RESEARCH AND INNOVATION IN TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING
e-ISSN: 2785-8138

RITVET

Vol. 5 No. 2 (2025) 102-111
https://publisher.uthm.edu.my/periodicals/index.php/ritvet

Study of Air Humidity and Air Temperature in Classrooms at The Faculty of Technical and Vocational Education

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DOI: https://doi.org/10.30880/ritvet.2025.05.02.013

Article Info

Received: 11 Februari 2025
Accepted: 30 May 2025
Available online: 30 December 2025

Keywords

Temperatures, Humidity, ASHRAE, ICOP IAQ, Classroom, Air Temperature

Abstract

High humidity and hot temperatures can cause discomfort to residents, especially when the weather becomes excessively hot, while frequent rain also affects air humidity. Uncontrolled temperatures not only impact physical comfort but can also affect students' learning. Hot temperatures can disrupt students' thoughts and emotions, decreasing productivity. Therefore, this study measured air humidity and room temperature using air conditioning in the FPTV tutorial rooms. The design of this study is experimental. Data were collected using the Testo 605 i and Testo 405 i measurement tools. This study was conducted in the Faculty of Technical and Vocational Education (FPTV) building in Block B, which includes tutorial room 1, tutorial room 2, tutorial room 3, and tutorial room 4. The method of data analysis will be presented in the form of tables or graphs and categorized according to their respective classes. The findings indicate that the air humidity and temperature are within acceptable ranges according to ICOP IAQ 2010. However, some readings did not comply with the ICOP IAQ 2010 standards, particularly in the afternoon when readings ranged from 20.0°C to 22.8°C due to changes in rainfall and the number of students present in the tutorial rooms. In conclusion, this study found that the air humidity in the FPTV tutorial rooms is at an optimal level and complies with ICOP IAQ 2010, while the air temperature showed some readings outside the specified range. The impact of this study can serve as a guide for students to adapt to the humidity and temperature in a room. The faculty management should also play an important role in ensuring a conducive environment throughout the teaching and learning process.

1. Introduction

The tutorial room is a facility for students and lecturers to carry out teaching and learning activities. The tutorial room, which is equipped with a variety of facilities to help students and lecturers, is able to provide benefits to students and lecturers. According to Nor Naqiuddin (2019), a tutorial room is a place where the teaching and learning process takes place. Therefore, a clean environment helps students focus on learning.

According to Abdullah et al., (2019), a comfortable environment plays an important role in improving human welfare and productivity. In the context of everyday life, a comfortable environment includes several key factors such as temperature, humidity, airflow, and air quality. High humidity and hot temperatures can cause discomfort to residents, especially when the weather gets too hot. In addition, temperature is an important factor in creating a comfortable environment in space. Temperature can affect physical comfort and can impact student learning.

According to Mohd Zamri (2012), air conditioning is a household appliance system, or a mechanism designed to dehumidify and remove heat from an area. The cooling cycle shows the movement of refrigerant gases in an air conditioning system such as R22, R134a and R12 gases. Air conditioning is to overcome the discomfort of heat in buildings, especially in countries in Malaysia which have a hot and humid climate.

Inappropriate air humidity and room air temperature will result in student discomfort and student health problems during the teaching and learning process. According to Marinah Awang et al., (2018), an unconducive environment in the lecture room, whether too cold or too hot, can disrupt learning activities and students are also distracted because the lecture room is not perfect and uncomfortable.

In the context of this study, measuring the humidity and temperature of the facilities provided by the university, namely the tutorial room, must be ensured so that it can help provide a conducive environment for students. The use of air conditioning is the key for students to stay focused and comfortable in the tutorial room. A lecture room is a space specifically designed for learning and teaching purposes in educational institutions such as universities, colleges, and schools. The rooms are equipped with facilities that support the learning process, including seating for students, desks, whiteboards or blackboards, projectors, audio systems, and so on. Lecture rooms may also be equipped with temperature and humidity control systems to ensure the comfort of students and lecturers. This room is usually used for lectures, seminars, group discussions, and various other academic activities.

