

# Comparative Study on Classroom Luminous Environment in School Designs with and Without Courtyards

Tanjina Rahman<sup>1</sup>; Rumana Rashid<sup>2</sup>

<sup>1</sup>Postgraduate Scholar, Department of Architecture Ahsanullah University of Science and Technology (AUST), Dhaka, Bangladesh

<sup>2</sup>Professor, Department of Architecture Ahsanullah University of Science and Technology (AUST), Dhaka, Bangladesh

Publication Date: 2026/03/06

**Abstract:** Primary schools in Dhaka are predominantly designed with a strong focus on classroom functionality, while the role of architectural elements that influence environmental quality, such as courtyards, remains largely underexplored. As a result, many school buildings fail to utilize courtyards as an effective means of introducing and distributing natural daylight within learning spaces. Access to adequate daylight is a fundamental requirement for children's visual efficiency, comfort, and long-term well-being, particularly given the extended hours students spend inside classrooms during their formative years. This study seeks to evaluate the contribution of courtyards to daylight performance in primary school classrooms and to determine their relevance in contemporary school design. The research focuses on comparing daylight conditions in classrooms located adjacent to courtyards with those in buildings lacking such spatial features. A mixed-method research strategy was adopted. Quantitative analysis was carried out through daylight simulations using Dialux Evo to measure and compare indoor illumination levels. Complementing this, a qualitative investigation was conducted through questionnaire surveys involving 150 primary school students from two selected schools in Dhaka. The survey assessed students' experiences and satisfaction levels regarding daylight conditions in their classrooms. The outcomes of the study reveal a clear relationship between the presence of courtyards and improved daylight quality within classrooms. Simulation results demonstrated higher daylight availability in courtyard-oriented classrooms, which was further supported by students' responses indicating greater visual comfort and learning satisfaction. In contrast, classrooms without courtyards were frequently associated with inadequate lighting and reduced indoor comfort. The study highlights the courtyard as a central spatial component that enhances environmental performance in school buildings. Integrating courtyards into primary school design can significantly reduce reliance on artificial lighting while promoting healthier and more supportive learning environments. These findings offer important insights for architects and planners and contribute to the broader discourse on sustainable and child-centered school design in Bangladesh and similar climatic contexts.

**Keywords:** School Courtyards, Classroom Daylight, Students' Overall Well-Being, Daylighting Environment.

**How to Cite:** Tanjina Rahman; Rumana Rashid (2026) Comparative Study on Classroom Luminous Environment in School Designs with and Without Courtyards. *International Journal of Innovative Science and Research Technology*, 11(2), 2668-2674. <https://doi.org/10.38124/ijisrt/26feb1175>

## I. INTRODUCTION

Courtyards within private school premises serve a crucial role beyond providing spaces for outdoor activities. Architecturally, they act as natural light wells that facilitate the penetration and distribution of daylight into interior classroom spaces. This results in brighter learning environments, enhanced visual comfort for students, and reduced reliance on artificial lighting during daytime hours. Recent studies emphasize that daylight performance in buildings with courtyards depends significantly on factors such as courtyard dimensions, orientation, and shading

strategies. For instance, research in 2024 demonstrated that optimizing courtyard size and window-to-wall ratios can substantially improve classroom daylight levels while promoting energy efficiency [2]. Climate-based daylight modeling in tropical school classrooms highlights the necessity of adapting daylight design to local environmental conditions, which is highly relevant for densely populated cities like Dhaka [3]. Furthermore, investigations into private primary school environments reveal that classrooms adjoining well-designed courtyards consistently experience superior daylight availability, which enhances students' visual comfort and overall well-being [2]. In the context of Dhaka, many

private primary schools lack sufficient daylight-responsive architectural planning, resulting in deep interior classrooms with limited natural light. Comparative observations confirm that classrooms adjacent to courtyards receive notably higher daylight levels throughout the day compared to those without courtyards. This increased daylight access not only improves students’ visual comfort but also fosters a healthier and more conducive learning atmosphere. Therefore, integrating well-proportioned courtyards into private primary school design is essential for enhancing daylight conditions and supporting effective learning environments in dense urban settings.

**II. AIM AND OBJECTIVES**

This study aims to analyze the impact of school courtyards on students, with particular emphasis on how these architectural features influence daylight availability in classrooms and the subsequent effects on students’ comfort. The objective of the research is to identify the effect of courtyards on classroom daylight levels and to understand how improved daylighting conditions can enhance students’ visual comfort, well-being.

