

# The Lighting Effectivity in the Classroom in Junior High School (Case Study: SMP Firdaus Bandung)

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## ABSTRACT

Lighting is very important for teaching, learning, and more activities in the classroom. In SMP Firdaus Bandung, there are several classrooms in which the form of lighting is natural lighting. However, the lighting is less effective and does not up to lighting standards. In fact, the purpose of adequate and effective lighting is to maintaining eye health and save energy. This is because in designing lighting that it should be taken into calculation. So that the use of lamps to distribute light evenly is not excessive. This study will examine more deeply a good design for lighting in the classroom based on the calculation of natural lighting. The method used for this research is quantitative, with calculations using SNI and then simulated with DIALux Evo Software. The results of this study show the strength of the lighting in natural lighting in the Firdaus Bandung Junior High School classroom and obtain lighting designs that can support student activities according to the standard of 250-500 lux.

**Keywords:** *Lighting, Classroom, DIALux exo simulation.*

## 1. INTRODUCTION

Light is an electromagnetic wave in the range 380 nm to 780nm. Light relates to lighting in space. This lighting is divided into natural lighting and artificial lighting. Natural lighting during the day, especially in the tropics, is used for indoor lighting during the day (8.00 – 16.00). The utilization of natural sunlight in buildings is very useful, especially to reduce the consumption of electrical energy in buildings, as well as provide physiological and psychological comfort for building occupants [1,2]. This is not like artificial lighting which requires electrical energy to turn it on [3,4].

Natural lighting is divided into two, namely sunlight and daylight. Sunlight is direct sunlight that has a high intensity and a narrow light angle. Skylights are indirect sunlight scattered by atmospheric particles, including clouds, of moderate to low intensity and a wide light angle. While artificial lighting is a source known as a lamp or luminaire. In bad weather and at night, artificial lighting is required.

In schools, the lighting system is very important for visual comfort in teaching and learning activities [5,6]. Where the main function of the school is a means of studying. The quality of teaching and learning in the classroom can be improved if the quality of physical facilities is adequate. The lighting system in the classroom can affect the comfort of students who are studying, as well as affect the fluency of the teacher in carrying out the teaching process for his students.

Firdaus Open Junior High School is one of the schools located in Paragliding, Arcamanik District, Bandung City. Previously, SMP Firdaus Open had researched effective furniture layout [7]. This Junior High School is an open and free school that is used as a place of learning for children who cannot afford public schools [8]. This school prefers to use natural lighting to save electricity costs. This makes SMP Firdaus an object that will be investigated for its natural lighting system. Based on the Indonesian National Standard (SNI), classrooms have 250-500 lux [9]. Therefore, in this study, we will examine the natural lighting in the classrooms produced to find out how effective the light that enters the classroom is. It is intended that teaching

and learning activities in the school classroom can be carried out optimally with good lighting.

**2. METHODS**

The research method was carried out at Firdaus Junior High School which is an open school in the city of Bandung. Data were collected by survey and from internet media. Then the data is processed quantitatively [10]. This study uses a sample of three classes with different openings as a source of natural lighting.

Next, the sample room was modeled, and then analyzed visually using the DIALux Evo 9.1 software [4,5]. DIALux is a software for simulating natural and artificial lighting. Its main function is to test exposure in a three-dimensional view and predict illumination calculations. Previously the model was adjusted to the type of material and color used in the field. The model is made as close as possible to the existing conditions. Then, the room is simulated to calculate the average amount of light and the pattern of light distribution in the rooms.

**3. RESULTS AND DISCUSSION**

The object of research includes 3 classrooms of Firdaus Junior High School Bandung, including classrooms for class 1, class 2, and class 3.



Figure 1 SMP Firdaus plan.

In the Firdaus Junior High School building, there are several classrooms that will be visualized with an area of 39 m<sup>2</sup> - 47 m<sup>2</sup>, with a classroom ceiling height of 2.8 m. Visualization and evaluation activities aim to provide solutions to problems that occur as described in the field data and verification process. To produce a precise and efficient lighting system.

During the simulation with natural lighting conditions, all lights in the classroom are turned off. Then the light comes from an open window, unobstructed, with good light conditions, the sky is not cloudy. Visualization is carried out according to student learning hours by taking time in the morning at 08.00, before noon at 10.00, in the afternoon at 12.00, and afternoon at 14.00.

**3.1. 1<sup>st</sup> Classroom**

Class 1 is 6.85 m long, 6.85 m wide, and 2.8 m high. This room has 4 glass windows on the southeast side and 4 glass windows on the southwest side. Here is the result of the simulation of natural lighting (table 1).

**Table 1.** 1<sup>st</sup> Classroom Graph of Natural Lighting Simulation

Time	Result	
	False Color	Lux Average
08.00		372 lux
10.00		645 lux
12.00		740 lux
14.00		631 lux
Information:		

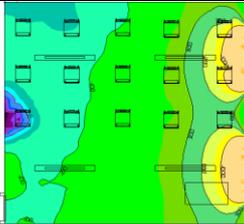
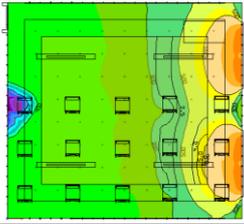
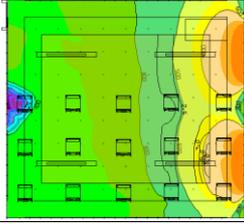
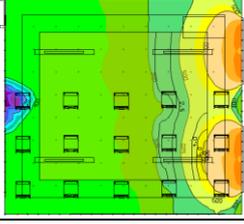
Simulation results of natural lighting in class 1 can be seen that the highest luminance calculation results are at noon, at 12.00 with an average value of 740 lux.

