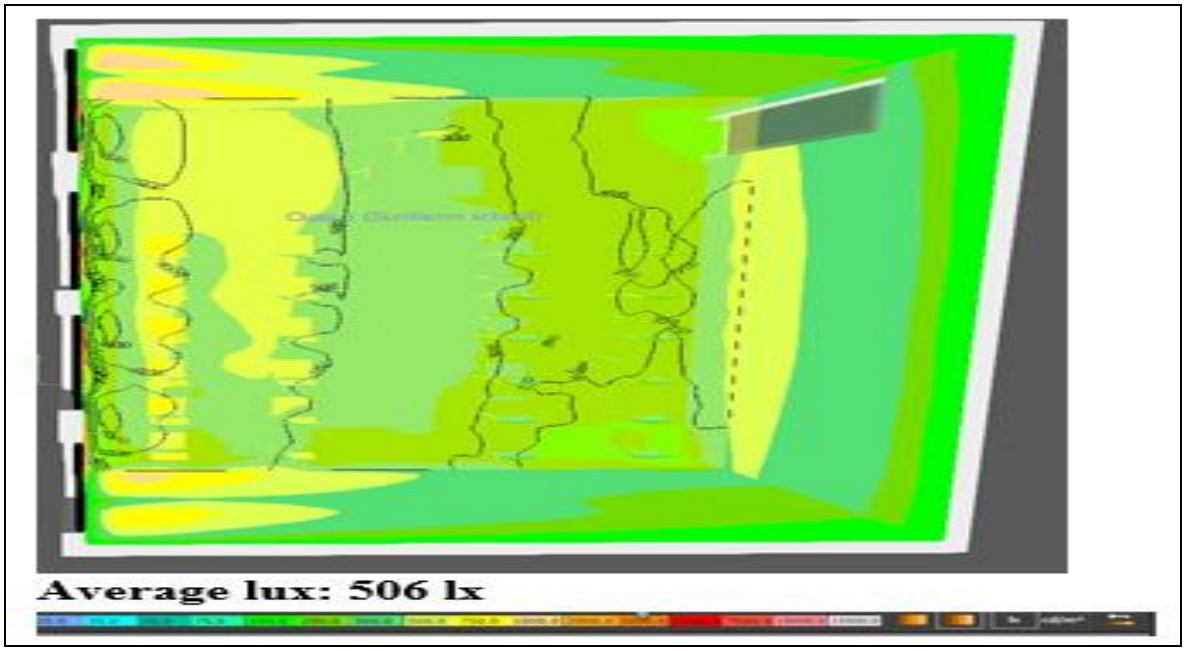

Fig 12 Class 1, Plan with False Color Rendering, Sun Beam School (with Courtyard)

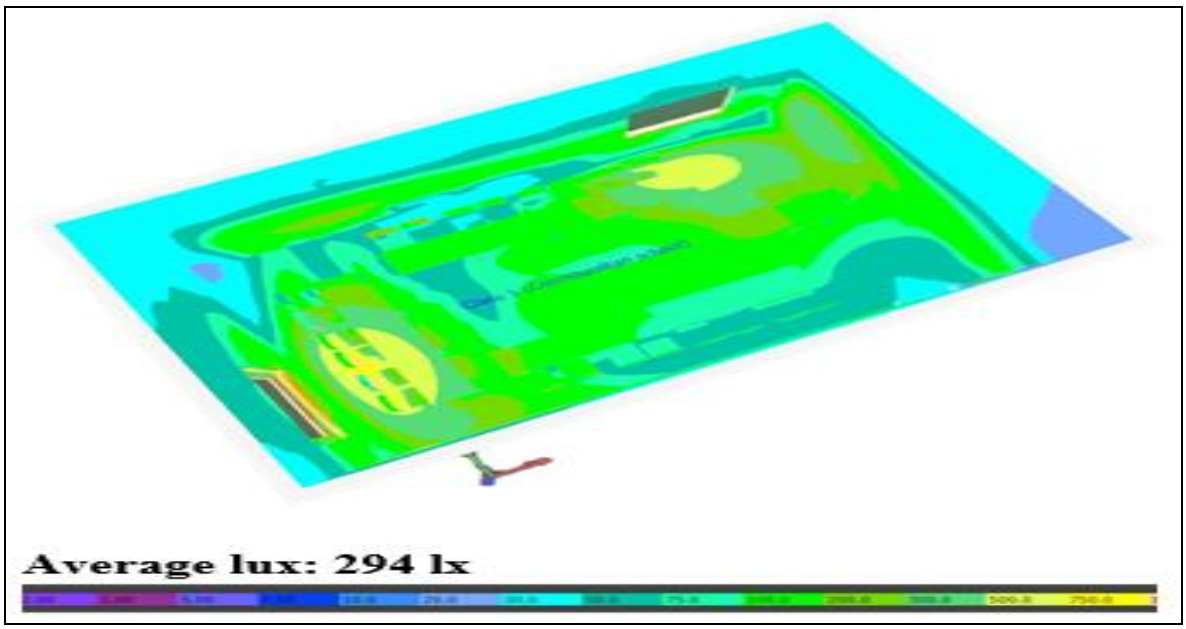

Fig 13 Class 1, Plan with False Color Rendering, Cosmopolitan Laboratory School (without Courtyard)

Based on the daylight simulation results, an analysis of Class 1 classroom data at 12:00 pm indicates that Sunbeam School, which incorporates a courtyard, achieves an average daylight illumination level of 506 lux (lx). According to internationally accepted standards, the recommended illumination level for classrooms ranges between 300 and 500 lux. Therefore, the daylight level observed in the Sunbeam School classroom falls well within the acceptable and comfortable range for learning activities.

In contrast, at the same time (12:00 PM, Class 1 data), Cosmopolitan School, which does not include a courtyard, records an average daylight illumination of only 294 lux in its Class 1 classroom. This value is significantly below the recommended standard, indicating insufficient daylight penetration due to the absence of a courtyard.

As a result, classrooms in schools without courtyards remain heavily dependent on artificial lighting throughout the day, even during morning hours. This increased reliance on artificial lighting leads to higher energy consumption and may adversely affect students' visual comfort and overall learning environment. Conversely, the presence of a courtyard enhances daylight availability, reduces dependence on artificial lighting, and supports a healthier and more energy-efficient classroom environment.

IV. CONCLUSION

The research findings indicate that the presence of a courtyard plays a crucial role in ensuring adequate daylight availability within classrooms. Schools with courtyards allow sufficient daylight to penetrate learning spaces,

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resulting in illumination levels that meet recommended classroom standards. This improved daylight condition enhances visual comfort, supports students' concentration, and creates a more effective environment.

In contrast, classrooms in schools without courtyards receive inadequate daylight, leading to poor natural illumination and increased dependence on artificial lighting throughout the day. Therefore, incorporating courtyards in school design is essential for achieving proper daylight performance, reducing energy consumption, and promoting healthy, child-friendly classroom environments.

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