

Identification of Natural Lighting Intensity in the Architectural Studio Classroom

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Article Info

Article history:

Received June 24, 2024

Revised Nov 21, 2024

Accepted Dec 27, 2024

Keywords:

Architectural Studio;
Lighting;
Learning Space;
Natural Lighting.

ABSTRACT

Architectural works offer various benefits to support user activities, including creating spaces that facilitate learning. For architecture students, studio spaces play a crucial role in their academic activities as these spaces are specifically designed for collaborative and individual learning. Natural light is considered the best source of illumination, providing a comfortable and energy-efficient environment. However, ensuring optimal lighting conditions in all parts of the studio is a challenge that requires thorough analysis. This research aims to examine architecture studio rooms as learning spaces, focusing on the quality and distribution of natural lighting to enhance student comfort and productivity, even in scenarios where artificial lighting might be necessary. The study employs a descriptive method, combining direct observation with quantitative analysis to compare field data with findings from relevant literature. Results reveal that while some areas of the studio receive adequate natural light, others fall short, highlighting the need for improvements in lighting design. This imbalance can impact the overall functionality and comfort of the space, emphasizing the importance of considering natural lighting in architectural design. The research also involves field measurements using specialized instruments to provide accurate insights into the lighting conditions. By addressing these issues, the study contributes to the broader understanding of how natural light influences learning spaces and offers recommendations for optimizing lighting in architectural spaces.

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1. INTRODUCTION

An architectural work cannot be separated from a different benefit in each architectural work. The benefits of architectural work can be shown as a support for various kinds of lives of users of architectural buildings. One of the supports for the lives of users of architectural buildings is a learning activity. In an area, a building for learning is one of the public facilities that supports educational activities. As a public building, the costs incurred for school operations come from the community and also the government, therefore energy saving efforts can have a fairly good impact on many parties.[1]

The architectural studio space is a learning center for architecture students where architecture students learn and develop their creativity. The learning process in the classroom is one strategy to achieve the goals of the architecture students. To achieve these goals, it will be very disruptive if the lighting conditions do not meet the specified standards. The comparison of the level of natural lighting in the room and natural lighting on a flat plane in an open field is determined by: a) the geometric relationship between the measuring point

and the light hole, b) the size and position of the light hole, c) the distribution of sky light, d) the part of the sky that can be seen from the measuring point. [2]. Lighting greatly influences an activity in a room. The main function of lighting is as a room light to support the activities taking place in the room. In addition, lighting can also provide added value in a room, including building a room atmosphere, physical and psychological effects are a unity that influences each other in lighting. Light is an electromagnetic wave that can be seen with the eye. A light source emits energy, some of this energy is converted into visible light. The propagation of light in free space is carried out by electromagnetic waves. [3]. It is necessary to have sufficient natural light from sunlight into the room. Lighting that is too bright will make the user of the room feel awake and very active..[4]. Natural lighting is very important to support learning because of the need for sufficient natural light to obtain visual comfort for students. Natural lighting is lighting obtained from direct sunlight, where this light is obtained in the morning to the afternoon. According to SNI 03-2396-200, natural lighting during the day can be said to be good if: (a) During the day between 08.00 and 16.00 local time there is enough light entering the room, (b) The distribution of light in the room is quite even and/or does not cause disturbing glare. [5]. Natural lighting has certain provisions to achieve such comfort. Natural lighting during the day must meet the following provisions: a) natural light during the day must be utilized as well as possible; b) in utilizing natural light, direct solar radiation entering the building must be minimized. Sky light must be prioritized over direct sunlight; c) natural lighting during the day in a building must meet the provisions of SNI 03-2396-1991 concerning "Procedures for designing natural lighting during the day for houses and buildings".[6].Therefore, an observation or observation, measurement and analysis of the level of lighting in the morning, afternoon and evening in the room is carried out to provide a picture of the average natural lighting conditions of the studio classroom which will then be compared with the standards that have been determined. Natural lighting comes from sunlight that enters the building space through openings in the building and is greatly influenced by the position of the building in relation to the position of the sun.[7]

