Perceptual Study of User Comfort Regarding the Temperature Comfort of Learning Teaching Space in Building B of The Faculty Engineering, Architecture Department, Lampung University.

Syifa Salsabila R[1], Agung Cahyo Nugroho[2]
[1,2] Arsitektur, Universitas Lampung, Indonesia

[*] syifasalsabila3131@gmail.com

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Abstract

This study addresses the importance of thermal comfort in educational spaces, focusing on Building B at the Faculty of Engineering, Universitas Lampung, where tropical climate conditions and suboptimal thermal control systems often result in uncomfortable room temperatures. The study aims to assess architecture students' perceptions of thermal comfort in classrooms and analyze the impact of temperature on their learning comfort. A quantitative research method was employed, collecting data through direct observation and questionnaires distributed to students. Results indicate that classroom temperatures do not meet optimal comfort standards, with most students feeling discomfort due to excessive heat, which affects concentration and productivity. The study concludes by recommending improvements in cooling and ventilation systems within classrooms to create a more conducive learning environment for architecture students in tropical regions.

Keywords: *thermal comfort, cooling system, temperature control, classroom environment, student perception.*

I. INTRODUCTION

Thermal comfort is an important component in building an effective educational environment. In this context, comfort denotes a state in which people are free from physical pain that may hinder their focus and productivity. Katharine (2003) asserts that comfort is a condition in which basic human needs are satisfied, resulting in a sense of well-being that enhances productivity. In the field of education, room temperature is a major factor in creating thermal comfort because temperatures that are too hot or too cold can cause discomfort that adversely affects student performance.

In Indonesia, which has a tropical climate with high temperatures and significant humidity, the challenge of maintaining thermal comfort in classrooms becomes more extensive. Mukono (2008) explains that significant temperature fluctuations can cause discomfort, fatigue and reduced productivity levels. Extreme temperatures, whether too high or too low can affect the physical and psychological condition of individuals so it is important to ensure the room temperature is within an appropriate range. Ministry of Health Regulation No. 70/2016 stipulates that a comfortable room temperature ranges from 23-26°C.

The Faculty of Engineering, University of Lampung, specially Building B, which is the center of student activities in the Department of Architecture, faces challenges in maintaining optimal thermal conditions. As a learning space used for theoretical lectures and design practices, temperature stability in classrooms is important to support students' critical and creative thinking processes. Previous studies (Wahyu, 2016; Sogol Salary et al., 2018) show that inadequate thermal conditions can disrupt focus and create fatigue especially for architecture students who often spend long hours in the same space.

The approach to understanding thermal comfort not only includes objective temperature measurements but also considers the subjective perception of users. This study aims to uncover student perceptions of thermal comfort and evaluate the influence of building elements on room temperature. With the results obtained, it is expected to formulate recommendations to create a more comfortable learning environment to support student productivity and become a reference for the

development of educational space design in tropical climates.

Comfort is a broad term that covers several aspects that allow a person to carry out work more easily and efficiently. Comfort is a condition in which individual and holistic essential human needs are met, leading to a sense of well-being for a person (Katharine, 2003). This is in line with the idea that people naturally seek comfort in their activities to achieve maximum results with minimum effort. Comfort applies across a wide range of areas, from workplace environments to technology that aims to create conditions that support productivity while reducing stress or pressure.

According to the Regulation of the Minister of Health of the Republic of Indonesia No. 1077 Year 2011, temperature is defined as the degree of warmth or coolness of air expressed in units of certain degrees, in accordance with the Guidelines for Indoor Air Quality in Homes. Air temperature is divided into two main types: dry temperature and wet temperature. Dry temperature describes the measurement of a thermometer after about 10 minutes of indoor adaptation, with a normal range between 24-34°C. Wet temperature reflects air conditions that are saturated with water vapor, usually lower than dry temperature, which is between 20-25°C. Understanding these two types of temperature is very important in assessing indoor air quality and comfort.