**III. METHODOLOGY**

This study employs a quantitative approach through a comparative analysis of multiple primary schools. The research aims to evaluate the influence of school courtyards on children's learning and physical development, with a particular focus on the availability of natural daylight within classrooms. Daylight distribution and quality were assessed using simulations performed with Dialux Evo software. A comparison was made between classrooms featuring courtyards and those without, in order to determine how courtyard design affects daylight penetration and its subsequent impact on students' comfort, learning experience, and activity levels. The selected schools are: Bangla Bazar Govt. girls High School (With courtyard) and South Point

School (Without courtyard). For this study, a comparative analysis was conducted between two schools to assess the impact of courtyards on classroom daylight and students’ comfort. Bangla Bazar Government Girls High School, which features a well-designed courtyard, was selected to represent schools with courtyard spaces. South Point School and College, which lacks a courtyard, was chosen to represent schools without such design elements. By comparing classrooms from these two schools, the study examines how the presence or absence of a courtyard influences daylight penetration, thermal comfort, and students’ overall learning environment. This approach enables a clear evaluation of the role of courtyards in enhancing indoor environmental quality and supporting student well-being.

**IV. RESULTS AND DISCUSSIONS**

➤ *Questionnaire Survey on School Daylighting Conditions:*

A questionnaire-based survey was conducted to assess the daylight environment of school buildings using a qualitative approach. Data were gathered from a total of 150 students across the selected schools. The survey aimed to capture students’ perceptions and experiences regarding the availability and adequacy of natural light within their classrooms. The responses were analyzed to compare the daylight conditions in schools with and without courtyards. The findings indicate that students attending schools with courtyards consistently reported higher satisfaction with daylight levels and visual comfort. In contrast, students from schools without courtyards frequently highlighted inadequate natural light in their classrooms. These results underscore the important role of courtyards in enhancing daylight penetration and creating more comfortable indoor learning environments for students.

Analysis of Questionnaire Survey: Schools with Courtyards: How do you feel about daylight in your classroom is enough or not?