The architectural studio space of the Institut Teknologi Indonesia uses a tropical architectural concept, but there are still several corners of the room that experience a lack of natural lighting, such as the area near the partition between studio A and studio B, which on December 20, 2023 had a light intensity of 220.11 lux. The lighting level in a room is defined as the average lighting level on the work plane in lux units. What is meant by the work plane is an imaginary horizontal plane located 0.75 meters above the floor in the entire room.[8]. The architectural studio space of the Indonesian Institute of Technology is located on the 3rd floor of building F with the west side facing the F seminar room, the east side facing the BPUD lab, the north side facing the garden, and the south side facing building G. Because natural lighting is one of the things that is very necessary to support learning for architecture students, it is necessary to utilize natural light from the sun that enters every corner of the architectural studio room optimally so that students who study in the architectural studio room can get comfort in natural lighting. Basically, light is needed by humans to see objects visually. With the light reflected by these objects, we can see them clearly. So that it will create visual comfort if the lighting obtained is sufficient. Which will have an impact on health, especially on the sense of sight (eyes). The lighting required for each job is different. The work area requires an adequate level of comfort so that users in it can carry out activities smoothly and have good work productivity. Visual comfort in a room that comes from lighting is influenced by the number, size and placement of openings/windows. [9]. To obtain visual comfort, the light should not be too bright or too dim. The minimum average lighting level and the minimum recommended color rendering should not be less than the lighting level in the Table and the lamp power density should not exceed the value (excluding ballast losses) [6].

Table 1. Lighting levels and color rendering

Room Function	Average minimum illumination level (lux)	Minimum color rendering
Classroom	350	80
Library Reading Room	350	80
Laboratory	500	90
Computer Practice Room	500	80

Source: SNI 03-6197-2000

Light Intensity/Illumination is a unit of the amount of lighting. The level of lighting can be seen from the intensity of light in the room. Light Intensity/Illumination (E) is the flow of light falling on the surface of a plane per square meter, the unit is Lux or Lumen/m². With the equation:[10]

$$E = \frac{\Phi}{A}$$

This Φ = light current unit is Lumen (lm)

A = illuminated surface area unit (m)²

There are factors that affect the intensity of light. The utilization factor is defined as the ratio of the luminous flux reaching the work area to the light output emitted by all lamps. The determination of the utilization coefficient based on the reflectance factor of the ceiling, walls, and floor is influenced by the reflection of each color. [11]. The reflectivity of the cat can be seen in Table 2.

Table 2. Paint Reflectivity Table

Paint color	Percentage of light reflection
White	85%
Yellow	75%
Light gray	75%
Bright blue	55%
Dark Blue	10%
Maple	7%
Mahogany	12%
Walnut	16%

Source: IES Hand Book, 1984

2. METHOD

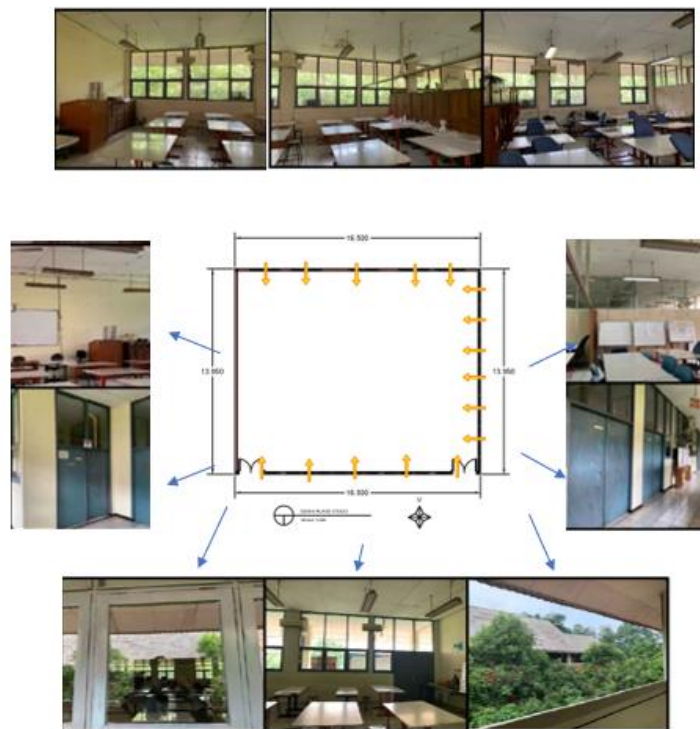
The method used in the problem of natural lighting in this architectural study room is a quantitative method using a direct observation method in the studio room of the Institut Teknologi Indonesia. This method is used to answer the formulation of the problem regarding the lack of natural lighting in the architectural space of the Institut Teknologi Indonesia by comparing the level of lighting in the classroom according to the Indonesian National Standard (SNI) with the lighting results measured directly in the architectural studio room which are then formulated hypotheses. The measuring instrument used in this study is to use a luxmeter found in the light maker application and is used directly to calculate the unit light flow which is then calculated using the light intensity formula.

3. RESULTS AND DISCUSSION

This study examines the natural lighting in the architectural studio space of the Indonesian Institute of Technology to meet the visual comfort for students carrying out learning activities in the architectural studio space. In this study, a study will be conducted from the results of measurements and calculations in the architectural studio space.

a) Building Orientation Towards the Sun.