FPTV tutorial rooms that are too cold or too hot make students feel uncomfortable sitting during the teaching and learning process for a long time. This is because the air conditioning in the FPTV tutorial room, which has 2 types of units that operate for a long period of time, causes students to feel uncomfortable with their surroundings. This student's discomfort due to inappropriate temperatures and severe humidity can cause problems for students. This is because poor ventilation and impaired student concentration can have a detrimental effect on students. This study aims to measure the air humidity and air temperature **in** the air conditioning usage room in the FPTV tutorial room. This is done to identify the comfort of students with the use of air conditioning during the teaching and learning process.

1.2 Literature Review

Air humidity, which refers to the amount of water vapor in the air, is an important factor in ensuring a comfortable and healthy environment indoors. As a result of a study by Gomes et al. (2018), the appropriate humidity level can increase the comfort of residents as well as reduce the risk of health problems
such as skin pain, respiratory disorders, and eye pain.

According to ASHRAE (2010), humidity is expressed in thermodynamic variables such as dew point temperature, vapor pressure, and humidity ratio as a general reference for the moisture content of the air. The humidity of the air containing water vapor in a volume of air is a specific humidity. The suitable relative humidity for a living space is between 50%-80%. The values for relative humidity are given in the form of percentages (%) and can be categorized as shown in Table 1.

Table 1 Relative Humidity Category (ASHRAE, 2010)

Moisture percentage (%)	Category
0 - 25	Very dry
25 - 50	Dry
50 - 75	Moist
75 - 100	Very moist

According to Mohamad Hairulnisham (2019), in relative humidity, effects are classified according to several factors, namely health, comfort, and quality of the indoor environment. The effects of health factors can cause asthma, allergies, bacteria, influenza, mites, pneumonia, and viruses. The effects of comfort factors can cause eye irritation, skin dryness, thermal comfort, and static electricity. As for the quality factors of the indoor environment, it can cause low indoor air quality (IAQ), ozone generation, high particle generation, and particle levels. Humans are very sensitive to moisture because the skin relies on air to remove moisture. The sweating process is your body's attempt to stay cool and maintain the current temperature. If the air is at a relatively high percentage of humidity, sweat will not evaporate into the air. According to Chandler (2001), as a result, we feel warmer than the actual temperature when the humidity is high.

Usually, the body cools down by opening the pores on the skin and removing water and salt. When the water evaporates, it will dissipate body heat to the air. Since water has a high latent heat, which is the heat required

to convert liquid water into steam, this process usually carries enough heat to do the cooling job well but the rate at which water or sweat evaporates depends on how much water is in the air. On dry days, sweat evaporates quickly which means it also carries heat faster. On humid days, when the air is saturated with sweat water evaporates more slowly (Dougherty, 2011). This explains why it feels so hot in high humidity. When the relative humidity reaches a sufficiently high level, the body's natural cooling system cannot function. Sweat evaporates very slowly if at all and the body is hot. In severe cases people start having heat stroke, which is basically organ failure when the body starts heating up on its own.

According to Mohd Zaidi (2020), teachers had to increase the temperature of the air conditioner because the students were cold and trembling when the air conditioner was activated. At the end of the school session and the absence of electricity, the problem of heat recurrence occurs, forcing teachers and students to open doors and windows. As a result of the act of opening the window, the students' focus on the teacher's teaching is disrupted. In the context of this study, the researcher measured the air humidity and air temperature of the room for the comfort of students in the FPTV tutorial room. According to Hwang et al. (2007), indoor temperature is considered a factor of the closed environment that affects human comfort and health, becoming a major concern for the public. Its importance lies not only in the physical but also psychological aspect, where temperature conditions that are too hot or too cold can cause serious discomfort, decreased productivity, and health problems such as respiratory diseases or high blood pressure. Therefore, the issue of internal temperature is a major concern for the public as it is closely related to the quality of daily life and general well-being.

Indoor air temperature that affects outdoor air temperature is a heat phenomenon that is generated inside a building or room that can transfer to the outside environment and affect the surrounding temperature. For example, sunlight entering through a building's window can heat a room, causing the temperature inside to rise. Similarly, the heat emitted by equipment or human activities in the tutorial room can affect the outdoor air temperature, especially if it is poorly ventilated. The results of a study by Daud et al. (2022) show that the change in indoor temperature begins to be felt as early as 11.00 am in line with the increase in external temperature due to the intensity of solar radiation. Residential spaces become increasingly incomplete towards the evening due to the release of latent heat from residential structures. As a result of the radiation, the living space becomes increasingly uncomfortable by the evening. The main factor causing this condition is latent heat escape from residential building structures.