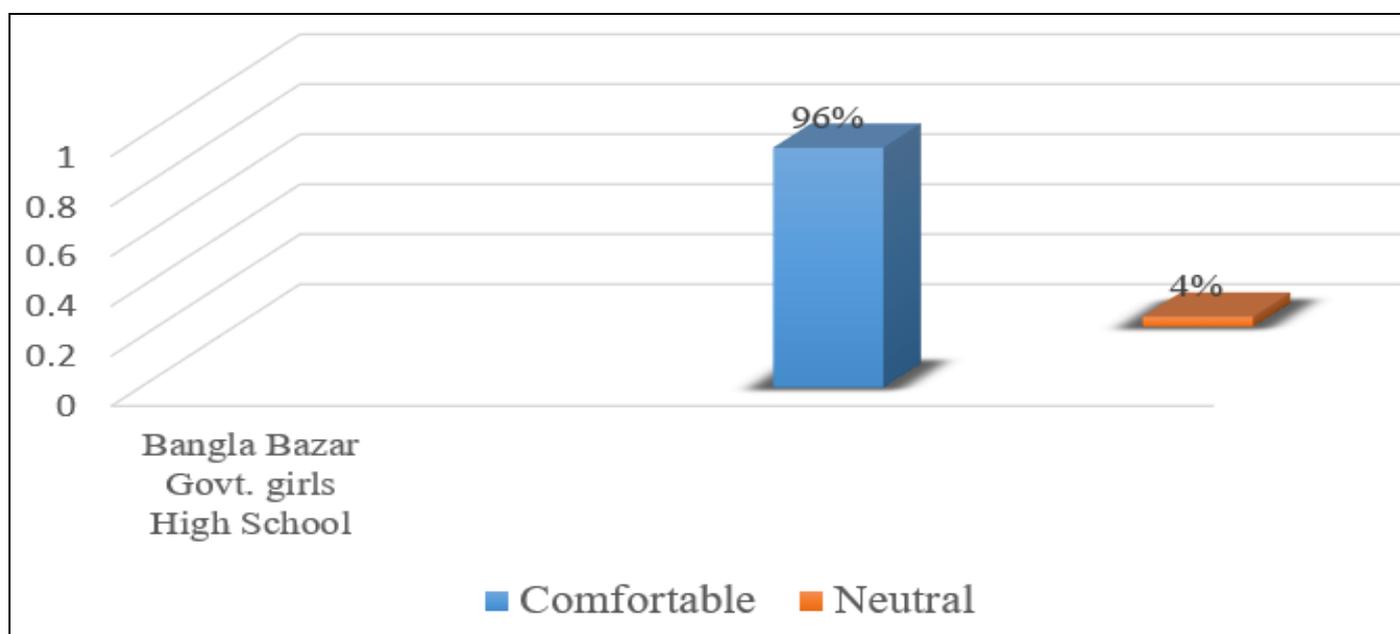


Fig 1 Students Response on Daylight, with Courtyard School

Figure 1 presents the results of the questionnaire survey conducted at Bangla Bazar Government Girls High School, where 96% of students reported their classrooms as comfortable, while 4% felt neutral. This demonstrates that the presence of a courtyard in the school significantly enhances natural light penetration in classrooms. Adequate daylight improves visual comfort, reduces reliance on artificial lighting, and contributes to a healthier and more engaging learning environment. Classrooms with courtyards provide better illumination, which can enhance

concentration, maintain student alertness, and create a more pleasant atmosphere for learning. Overall, these results highlight the positive impact of courtyards on classroom daylight and the overall comfort and learning experience of students at Bangla Bazar Government Girls High School.

Analysis of Questionnaire Survey: Schools without Courtyards: How do you feel about daylight in your classroom is enough or not?