In the architectural studio space of the Institut Teknologi Indonesia, the building orientation faces west so that the architectural studio space only gets sunlight through openings on the north and south sides of the building.



Picture 1: Classroom studio condition

b) *Light Openings on the Walls.*

The light openings on the walls in the architectural studio space of the Indonesian Institute of Technology are window openings located on the north and south sides of the architectural studio space, openings on dead windows located on the four sides of the architectural studio, and openings on doors located on the south side of the architectural studio. With a total of 28 openings in the form of living windows measuring 80 x 85 cm, 32 openings in the form of dead windows above living windows and doors measuring 80 x 200 cm, 9 openings in the form of dead windows on the east side measuring 84 x 85 cm, and 2 openings in the form of doors measuring 160 x 200 cm.

c) *Natural Lighting Measurement.*

Lighting measurements in the architectural studio space of the Institut Teknologi Indonesia were carried out with the lights turned off and only utilizing natural light from the sun so that the results of the light flow measurements were obtained as follows

Table 3. Measurement results

No	Measurement Time	Weather Conditions	Luminous Current Unit (lm)
1	08.00	Overcast and cloudy	23.017
2	09.00	Overcast and cloudy	40.279
3	10.00	Bright	47.415
4	11.00	Bright	80.559
5	12.00	Bright	80.559
6	13.00	Bright	80.559
7	14.00	Overcast and cloudy	40.280
8	15.00	Rain and cloudy	34.525
9	16.00	Rain and cloudy	28.771

Source: analysis, 2024

The table above is a table of the results of natural lighting measurements in the architectural studio space of the Indonesian Institute of Technology that have been carried out. The table contains

figures from the amount of natural light flow obtained during measurements from 08.00 WIB to 16.00 WIB in the architectural studio space. Institut Teknologi Indonesia.

d) *Reflectivity of Paint in the Architecture Studio Room.*

The architecture studio room of the Indonesian Institute of Technology has the same paint color on all four sides, both on the north side, south side, east side, and west side. The paint color of the architecture studio room is white. In the theory of the table of the percentage of light reflection against the reflectivity of paint color, the white paint color in the architecture studio room of the Indonesian Institute of Technology has a light reflection percentage of 85%. So that 85% of the light that enters the studio room of the Indonesian Institute of Technology will be reflected inside the room.

e) *Calculation of Natural Light Intensity.*

The light intensity in an architectural room is obtained from the calculation of the light intensity formula based on data obtained from the results of measuring the light flow measured in the architectural studio and the results of measuring the area of the architectural studio room. The light intensity in the architectural room is obtained from the calculation of the light intensity formula based on the data obtained from the results of measuring the light flow measured in the architectural studio and the results of measuring the area of the architectural studio room.

Table 4. Light Intensity Calculation

<i>Measurement Time</i>	<i>Time</i>	<i>$E = \frac{\Phi (lm)}{A (m^2)}$</i>	<i>Light Intensity (E)</i>	<i>Compliance</i>
Morning	08.00	<u>23.017</u> 230,17	100 Lux	No
	09.00	<u>40.279</u> 230,17	175 Lux	No
	10.00	<u>47.415</u> 230,17	206 Lux	No
Afternoon	11.00	<u>80.559</u> 230,17	350 Lux	Yes
	12.00	<u>80.559</u> 230,17	350 Lux	Yes
	13.00	<u>80.559</u> 230,17	350 Lux	Yes
Evening	14.00	<u>40.280</u> 230,17	175 Lux	No
	15.00	<u>34.525</u> 230,17	150 Lux	No
	16.00	<u>28.771</u> 230,17	125 Lux	No

Source: analysis, 2024

The highest Lux value occurs during the day and starts at 11.00 am. This condition is the best point of light in the studio classroom and is in accordance with standards SNI 03-6197-2000 , when a Average minimum illumination level in 350 Lux with 80.559 Luminous Current Unit.

4. CONCLUSION

Based on the discussion that has been done above, it can be concluded that the natural lighting in the architectural studio space of the Institut Teknologi Indonesia still does not meet the SNI 03-6197-2000 standard on Room Lighting Levels. Based on the measurement results and calculation results that have been carried out, light intensity data is produced in the architectural studio space of the Institut Teknologi Indonesia. The light intensity does not meet the visual comfort standards of the reading room, which is 350 Lux. In the architectural

studio space, the light intensity figures obtained are relatively small, measurement data shows that the average light intensity carried out at 08.00 - 16.00 WIB is 220.11 lux. With the highest light intensity of 350 Lux at 11.00 WIB, 12.00 WIB, and 13.00 WIB and the lowest light intensity is 100 Lux at 08.00 WIB. To meet visual comfort in the studio space, artificial lighting is needed in the morning and evening so that visual comfort in the studio space is still met.

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