2. Methodology

2.1 Study Design

In this study, no model was used as a study concept because this study is based on an experimental study. The study design for the study was experimental. Therefore, quantitative methods are used to collect the data obtained. The emphasis given through this study is to measure the level of comfort of students with the use of air conditioning during the teaching and learning process. The data collection was taken through parameters that were comfortable for students with the use of air conditioning during the teaching and learning process. The data collection was taken through the parameters that have been described with the use of measurement tools to measure the air humidity of the room in the FPTV tutorial room.

2.2 Data Collection

At this stage, data collection is an important process in research that involves the collection of information or facts related to the research topic. In this study, data collection involved measuring air humidity and room air temperature using tools, namely Testo 605 i – i-thermohygrometer operated via smartphone and Testo 405 i – i-thermal anemometer with smartphone operation within 8 hours.

3. Results and Discussion

The data analysis process is an important step to assess the achievement of the objectives of the study. In the study, the researchers analysed the data using collection and visualization methods in Tutorial Room 1, Tutorial Room 2, Tutorial Room 3, and Tutorial Room 4. The recorded data includes indoor air temperature and relative humidity. The analysis is carried out to assess the air temperature and relative humidity between the rooms. Researchers use graphs and tables to report the findings of the study so that the data can be presented clearly and in an organized manner. In addition, the findings of the study will be referred to whether they meet the ICOP IAQ 2010 standards through actual experimental measurements, as shown in Table 2.

Table 2 Acceptable ranges for certain physical parameters

Parameter	Acceptable range
Air temperatures	23-26°C
Relative humidity	40-70%

3.1 Data Analysis Based on Relative Humidity and Air Temperature

In this study, the primary data collected involved relative humidity and air temperature. This study was conducted for 10 days of lecture time, namely in each tutorial room. Measurements were conducted at 9:00 am, 12:00 pm, and 4:00 pm daily during the 10-day lecture as shown in Table 3. This data was recorded in four rooms, namely Tutorial Room 1, Tutorial Room 2, Tutorial Room 3, and Tutorial Room 4.

Table 3 Study data collection

Date	Time	Room
• 10-14 October 2024 • 17-21 October 2024	• 9:00 a.m. • 12:00 p.m. • 4:00 p.m.	• Tutorial Room 1 • Tutorial Room 2 • Tutorial Room 3 • Tutorial Room 4