Workspace temperature can significantly affect workers' physical comfort and fatigue levels. For example, when workspace temperatures exceed 28°C, workers may experience faster heat exhaustion. Workspace temperatures below 18°C can slow down the fatigue process, as lower temperatures reduce sweating and slow down the body's metabolic rate. Temperature balance plays an important role in the workplace as both too hot and too cold conditions can damage productivity and affect well-being. Mukono (2008) emphasizes that extreme temperature fluctuations not only cause discomfort, but also have the potential to cause health problems and trigger various diseases in humans.

According to Ministry of Health Regulation No. 70/2016 on Industrial Occupational Health Standards, extreme working temperatures can have a negative impact on the body such as fatigue and excessive sweating due to heat or reduced dexterity and hand grip strength due to cold conditions that trigger sweating in the palms. Minister of Manpower Regulation No. 5/2018 on Occupational Safety and Health stipulates that the ideal room temperature is in the dry temperature range of 23-26°C. Exposure to extreme temperatures can pose serious health risks such as hypothermia from too low temperatures or dehydration to heatstroke from too high temperatures.

II. METODE

The method used in this research is a quantitative method that tries to measure existing variables and evaluate numerical or statistical data. The quantitative method was chosen because it allows researchers to identify relationships between variables, test hypotheses and can produce findings that can be generalized. This research uses instruments such as questionnaires or surveys that provide objective data that can be processed statistically to produce measurable and accurate conclusions.

This research was conducted in Building B, Faculty of Engineering, Department of Architecture, University of Lampung (UNILA) with a focus on lecture rooms in the department of architecture. Researchers chose this location because the lecture rooms in the architecture department have diverse characteristics and are often used in the teaching and learning process. The research was conducted on July 24 and 25 with data collection at 09:00, 13:00 and 16:00. The selection of different times aims to observe variations in room temperature and thermal comfort at different hours to determine the difference in impact on student comfort.

This research utilizes two types of data sources, namely primary data and secondary data. Primary data was obtained through direct observation and interviews with students studying in the department of architecture. Observations were made to observe the physical condition of the lecture hall, interviews were conducted using a questionnaire specifically designed to measure student perceptions of thermal comfort in the classroom. The questionnaire contains questions that aim to explore the extent to which the room temperature affects the comfort of students during the teaching and learning process. Secondary data were obtained through literature studies of various relevant publications such as books, scientific journals and regulations on the comfort requirements of the lecture hall. To obtain the data, this study used various strategies, including direct observation, questionnaires and literature studies. Direct observation was conducted to objectively observe the physical condition of the classroom such as room temperature and students' reactions to thermal comfort. The tool used in temperature measurement is the BOSCH GTC 400C thermal camera which has the ability to measure temperature accurately and detect temperature differences at various points of the room. Questionnaires are used to explore student perceptions of thermal comfort in the lecture hall. The questionnaire was designed with a rating scale to facilitate

quantitative analysis.

III. Results and Discussion

A. Analysis of Student Perceptions

a. Room B 1.1 to B 2.1

Based on the results of the comfort survey conducted in Lecture Room B 1.1, the majority of respondents expressed dissatisfaction with the room temperature. The most frequent rating given was a score of 2 which indicates that although the room temperature is not ideal for comfort, it does not interfere significantly with learning activities. A small number of respondents felt quite comfortable but very few rated the room temperature as comfortable or very comfortable. Some respondents even expressed high levels of discomfort, indicating a significant temperature problem. This indicates the need for a review and potential upgrade of the cooling or ventilation system in Lecture Room B 1.1 to improve user comfort.

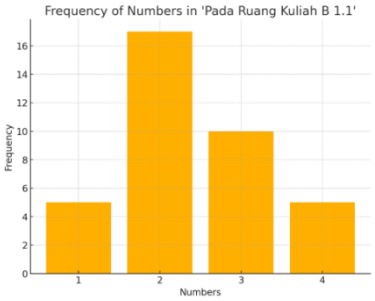


Figure 4.1 Frequency in Lecture Hall B 1.1

In Lecture Room B 1.2 the majority of users rated the room temperature as quite comfortable (category 3) with the highest frequency. This shows that most respondents felt that the room temperature was adequate although not ideal. Some users rated the temperature as uncomfortable (category 2), a small number of users felt very uncomfortable (category 1).