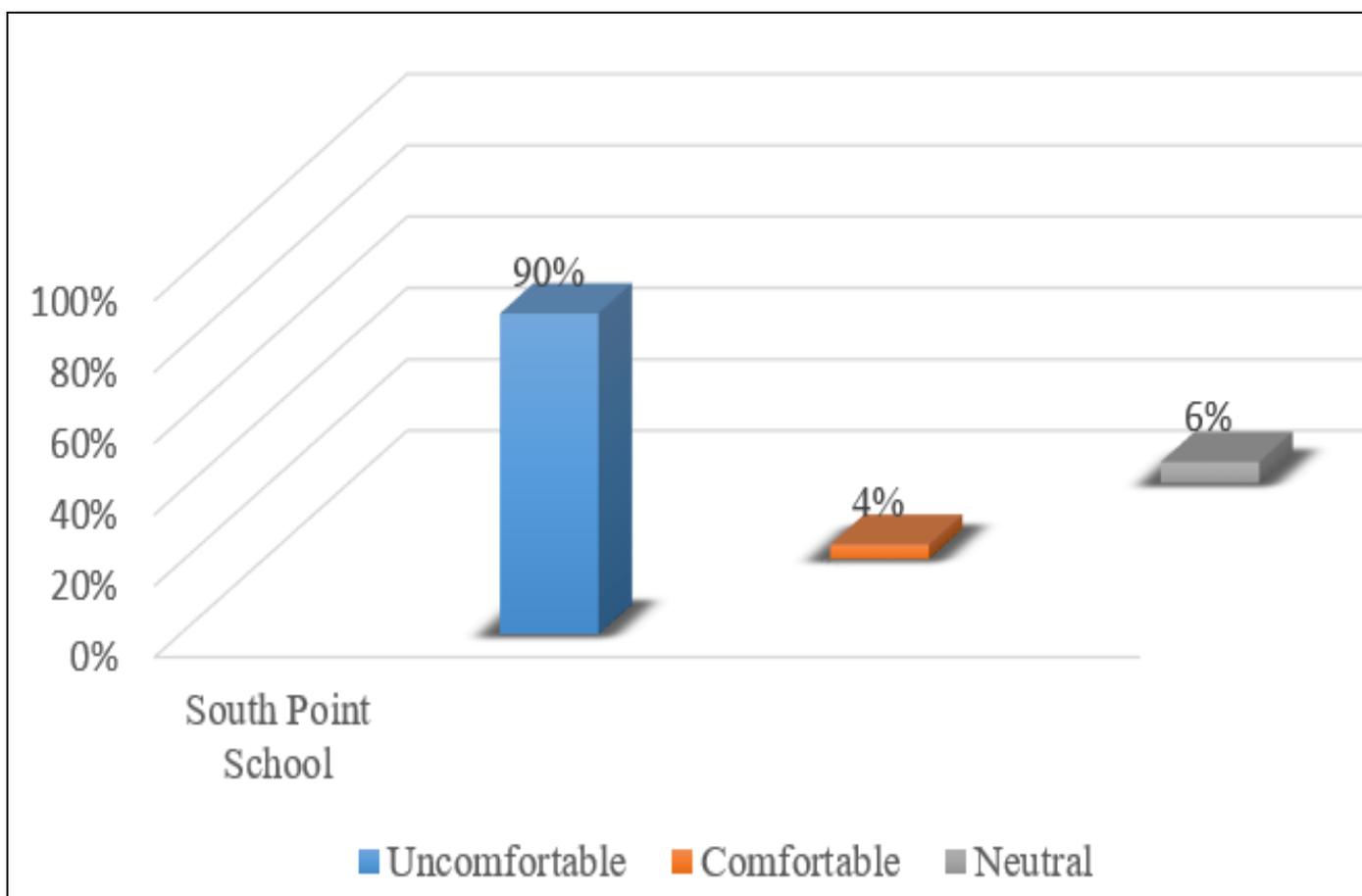


Fig 2 Students Response on Daylight, Without Courtyard School

Figure 2 presents the results of the questionnaire survey conducted at South Point School, where 90% of students reported their classrooms as uncomfortable, 4% felt comfortable, and 6% expressed neutral opinions. These findings indicate that the absence of a courtyard significantly limits natural light penetration in classrooms. Insufficient daylight can create a visually dull learning environment, increase reliance on artificial lighting, and potentially cause eye strain. Poor natural lighting may also reduce student concentration, lower enthusiasm, and make the classroom atmosphere less conducive to learning. Overall, the results highlight the adverse impact of the lack of a courtyard on classroom daylight, visual comfort, and the overall learning experience of students at South Point School and College.

Comparative Analysis of Classroom Daylighting Based on Students' Perceptions in Schools with and Without Courtyards: How do you feel about daylight in your classroom is enough or not?

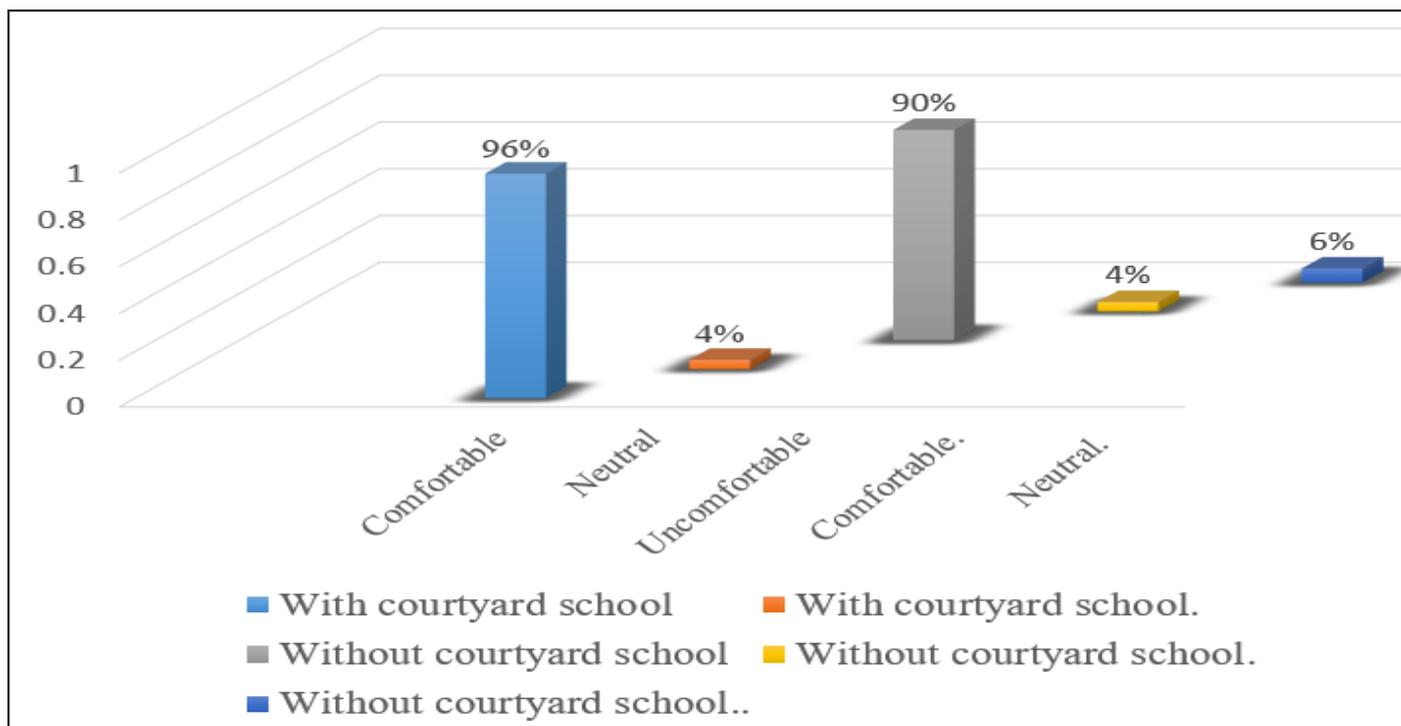


Fig 3 Comparative Analysis of Classroom Lighting and Students' Response to Daylight.