3.2 Relative Humidity Monitoring Data in the Classroom

a) Data 10-14 October 2024 Relative Humidity

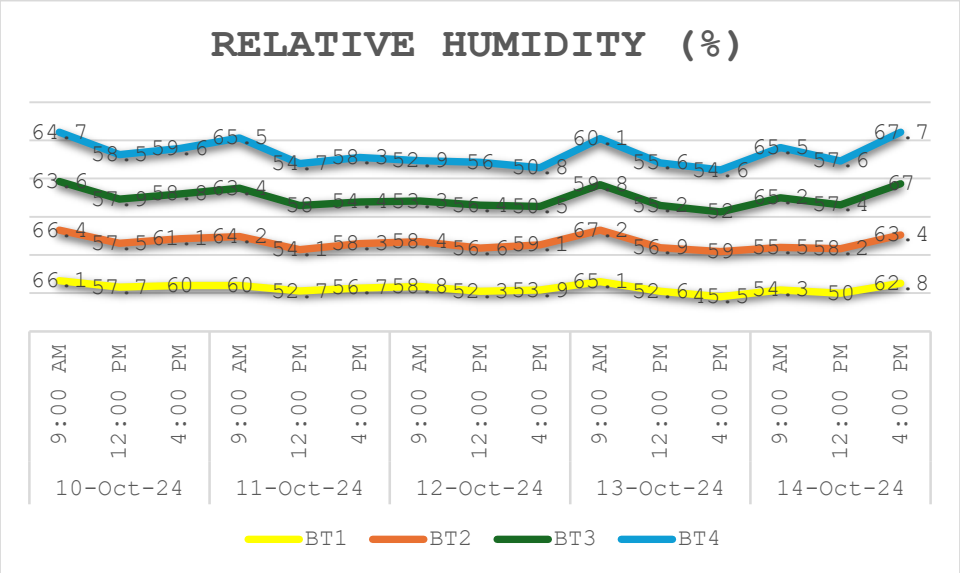

Fig. 1 Relative Humidity Graph of the First Week Tutorial Room Equations

The findings of the study in Figure 1 show that the relative humidity on 13 October 2024 the lowest reading was recorded in tutorial room 1 at 4:00 PM with a reading of 45.5% (7 students). Meanwhile, on 12 October 2024, tutorial room 1 was at 4:00 PM with 53.9% reading (7 students).

In addition, the relative humidity at the moderate reading on October 11, 2024 was recorded in tutorial room 1 at 12:00 PM with a reading of 52.7% (19 students). Meanwhile, on October 14 at 9:00 AM with a reading of 54.3% (11 students). In addition, the relative humidity recorded the highest reading on October 10, 2024 in tutorial room 2 at 9:00 AM with a reading of 66.4% (15 students). Meanwhile, on 13 October 2024, the highest reading was recorded in tutorial room 1 at 9:00 AM with a reading of 65.1% (18 students).

b) Data 17-21 October 2024 Relative Humidity

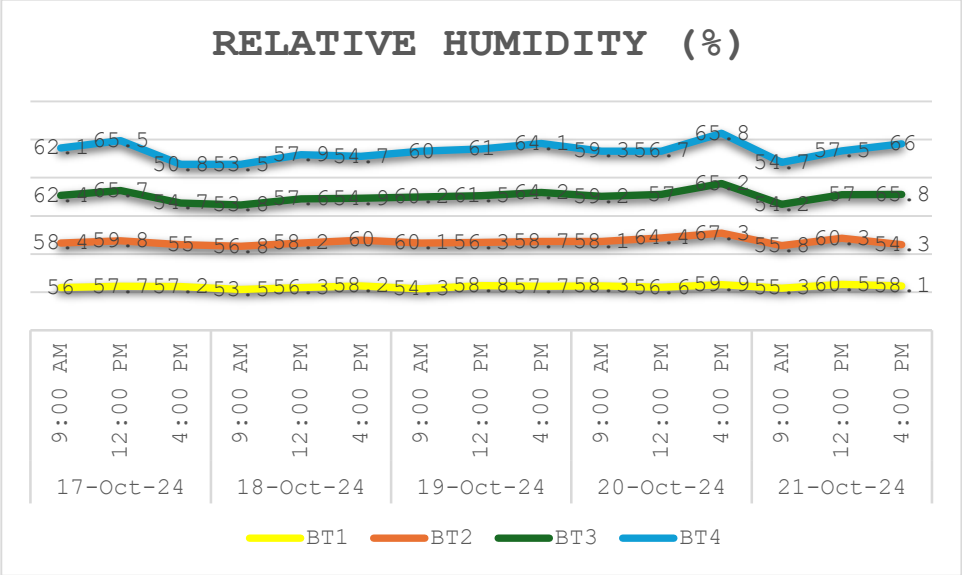

Fig. 2 Relative Humidity Graph of the First Week Tutorial Room Equations

The findings of the study in Figure 2 show that the relative humidity on 17 October 2024, the lowest reading was recorded in the tutorial room 4 at 4:00 PM with a reading of 50.8% (15 students). Meanwhile, on October 18, 2024, tutorial room 1 is at 9:00 AM with a reading of 53.5% (29 students).

In addition, the relative humidity on the moderate reading of 21 October 2024 was recorded in tutorial room 4 at 12:00 PM with a reading of 57.5% (21 students). Meanwhile, on 20 October 2024, tutorial room 2 is at 9:00 AM with a reading of 58.1% (17 students). In addition, Relative humidity recorded the highest reading on 21 October 2024 in tutorial room 4 at 4:00 PM with a reading of 66% (10 students). Meanwhile, on 17 October 2024, the highest reading was recorded in tutorial room 4 at 12:00 PM with 65.5% of no students.