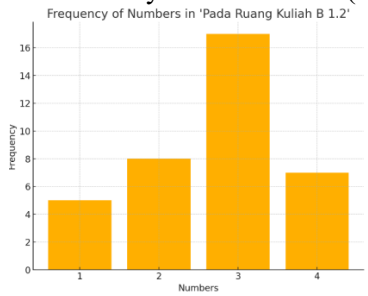


Figure 4.2 Frequency in Lecture Room B 1.2

Regarding temperature comfort in Lecture Room B 1.3 the majority of users rated their satisfaction at levels 2 and 3 indicating that most felt the room temperature comfort still required improvement. A small number of users rated at levels 4 and 5 which indicates higher satisfaction while only a few rated at level 1 indicating dissatisfaction.

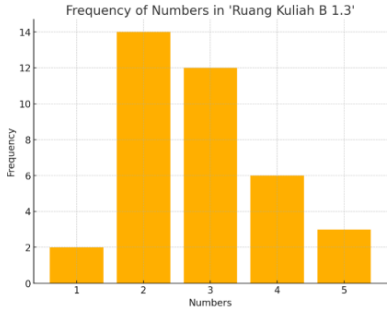


Figure 4.3 Frequency in Lecture Hall B 1.4

Based on the temperature comfort survey in Lecture Room B 1.4 most respondents rated the temperature as moderately comfortable (category 3) and comfortable (category 4) with a fairly high frequency for both categories. Some respondents also felt uncomfortable (category 2) while a small percentage rated the temperature as very uncomfortable (category 1) or very comfortable (category 5).

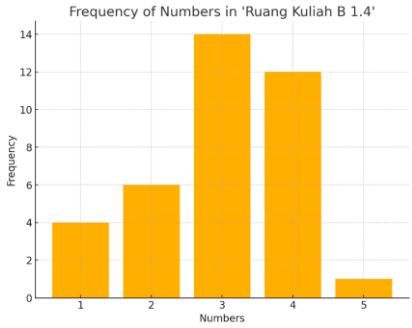


Figure 4.4 Frequency in Lecture Hall B 1.4

The survey results available in Lecture Room B 2.1 show that the room temperature is perceived by the majority of users as comfortable (category 4) with the highest frequency, some people also feel quite comfortable (category 3) and very comfortable (category 5) indicating that the room temperature generally meets the comfort requirements. However, some people rated the temperature as uncomfortable (category 2) and very uncomfortable (category 1). Room B 2.1 has the highest level of satisfaction with an average score of 3.35 indicating that users of this room are generally more satisfied than other rooms. Rooms B 1.1 and B 1.2 have lower average satisfaction scores of 2.41 and 2.70 respectively but the difference is not too noticeable.

Most of the median and mode satisfaction values for spaces B 1.1 to B 1.4 are on a scale of 2 or 3 reflecting that user perceptions of these spaces tend to be moderate. However, space B 2.1 has a median and mode on a scale of 4 which indicates that most respondents have a higher level of satisfaction in this space compared to the other spaces. The higher median and mode in B 2.1 could imply that this space offers better facilities or conditions or perhaps a more comfortable and adequate user experience than spaces B 1.1 to B 1.4. This difference could be due to various

factors, such as cleanliness, lighting or a more comfortable room layout. Thus, room B 2.1 shows consistently higher satisfaction which can be a reference for quality improvement in other rooms.

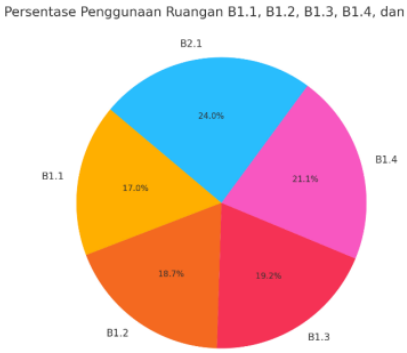


Figure 4.5 Percentage of Room Usage

b. Survey Results in the Design Studio Room

The survey results found in Design Study Room S 1.1 showed that the room temperature was categorized as moderately comfortable (category 3), followed by comfortable (category 4), indicating that most people using this room felt the temperature was adequate, although not perfect. Only a few people rated the temperature as very uncomfortable (category 1) or very comfortable (category 5).