The comparative analysis of Figure 3 highlights the impact of courtyards on students' perceptions of natural light in classrooms. In Bangla Bazar Government Girls High School, which features a courtyard, 96% of students reported feeling comfortable with the level of natural light, indicating that daylight was perceived as sufficient, while 4% were neutral. The presence of a courtyard allows sunlight to penetrate deeper into classrooms, creating brighter and more evenly lit spaces. Adequate natural light enhances visual comfort, reduces reliance on artificial lighting, and helps maintain student alertness and concentration. Additionally, exposure to daylight has been linked to improved mood, reduced eye strain, and a healthier overall learning environment. In contrast, at South Point School and College, which lacks a courtyard, 90% of students reported discomfort due to insufficient natural light, 4% felt comfortable, and 6% were neutral. These findings clearly demonstrate that incorporating courtyards into school design not only improves daylight availability but also positively affects students' well-being, engagement, and overall learning experience.

➤ *Simulation-Based Analysis of Classroom Daylight:*

A simulation-based analysis was conducted using DIALux Evo software to evaluate the luminous environment of Class 3 classrooms in two selected schools. The primary objective was to assess and compare daylight availability in classrooms with courtyards and those without. The simulation results indicate a clear difference in daylight performance between the two school designs. Classrooms in

Bangla Bazar Government Girls High School, which features a courtyard, exhibited enhanced daylight penetration and more uniform light distribution, providing a visually comfortable and well-lit learning environment. In contrast, classrooms in South Point School and College, which lacks a courtyard, demonstrated lower daylight levels and uneven light distribution, indicating limited access to natural light during daytime hours. These findings highlight that the inclusion of a courtyard significantly improves daylight availability and quality in classrooms, reinforcing its role as an effective passive daylighting strategy in primary school design. Daylight levels in classrooms were evaluated in accordance with the Bangladesh National Building Code (BNBC), which recommends a minimum of 300 lux at desk level for general classroom activities and 450 lux for detailed tasks. Previous studies in Dhaka suggest that 300–500 lux is ideal for general classroom use (Saha et al., 2017). Measurements and simulations were conducted in Class 3 classrooms at 9:00 AM and 12:00 PM in Bangla Bazar Government Girls High School (with a courtyard, north-south oriented classrooms) and South Point School (without a courtyard, southeast-oriented classrooms). Simulations were performed using DIALux Evo software to assess daylight availability and distribution. The analysis focused on both individual school performance and a comparative evaluation, highlighting the significant impact of courtyard design on daylight levels and overall luminous quality in primary school classroom.

Table 1 Daylight Data Analysis

School Name	Class 3	
	9.00 am	12.00 pm
Bangla Bazar Govt. Girls High School (with courtyard)	385 lx	412 lx
South Point School (without courtyard)	215 lx	295 lx

The comparison of daylight levels between schools with and without courtyards underscores the influence of courtyard design on natural lighting in classrooms. Classrooms in schools with courtyards exhibited adequate daylight penetration, generally meeting or exceeding the recommended luminance standards. In contrast, classrooms in schools lacking courtyards showed markedly lower daylight levels, frequently falling below the prescribed thresholds. As a result, these spaces depend heavily on artificial lighting to achieve sufficient illumination. These findings highlight the importance of courtyards in enhancing natural light access, promoting visual comfort, and reducing energy consumption in educational buildings.