Based on the data obtained, the relative humidity in Tutorial Room 1, Tutorial Room 2, Tutorial Room 3, and Tutorial Room 4 in the first week of the observation period was within the range set by the ICOP IAQ 2010 standard, which is between 40% to 70%. Overall, the relative humidity in the tutorial room during the observation period was still within the IAQ 2010 ICOP standard range. Low readings (45.5%-53.9%), moderate at (52.7%-54.3%), indicate a stable and comfortable environment, while the highest readings (65.1%-66.4%) are still within the range suitable for student activities without affecting comfort.

Furthermore, based on the data obtained, the relative humidity in Tutorial Room 1, Tutorial Room 2, Tutorial Room 3, and Tutorial Room 4 in the second week of the observation period was within the range set by the IAQ 2010 ICOP standard, which is between 40% to 70%. The findings of this study showed the lowest relative humidity (50.8%-53.5%), which indicates a stable and comfortable environment for learning. Moderate readings are between (57.5%-58.1%). This reading indicates that the humidity is in a stable state and is suitable for student activities. The highest relative humidity readings ranged from (65.5%-66%). Approaching the upper limit of the standard range but still within the accepted range. Overall, the relative humidity in the tutorial rooms during the observation period was within the standard range of the IAQ ICOP. Low to moderate readings indicate a stable and comfortable environment for study and learning activities, while the highest readings are still within the appropriate range without compromising comfort.

3.3 Air Temperature Monitoring in Classrooms

The findings of the study in Figure 3 show the air temperature reading on 14 October 2024, with the lowest reading of 20°C in tutorial room 4 at 4:00 PM (10 students). Meanwhile, on 10 October 2024 with the lowest reading of 20.2°C in tutorial room 4 at 9:00 AM (25 students). The findings did not comply with the IAQ 2010 ICOP standard, which is a range reading between (23-26°C).

In addition, the air temperature on 11 October 2024 was recorded as a moderate reading in tutorial room 4 at 12:00 PM with a reading of 24.3°C (31 students). Meanwhile, on 13 October 2024, the tutorial room will be at 12:00 PM with a reading of 24.4% (27 students). In addition, the air temperature recorded the highest reading on 10 October 2024 in tutorial room 2 at 4:00 PM with a reading of 25.3°C (12 students). Meanwhile, on 14 October 2024, the highest reading was recorded in tutorial room 2 at 12:00 PM with a reading of 25.6°C with no students.

