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Thermal Comfort and Adaptive Behaviour in a Naturally Ventilated Heritage School: A Field Study in a Tropical Highland Climate

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ABSTRACT

Achieving thermal comfort in educational environments is crucial for student well-being, yet it poses a significant challenge for naturally ventilated heritage buildings in tropical climates. This study investigates the relationship between objective thermal conditions and subjective comfort perceptions in a colonial-era, naturally ventilated school in Bandung, Indonesia. A mixed-methods approach combined objective physical measurements (T_a, RH, T_g, WBGT) with subjective questionnaires (N=50) assessing thermal sensation, comfort, and adaptive behaviors. Findings reveal a significant disconnect between physical data and subjective experience. Counterintuitively, the objectively warmer classroom was perceived as more comfortable and less disruptive. Statistical analysis confirmed no significant correlation between thermal data and subjective responses ($p > 0.05$). Instead, higher occupant density and student physiology post-recess (thermal alliesthesia—the phenomenon where thermal perception is influenced by recent physiological changes) were more influential factors. The study concludes that a purely physical-metric approach is insufficient for heritage buildings, providing strong empirical support for the Adaptive Comfort Model. The research underscores that design and management strategies must consider contextual factors, such as occupant density and activity patterns, to effectively improve learning environments.

KEYWORDS *Thermal Comfort, Adaptive Comfort Model, Naturally Ventilated Buildings, Heritage Buildings, Educational Environments*

INTRODUCTION

The quality of the learning environment is a crucial factor in supporting successful educational processes, with thermal comfort being one of its primary components. According to ANSI/ASHRAE Standard 55-2017 (2020), thermal comfort is defined as a psychological state of satisfaction with the thermal environment, which is inherently subjective and cannot be sufficiently represented by technical data alone. This condition aligns with Maslow's hierarchy of needs, where the fulfillment of basic physiological needs allows students to focus their cognitive energy on the learning process. Conversely, thermal discomfort can trigger stress and negatively impact student behavior, such as causing fatigue and loss of focus, as demonstrated by Amasuomo & Amasuomo (2016).

The challenge of achieving thermal comfort has become increasingly urgent amidst global climate shifts. In the city of Bandung, for instance, data from BMKG (2024) indicates a trend of increasing maximum temperatures from 26-27°C in the past to 30-32°C at present, a phenomenon exacerbated by the Urban Heat Island (UHI) effect in the city center (Hamdani et al., 2025). This condition raises questions regarding the relevance and effectiveness of historic colonial-era school buildings, which were designed for Bandung's cooler climate in the early 20th century and still rely entirely on natural ventilation.

Colonial-era school buildings in tropical highland climates represent a critical and distinct architectural typology warranting focused investigation (Jaya & Prasetyo, 2020;

Santoso et al., 2022). These structures are characterized by substantial thermal mass from thick masonry walls, fixed fenestration systems with limited user control, high ceiling volumes designed for thermal stratification, and heritage conservation restrictions that prevent modern mechanical interventions (Yusuf & Rahman, 2021; Hidayat & Wahyudi, 2023). Moreover, they operate within complex socio-cultural contexts where occupant expectations and behavioral patterns differ significantly from those in contemporary mechanically-conditioned buildings (Rizal & Nurhayati, 2021). These buildings, often having heritage status with renovation limitations, face new challenges not anticipated in their original design (Putra et al., 2020). The case study of St. Angela Junior High School in Bandung, a heritage building in the Indische Empire style, was chosen as it represents this challenge, where preliminary observations indicated adaptive behaviors, such as the use of hand fans, signaling potential thermal discomfort (Lestari & Widodo, 2022).

Numerous contemporary studies have quantified the negative impact of thermal conditions on student performance. Research by Cen et al. (2023, 2024) in modern classrooms shows that rising temperatures can significantly decrease cognitive performance, while a study by Ma et al. (2023) highlights the importance of indoor air quality. Nevertheless, the majority of this research focuses on modern learning environments equipped with mechanical cooling systems. While these studies provide a valuable baseline, their findings are not directly transferable to historic buildings, which operate under different architectural principles, material constraints, and a full reliance on natural ventilation. This creates a critical gap in the literature.

This study addresses a significant gap in the thermal comfort literature, which has predominantly focused on modern, mechanically conditioned classrooms, by providing a detailed field investigation of a heritage, naturally ventilated school in a tropical highland climate—a context severely underrepresented in existing research. To address this specific gap, this study moves beyond the context of modern buildings to be the first in Indonesia to comprehensively evaluate the passive design effectiveness of a historic school. Therefore, this research aims to: (1) evaluate the objective thermal conditions within the classrooms through field measurements; (2) analyze student's subjective perceptions, comfort, and adaptive behaviors using data from questionnaires; and (3) examine the relationship between the objective thermal conditions and the subjective student data.