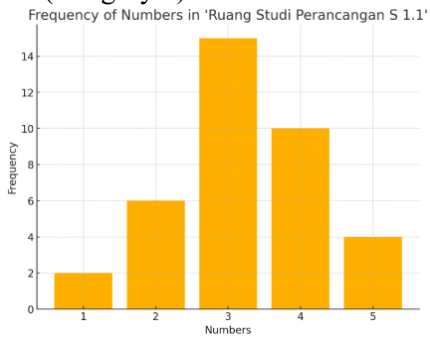


Figure 4.6 Frequency in Design Study Room S 1.1

Based on the temperature comfort survey in Design Study Room S 1.2, most users rated the room temperature as moderately comfortable (category 3) and comfortable (category 4), with category 3 having the highest frequency. Some respondents felt uncomfortable (category 2), and only a few gave ratings of very uncomfortable (category 1) or very comfortable (category 5).

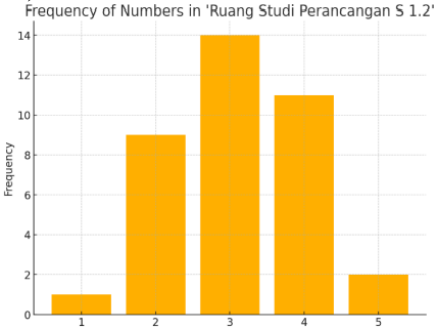


Figure 4.7 Frequency in Lecture Hall B 2.1

c. Survey Results in the Design Studio Room

The survey results found in Design Study Room S 1.1 showed that the room temperature was categorized as moderately comfortable (category 3), followed by comfortable (category 4), indicating that most people using this room felt the temperature was adequate, although not perfect. Only a few people rated the temperature as very uncomfortable (category 1) or very comfortable (category 5).

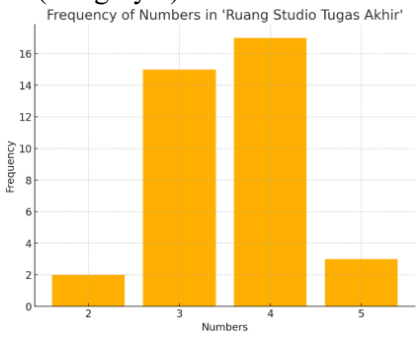


Figure 4.8 Frequency in the Final Project Studio Room

B. Room Temperature Analysis

Room temperature research at Lampung University (Unila) uses the BOSCH GTC 400C tool. The analysis was carried out by recording temperature data at different times and days so that the pattern of temperature changes in various rooms could be known.

a. Room Temperature B 1.1

On July 25, 2024, the temperature of the envelope of space B 1.1 measured using a temperature measuring device showed a result of 27.9 degrees Celsius at 9 am.

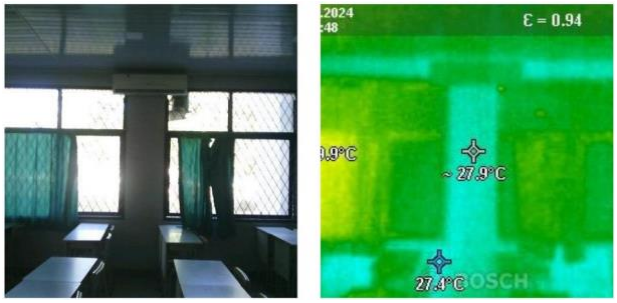


Figure 4.9 Temperature measurement in Room B 1.1 on July 25, 2024 at 9 a.m.

b. Room Temperature B 1.2

In room B 1.2, the temperature changed significantly between July 24 and 25. On July 24 at 9am, the temperature was recorded at 26.5°C and increased to 28.7°C at 1pm. The next day, July 25, the morning temperature was higher at 27.4°C at 9am and again reached 28.7°C at 1pm. This pattern shows an increase in temperature during the afternoon, while the morning temperature on July 25 was warmer than the previous day.