a) Data 10-14 October 2024 Air Temperature

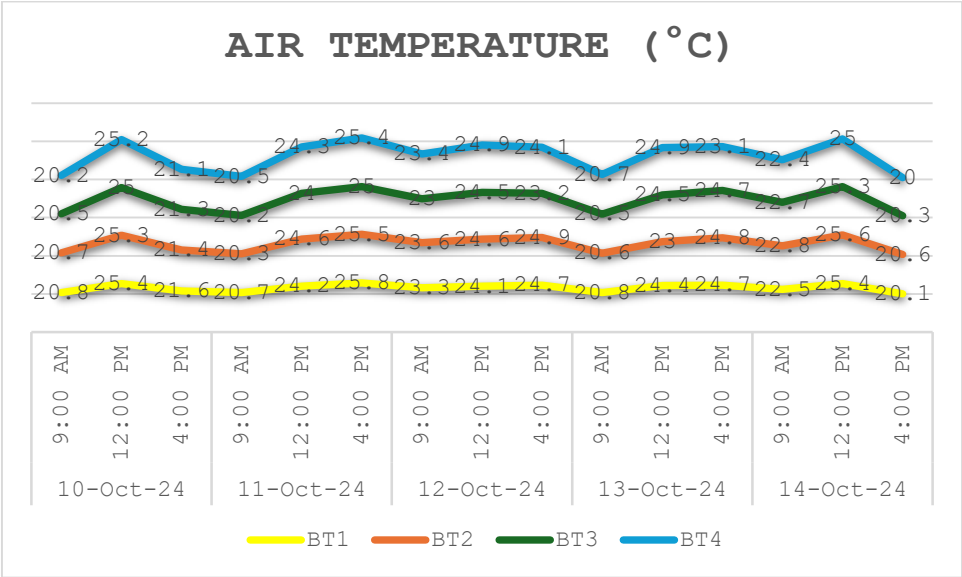

Fig. 3: Indoor air temperature graph of the First Week in the Tutorial Room

b) Data 17-21 October 2024 Air Temperature

The findings of the study in Figure 4 show that the air temperature on 17 October 2024 received the lowest reading in tutorial room 4 at 9:00 AM, with a reading of 21.3°C (25 students), and tutorial room 3 at 9:00 AM, with a reading of 21.4°C (19 students). In addition, the air temperature reading was at a moderate level recorded in the tutorial room 2 at 4:00 PM with a reading of 23.1°C (12 students). Meanwhile, on 17 October 2024, the tutorial room will be at 4:00 PM with a reading of 24.1°C (15 students). In addition, the air temperature on October 20, 2024 showed the highest reading in tutorial room 4 at (12:00 PM) with a reading of 25.8°C (30 students). Meanwhile, on 21 October 2024, the highest reading was recorded in tutorial room 4 at 12:00 PM with a reading of 25.5°C (21 students).

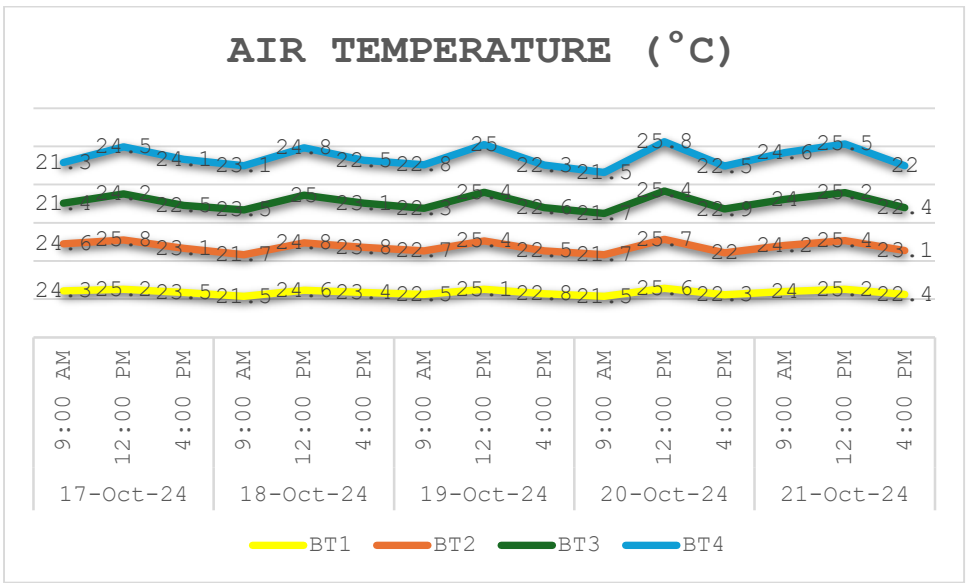

Fig. 4: Indoor air temperature graph in Tutorial Room, Week two

In addition, based on the air temperature readings in the tutorial rooms during the observation period of the first week, it showed variations that were within and outside the standard range of ICOP IAQ 2010 which was (23°C-26°C). The lowest air temperature reading was recorded at (20.0°C-20.2°C). This reading is below the

standard range, indicating room conditions that are colder than recommended due to cloudy and rainy evenings and no sunlight in the morning. Moderate air temperature readings of (24.3°C-24.4°C). These readings are within the standard range set by the IAQ 2010 ICOP, which indicates a stable and comfortable condition for learning and learning activities. The highest air temperature readings (25.3°C-25.6°C) are also in the standard range, indicating conducive and comfortable room conditions. Overall, the air temperature in the tutorial rooms during the observation period was mostly within the standard range of the IAQ 2010 ICOP. However, there are the lowest readings that are below the standard range, indicating colder room conditions than recommended. Moderate to high readings indicate a stable and suitable environment for study and learning activities.