Fig 4 Bangla Bazar School, with Courtyard, 2019

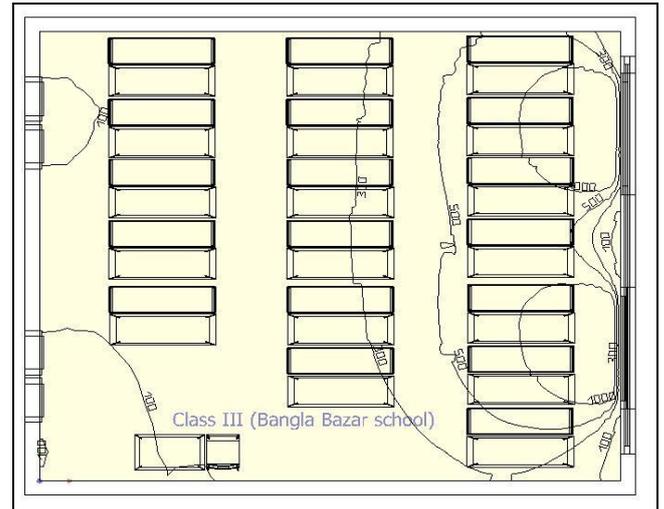


Fig 6 Bangla Bazar School Plan with Lux Level

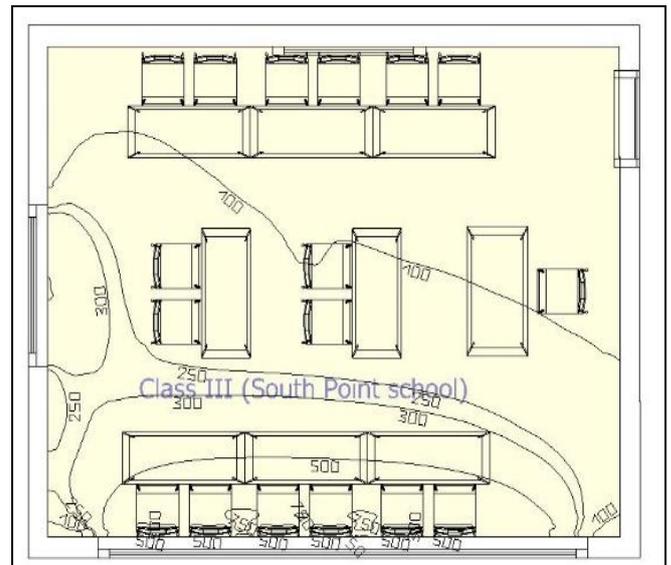
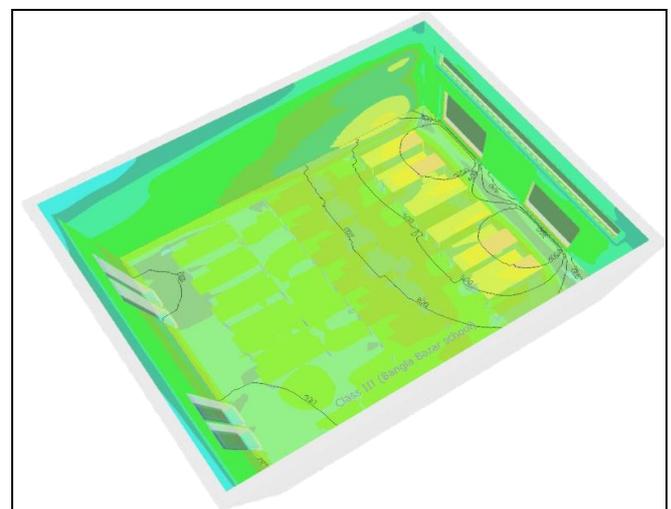


Fig 7 South Point School Plan with Lux Level



Fig 5 South Point School, Without Courtyard, 2019



Average Lux: 385 lx

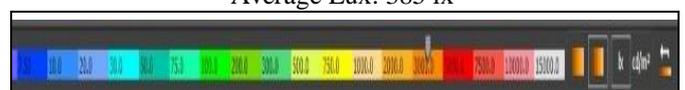


Fig 8 Bangla Bazar School False Color Rendering

Classroom daylight simulation at 9.00 am: A comparative analysis of Bangla Bazar Govt. Girls High school (with courtyard) and South Point School: Class 3



Fig 9 South Point School False Color Rendering

Based on the daylight simulation results at 9:00 AM, the lighting performance of the Class 3 classroom was analyzed for two selected schools: Bangla Bazar Government Girls’ High School, which incorporates a courtyard, and South Point School, which does not include a courtyard. The simulation results show that the classroom in Bangla Bazar Government Girls’ High School achieves an average daylight illumination level of approximately 385 lux (lx). This value falls within the internationally recommended illumination range for classrooms (300–500 lux), indicating that sufficient natural daylight is available during morning hours and providing a comfortable learning environment.

In contrast, at the same time (9:00 AM), the Class 3 classroom of South Point School records an average daylight illumination level of only 215 lux (lx), which is significantly below the recommended standard. The absence of a courtyard limits effective daylight penetration into the classroom, resulting in inadequate natural lighting even in the morning. As a result, classrooms in schools without courtyards remain dependent on artificial lighting throughout the day, including morning hours.