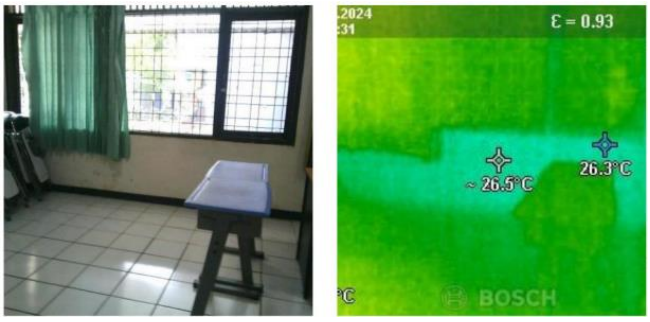


Figure 4.10 Temperature measurement in Room B 1.2 on July 24, 2024 at 9 a.m.

Figure 4.11 Temperature measurement in Room B 1.2 on July 24, 2024 at 1 p.m.

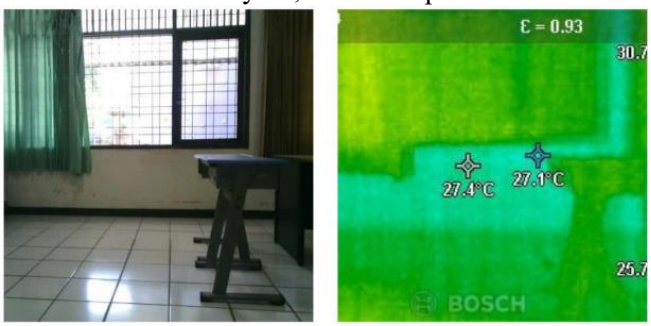


Figure 4.12 Temperature measurement in Room B 1.2 on July 25, 2024 at 9 a.m.

Figure 4.13 Temperature measurement in Room B 1.2 on July 25, 2024 at 1 p.m.

c. Room B 1.4

In room B 1.2, the temperature changed significantly between July 24 and 25. On July 24th

Figure 4.14 Temperature measurement in Room B 1.4 on July 24, 2024 at 9 a.m.

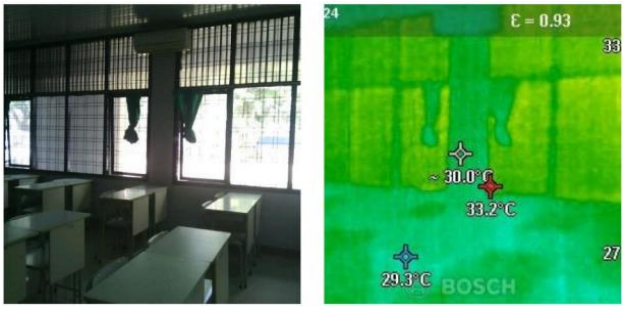


Figure 4.15 Temperature measurement in Room B 1.4 on July 24, 2024 at 1 p.m.

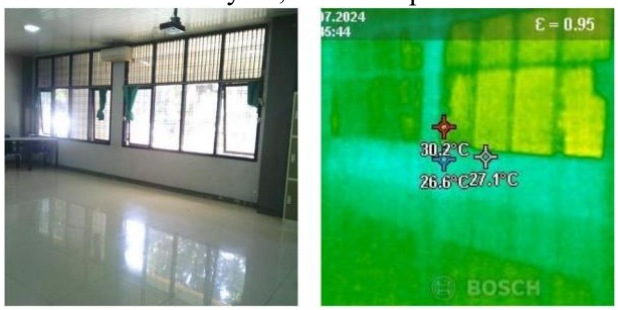


Figure 4.16 Temperature measurement in Room B 1.4 on July 25, 2024 at 9 a.m.

d. Room Temperature B 2.1

Temperature measurements in Room B 2.1 were taken on July 25, 2024. At 9am, the temperature was recorded at 27.1°C, indicating a relatively stable temperature in the morning. At 1pm, the temperature rose slightly to 28.3°C indicating a slight increase in temperature during the day. The temperature in this room is still fairly comfortable and does not experience significant fluctuations.