Finally, based on the air temperature readings in the tutorial rooms during the first week of the observation period, it shows variations that are within and outside the standard range of ICOP IAQ 2010, which is (23°C-26°C). The lowest air temperature reading was recorded (21.3°C-21.4°C). This reading is below the standard range, indicating an environment that is colder than the recommended temperature due to cloudy weather and no sunlight. Moderate air temperature readings were recorded (23.1°C-24.1°C), which is within the standard range, reflecting suitable and comfortable conditions for study and learning activities. The highest air temperature reading of (25.5°C-25.8°C) is also within the standard range, which indicates the room conditions are suitable and conducive to student activities. Overall, the air temperature in the tutorial rooms during the observation period was mostly within the standard range of the IAQ 2010 ICOP.

3.4 Indoor Air Humidity in the Classrooms

The findings showed that the air humidity in the FPTV tutorial room was in accordance with the range set by the IAQ 2010 ICOP standard (40% - 70%), which is between the acceptable ranges (50% - 67.7%). The findings of the study are in line with the findings of the study conducted by Ahmad Halili et. al., (2022), showed that the student dormitories, residences and prayer halls of the Islamic Engineering Campus Centre, USM within the air humidity parameters according to the humidity range acceptable by ICOP IAQ 2010. In addition, the highest relative humidity reading of the FPTV tutorial room was 66% which was within the range accepted by the ICOP IAQ 2010. This is in line with the findings of a study conducted by Abd Wahid et. al. (2020), which showed the building in the laboratory of Universiti Pendidikan Sultan Idris (UPSI) for relative humidity showed the highest reading was 67.7% which complied with the range and was acceptable to ICOP IAQ 2010.

In addition, with the findings of a study conducted by Setyawan et. al., (2020), showed that the variation in the relative humidity of the outside air on the performance of the air conditioning system under constant dry bulb temperature was performed relative humidity varying from 40% to 70%. The highest relative humidity observation in the morning was 66.1%. This is in line with the findings of a study by Teleszewski (2020), stating that during the class, the relative humidity increases to 42% and 50% in winter and spring is still within the normal range. Finally, the relative humidity in the FPTV tutorial room for two weeks was still within the range set by the IAQ 2010 ICOP between 40%-70%. This is in line with the study of Shamsudin et. al., (2023), shows that a relative humidity reading between 40%-70% is a stable reading being within the set range. Based on this study, the relative humidity is still within the range accepted by the 2010 IAQ ICOP.

3.5 Air Temperature in the Classrooms

The findings of the study show that the air temperature in the FPTV tutorial room is mostly within the acceptable range. However, there are some readings that do not comply with the IAQ 2010 ICOP standard which is an intermediate reading (20°C-22.9°C). The results of this study are in line with the study of Hazeera et. al., (2023), which shows that the air temperature parameter recorded a lower temperature of 22.18°C with the air conditioning condition working well. The parameters for the air temperature did not meet the acceptable range of the IAQ 2010 ICOP. Monitoring of this study found that the lowest temperature was 20°C due to the number of students, dim weather and rain during the study. The study found that the lowest temperature recorded was 20°C, influenced by several variations such as the number of students, dim weather, and rain. In addition, dim weather reduces exposure to sunlight, causing the ambient temperature to be cooler, while rain lowers the temperature through the process of evaporation and heat conduction. Based on a documentary conducted by Falarz (2021), the influence of atmospheric rain on human life and activities in the temperate zone is smaller than others. Findings of the study Baharudin et. al., (2023), states that the lowest air temperature reading is 20.8°C in the surgical outpatient room. The effects of thermal comfort are controlled by body temperature, which in turn is influenced by human activities, clothing, and environmental elements such as air temperature and relative humidity.

In addition, the low air temperature reading of 20.1°C is due to cloudy and rainy weather. Hou et. al., (2022), states that changes in air temperature are influenced by many factors, such as geographic distribution, atmospheric circulation of ocean currents, sunlight, wind speed, body temperature, vegetation cover, and geomorphic features. Low air temperatures can cause students to feel cold and uncomfortable. The findings of the study showed that the lowest air temperature reading was 18°C within 7 days. These readings are not within the