Adequate daylight at 9:00 AM has a positive impact on students’ physical and psychological well-being. Natural light reduces eye strain, improves visual comfort, and helps students maintain attention during early learning hours. Exposure to daylight also supports better mood, reduces fatigue, and enhances students’ concentration and overall learning performance.

Overall, the presence of a courtyard significantly improves daylight availability in classrooms during morning hours, reduces reliance on artificial lighting, and supports a healthier and more effective learning environment. Conversely, the lack of a courtyard results in insufficient daylight, higher energy consumption, and potential negative impacts on students’ visual comfort and learning experience.

Classroom daylight simulation at 12.00 pm: A comparative analysis of Bangla Bazar Govt. Girls High school (with courtyard) and South Point School: Class 3

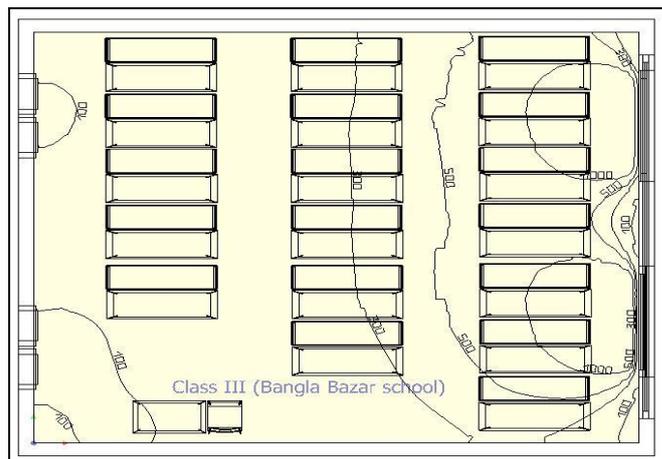


Fig 10 Bangla Bazar School Plan with Lux Level

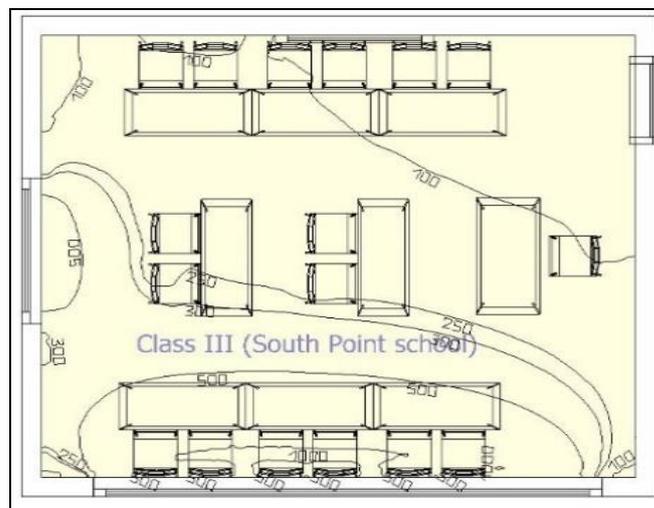


Fig 11 South Point School Plan with Lux Level

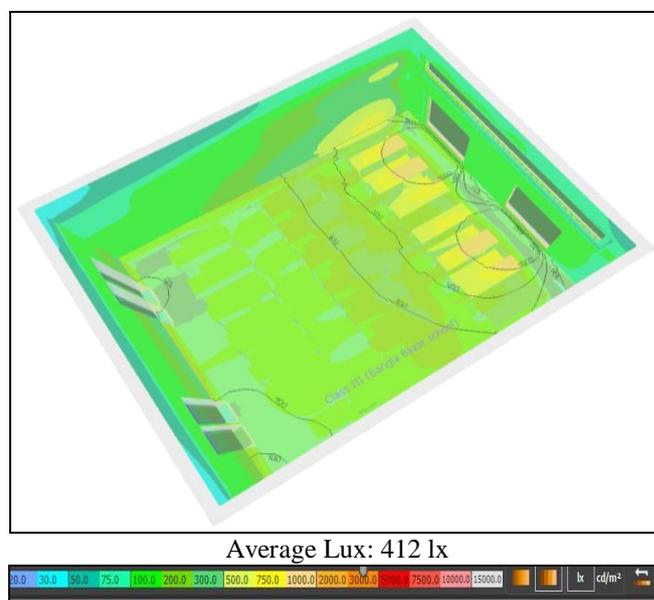


Fig 12 Bangla Bazar Govt. Girls High School False Color Rendering

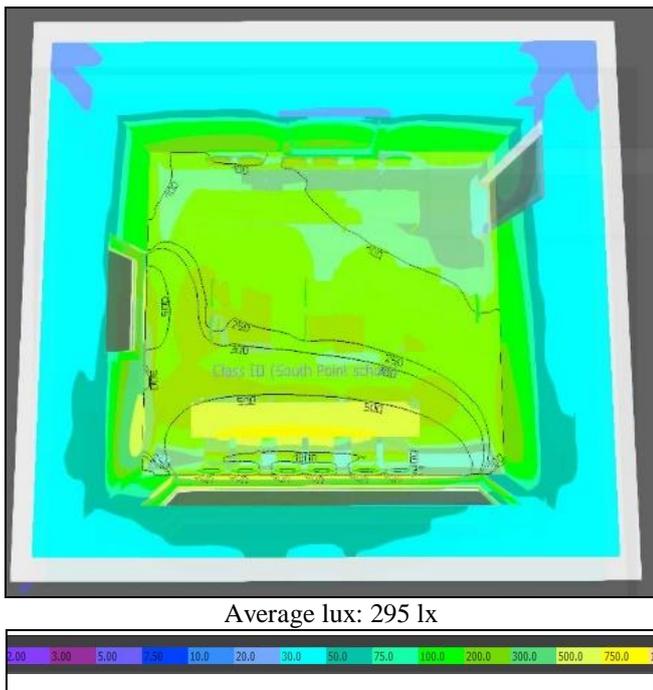


Fig 13 South Point School False Color Rendering

Based on the daylight simulation results at 12:00 PM, the lighting performance of the Class 3 classroom was analyzed for Bangla Bazar Government Girls' High School, which includes a courtyard, and South Point School, which does not have a courtyard. The simulation results indicate that the Class 3 classroom in Bangla Bazar Government Girls' High School achieves an average daylight illumination level of approximately 412 lux (lx). This value lies within the internationally recommended illumination range for classrooms (300–500 lux), demonstrating that the presence of a courtyard allows sufficient daylight to penetrate the classroom even during midday hours.

In contrast, at the same time (12:00 PM), the Class 3 classroom of South Point School records an average daylight illumination level of approximately 295 lux (lx). Although this value is close to the lower limit of the recommended standard, it still indicates relatively inadequate daylight availability compared to the courtyard-based school. The absence of a courtyard restricts effective daylight distribution within the classroom, resulting in reduced lighting quality and a continued need for artificial lighting support. Adequate daylight at midday has a positive impact on students' comfort and learning efficiency. Proper natural lighting reduces visual discomfort and eye