Figure 4.17 Temperature measurement in Room B 2.1 on July 25, 2024 at 9 a.m.

Figure 4.18 Temperature measurement in Room B 2.1 on July 25, 2024 at 1 p.m.

e. Design Study Room Temperature 1.1

In Design Study Room S 1.1, temperature measurements were taken on July 25, 2024. At 9 am, the temperature was recorded at 27.0°C. At 1pm, the temperature rose to 28.0°C indicating a slight increase in temperature during the day. This temperature remains within the range considered comfortable by the majority of users.

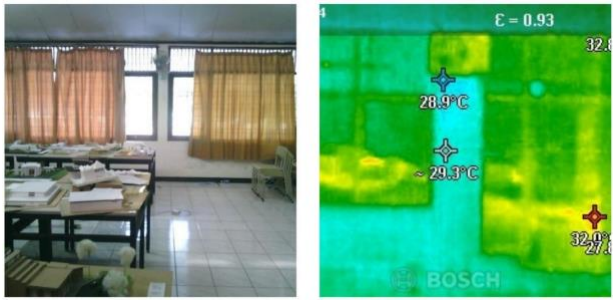
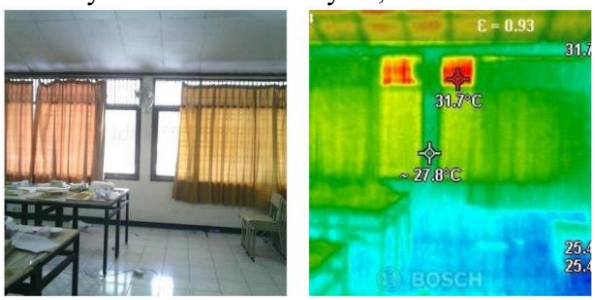


Figure 4.19 Temperature measurement in Design Study Room S 1.1 on July 25, 2024 at 9 a.m.



Gambar 4.20 Pengukuran suhu di Ruang Studi Perancangan S 1.1 pada 25 Juli 2024 pada pukul 1 siang

f. Design Study Room Temperature 2.1

In Design Study Room S 2.1, the temperature was measured on July 25, 2024. At 9am, the temperature was recorded at 27.3°C while at 1pm, the temperature increased slightly to 28.5°C. This temperature fluctuation is quite normal, considering the sunlight factor that can affect the room temperature. Even so, the temperature in this room is relatively comfortable and does not experience a significant increase.

Figure 4.21 Temperature measurement in Design Study Room S 2.1 on July 25, 2024 at 9 a.m.

Figure 4.22 Temperature measurement in Design Study Room S 2.1 on July 25, 2024 at 1 p.m.

g. Final Project Studio Room Temperature

Temperature measurements in the Final Project Studio Room were taken on July 25, 2024. At 9am, the temperature was recorded at 27.2°C. At 1pm, the temperature increased slightly to 28.2°C but remained within a comfortable temperature range for users. These measurements show good temperature stability throughout the day with little fluctuation between morning and afternoon.

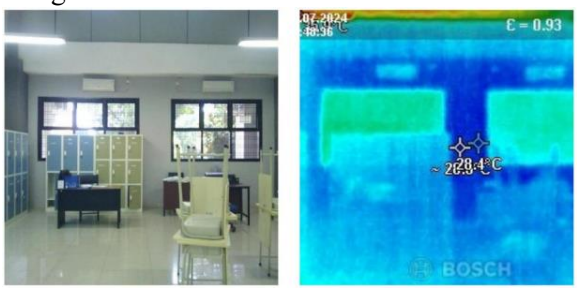


Figure 4.23 Temperature measurement in the Final Project Studio Room on July 25, 2024 at 9 a.m.