IAQ 2010 ICOP range standard. The results of this study are in line with the findings of the Salthammer et study. al., (2022), who showed that the lowest air temperature reading was 20°C, which indicates that the air temperature is outside the range set by ICOP IAQ 2010. According to Arifin et. al., (2021), the effects of too low temperatures lead to reduced hand efficiency, low fingertip sensitivity, muscle spasm, and chills. Pisani et. al. (2023) stated that air temperature is a major variable in indoor air conditioning in the refrigeration industry process. However, some factors affect indoor air temperature, which is largely human activity. Air temperature can be considered the most measured quantity in life, industry, technology, and science. And the rest. Lan et. al., (2022), state that a comfortable air temperature is 24°C. Human activities that affect changes in the temperature of the air and its environment. This study found that the air temperature readings were between (23°C-25.8°C), which met the IAQ 2010 ICOP standard.

4. Conclusion

The introduction of this study provides an overview of the study to be conducted and provides a comprehensive overview of the issues related to the study title. The background of the study is discussed in this chapter to emphasize the importance of the comfort of using air conditioning on students' activities. The purpose of the study was clarified by measuring the air humidity and air temperature of the room to focus on seeing the comfort of students with the use of air conditioning during the teaching and learning process. In addition, the objectives of the study were also stated to achieve the objectives of the study, namely measuring the air humidity in the FPTV tutorial room and measuring the air temperature in the FPTV tutorial room. The question of the study was also stated as a guide in data analysis. The scope of the study was described to ensure that the researcher was always within the scope of the study. The importance of this study was also clarified to benefit stakeholders such as students, lecturers, FPTV management and UTHM. Finally, the definition of terms/operations has also been clarified to make it easier for readers to understand the context used in this study.

The highlights of the writing discuss past studies related to the title of the study. The researchers have discussed the main context in this study by highlighting past studies on air humidity and air temperature, especially in FPTV buildings. FPTV is a place provided by UTHM to provide facilities to its students. The focus of the study was given by clarifying the air humidity and air temperature. Air humidity is an important aspect because it involves the health level of students during the teaching and learning process taking place in the FPTV tutorial room. In addition, the temperature has also been clarified by the researchers by providing past studies. Air temperature is a subjective matter because the opinion of the student or individual is a subjective matter In addition, the aspect of air quality is discussed with affirmation from previous studies. Air quality is an aspect studied in this study that can affect the comfort of students. Air quality involves aspects of relative humidity and air temperature in providing complete comfort to students.

The study methodology discusses the methods used by the researchers to carry out this study. The design in this study does not have any model used as a study concept because this study is based on an experimental study. In this study, the study instrument used a checklist form to record the air humidity and air temperature in line with the objectives of the study. Finally, researchers use data analysis methods by using graphs to be analyzed to show patterns and trends based on the data that has been collected.

The data analysis section reports the findings of the study in detail based on patterns and trends. The findings of the study showed that the air humidity was at the optimum level and within the acceptable range of the IAQ 2010 ICOP. This shows that the environment of the tutorial room is in good condition during the lesson and learning process. In addition, the findings of the study showed that the air temperature was within the accepted range and outside the set range. This shows that there are air temperature readings that are not within the range set by the IAQ 2010 ICOP due to the number of students, cloudy weather, rain and no sunlight causing the air temperature to be at a cold level.

Finally, this discussion, conclusion and recommendation study summarizes the findings of the study by referring to the objectives of the study. The findings of the study showed that the air humidity was at an optimal level. Meanwhile, for the air temperature, there are readings outside the range set by ICOP IAQ 2010. This is due to different weather conditions that make students feel uncomfortable. In addition, several suggestions have been given so that measuring the air humidity and air temperature in the FPTV tutorial room can be fully achieved as ensuring that the air conditioning in UTHM is always maintained.

Acknowledgement

The author would like to express appreciation to the Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia.

Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: Hafizul Hakim Zol Arini, Nurul Hidayah Liew Abdullah; ***data collection:*** *Hafizul Hakim Zol Arini, Nurul Hidayah Liew Abdullah;* ***analysis and interpretation of results:*** *Hafizul Hakim Zol Arini, Nurul Hidayah Liew Abdullah;* ***draft manuscript preparation:*** *Hafizul Hakim Zol Arini, Nurul Hidayah Liew Abdullah All authors reviewed the results and approved the final version of the manuscript.*

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