While the lowest values are in the morning and evening, namely 372 – 347 lux. Overall, the level of lighting in class 1 has met the recommended standard, which is between 250-500 lux. However, on average, the highest lux value is in the area that is close to the window.

### 3.2. 2<sup>nd</sup> Classroom

Class 2 is 6.85 m long, 6.35 m wide, and 2.8 m high. This room has 4 glass windows on the Southwest side. Here is the result of the simulation of natural lighting (table 2).

**Table 2.** 2<sup>nd</sup> Classroom graph of natural lighting simulation

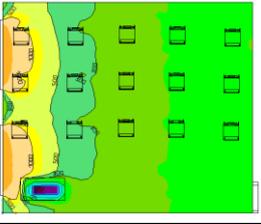
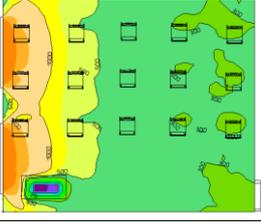
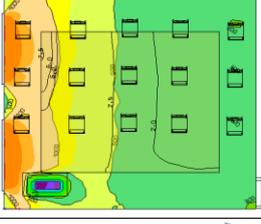
Time	Results	
	False Color Graph	Lux Average
08.00		262 lux
10.00		455 lux
12.00		522 lux
14.00		445 lux

Simulation results in Class 2, obtained the highest simulation calculation at 12.00, which was 522 lux. However, the light does not spread as well as Class 1 luminance. Good light is only found in the Window section. This is because the natural light source comes from one side, causing the opposite side to darken, and has a value of approximately 10 lux.

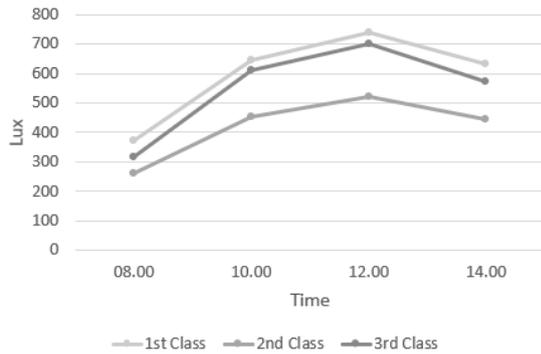
### 3.3. 3<sup>rd</sup> Classroom

Class 3 is 6.85 m long, 5.85 m wide, and 2.8 m high. This room has 4 glass windows on the Northeast side. Here is the result of the simulation of natural lighting (Table 3).

**Table 3.** 3<sup>rd</sup> Classroom graph of natural lighting simulation

Time	Result	
	False Color Graph	Lux Average
08.00		340 lux
10.00		623 lux
12.00		710 lux
14.00		573 lux

The simulation results in Class 3 (Table 3), obtained the highest simulation calculation at 12.00, which is 710 lux. The overall result obtained is smaller than Class 1 and larger than Class 2. However, the light does not spread well, because the light that has the highest value is only in the Window. The minimum luminance value for a Class 3 room in the entire room is approximately 100 lux.



**Figure 2** Lux value comparison in classroom.

Based on the figure 2, that natural lighting in all classes has met the standard. The greatest illumination is entirely in class 1, then class 3 and class 2. The highest value is obtained at 12.00 with a value of 740 lux. This is influenced by the time, the location of the openings in each different class, the number of different openings, and the size of the different spaces. At 08.00 to 12.00 there is an increase in illumination in each class and then at 14.00, there is a decrease in the value of illumination in each class.

Based on the results of the verification process data using DIALux Evo 9.1, and the optimization process, it can be concluded that the lighting systems in the Firdaus Junior High School classrooms do not all refer to the energy conservation of the lighting system recommended in Indonesia (SNI). This can be seen from the results of the pattern of natural light distribution in the uneven graphic result and the average luminance in classrooms is still less than 250 lux in accordance with the average lighting standard in Indonesian classrooms (SNI).

#### 4. CONCLUSION

This lighting serves as a visual comfort for our eyes in seeing an object. If a room already has natural lighting but does not provide visual comfort, artificial lighting is needed as an achievement in that visual comfort. Lux is a unit of luminance and light transmittance in a class. Based on SNI (Indonesian National Standard) the recommended lighting for learning activities such as reading, and writing is 250 lux to 500 lux.

The natural lighting at Firdaus Junior High School which was analyzed resulted in a calculation that was not too high, between 260-740 lux in all classrooms. However, the results are still within the average standard. In terms of natural lighting, the highest lux is only at the table near the window. Therefore, schools must use artificial lighting. This is because natural lighting is not static, it will be dim depending on the season. This will be done in the next stage of research,

to find out the value of artificial lighting needed in each sample class and how the layout of the artificial lighting arrangement.

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