strain, supports sustained concentration, and creates a more pleasant classroom environment. Overall, the simulation results at 12:00 PM further confirm that the presence of a courtyard significantly enhances daylight availability in classrooms, ensures compliance with recommended illumination standards, and contributes to a healthier, more comfortable, and energy-efficient learning environment. Conversely, classrooms in schools without courtyards experience comparatively lower daylight levels, leading to increased dependence on artificial lighting and reduced visual comfort for students.

## V. CONCLUSION

The results of this study clearly demonstrate that the inclusion of a courtyard has a significant impact on improving daylight performance in classroom environments. Schools designed with courtyards facilitate better penetration and distribution of natural light, allowing classrooms to achieve illumination levels that comply with recommended standards. Enhanced daylight availability improves visual comfort, reduces eye strain, and supports students' concentration and learning efficiency. Beyond daylight improvement, courtyards offer several additional benefits. They promote natural ventilation, help regulate indoor thermal comfort, and create a healthier microclimate within the school building. Courtyards also provide visual connection to outdoor spaces, which can positively influence students' mental well-being, reduce stress, and create a more pleasant and engaging learning atmosphere.

In contrast, schools without courtyards experience limited daylight access, resulting in insufficient natural illumination and a greater dependence on artificial lighting throughout the day. This increased reliance on artificial lighting leads to higher energy consumption and may negatively affect students' comfort and overall learning experience.

Therefore, incorporating courtyards into school design is a highly effective architectural strategy. It not only enhances daylight performance and energy efficiency but also contributes to healthier, more sustainable, and child-friendly learning environments that support both academic performance and student well-being.

## REFERENCES

- [1]. DergiPark (2023). Improving natural lighting performance in historical education venues: Ulugazi Primary School. *DergiPark*.
- [2]. Energy and Buildings (2024). Energy savings evaluation of enhanced classroom daylighting utilization. *Energy and Buildings*.
- [3]. Science of the Total Environment (2023). Formulation of climate-based daylighting design prediction model for high performance tropical school classrooms. *Science of the Total Environment*.