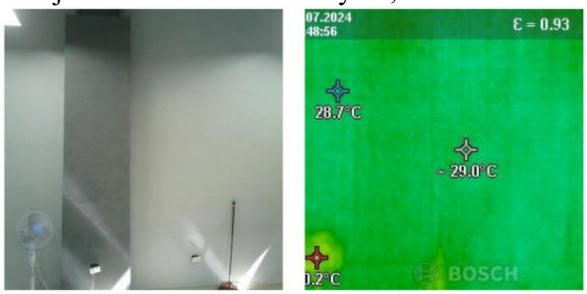


Figure 4.24 Temperature measurement in the Final Project Studio Room on July 25, 2024 at 1 p.m.

Based on the measurement results above, it can be tabulated as below:

24°C - 26.9°C	
27°C – 29.9°C	
30°C – 31.9°C	
32°C – 33.9°C	

On July 24, 2024, at 9:00 a.m.

NO	Nama Ruangan	Suhu (°C)	Surface	Interpretasi Warna
1	**B 1. 1**	27.9 °C	Mortar	
2	**B 1. 2**	26.5 °C	Mortar	
3	**B 1. 4**	26.3 °C	Mortar	
4	**Studio PA 1. 1**	25.6 °C	Mortar	
5	**B 2. 1**	27.4 °C	Mortar	
6	**Studio PA 2. 1**	26.2 °C	Mortar	
7	**Studio TA**	25.7 °C	Mortar	

On July 24, 2024, at 1 p.m.

NO	Nama Ruangan	Suhu (°C)	Surface	Interpretasi Warna
1	**B 1. 1**	Unrecorded Data	Unrecorded Data	Unrecorded Data
2	**B 1. 2**	28.7 °C	Mortar	
3	**B 1. 4**	30.0 °C	Mortar	
4	**Studio PA 1. 1**	29.3 °C	Mortar	
5	**B 2. 1**	29.0 °C	Mortar	
6	**Studio PA 2. 1**	31.1 °C	Kaca	
7	**Studio TA**	26.2 °C	Mortar	

On July 25, 2024, at 9:00 a.m.

NO	Nama Ruangan	Suhu (°C)	Surface	Interpretasi Warna
1	**B 1. 1**	Unrecorded Data	Unrecorded Data	Unrecorded Data
2	**B 1. 2**	27.4 °C	Mortar	
3	**B 1. 4**	26.8 °C	Mortar	
4	**Studio PA 1. 1**	27.8 °C	Mortar	
5	**B 2. 1**	29.7 °C	Mortar	
6	**Studio PA 2. 1**	29.9 °C	Mortar	
7	**Studio TA**	26.8 °C	Mortar	

On July 25, 2024, at 1 p.m.

NO	Nama Ruangan	Suhu (°C)	Surface	Interpretasi Warna
1	**B 1. 1**	Unrecorded Data	Unrecorded Data	Unrecorded Data
2	**B 1. 2**	28.7 °C	Mortar	
3	**B 1. 4**	30.0 °C	Mortar	
4	**Studio PA 1. 1**	31.7 °C	Kaca	
5	**B 2. 1**	30.4 °C	Mortar	
6	**Studio PA 2. 1**	31.1 °C	Mortar	
7	**Studio TA**	29.0 °C	Mortar	

IV. CONCLUSIONS

Based on the analysis of the results of temperature measurements and user perception surveys, this study found that thermal conditions in lecture rooms and studios in Building B Faculty of Engineering, Lampung University have not met the ideal comfort standards. The study revealed significant temperature variations between rooms with some rooms showing extreme temperature fluctuations to exceed thermal comfort limits, especially during the day. These findings suggest that architectural design factors and thermal control in the building need to be improved to create a more supportive learning environment. Students' perceptions of room temperature generally tend to be negative where too high temperatures are often perceived as disrupting their comfort, concentration and learning productivity. This suggests that this research provides new insights into the direct relationship between thermal comfort and the effectiveness of the learning environment and becomes the basis for efforts to improve the quality of learning spaces in educational institutions, especially in Building B Faculty of Engineering, University of Lampung.

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