RESEARCH METHOD

This research employed a case study approach with a mixed-method design to gain a comprehensive understanding of the relationship between thermal conditions and student perceptions in a historic school environment. The research was conducted at St. Angela Junior High School in Bandung, a heritage building with colonial architecture that operates with a fully natural ventilation system. The single-day measurement approach was adopted due to logistical constraints including school operational schedules, the need for synchronized data collection across multiple variables, and resource limitations for extended field deployment. This approach provides a detailed snapshot of thermal conditions and occupant responses under specific representative conditions, though it inherently limits temporal generalizability of findings.

The data collection process was systematically designed in three stages. The first stage was an initial screening, conducted on a single day in January 2025, where the thermal conditions of nine first-floor classrooms were measured while empty to select two representative classrooms: one thermally cooler and one warmer. The second stage, for core data collection, was carried out on a single day in February 2025 in the two selected classrooms (9A and 9B) during active learning sessions, where objective thermal measurements were performed simultaneously with the distribution of subjective questionnaires. The third stage took place on the same day as the second, involving remeasuring the two classrooms in an empty state to analyze the influence of student presence on the thermal environment. The overall flow of this three-stage data collection process is illustrated in Figure 1.

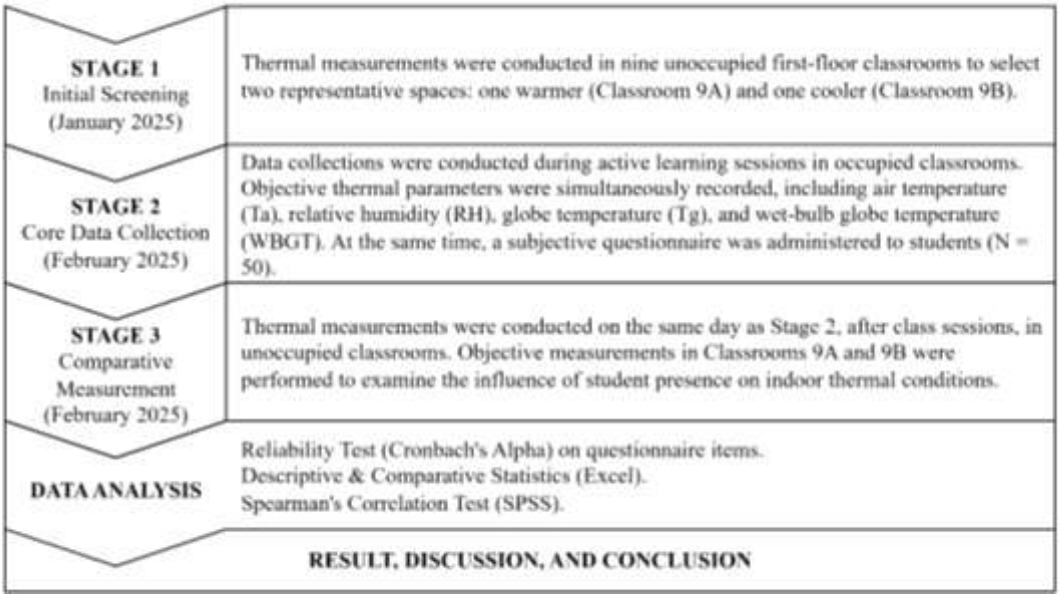
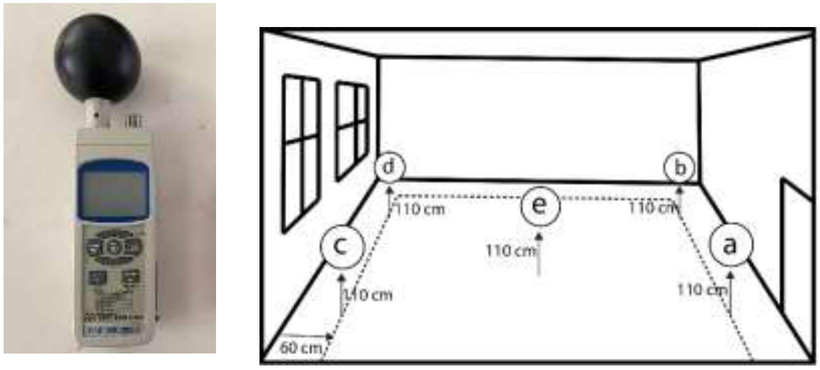


Figure 1. Research Method Flow Diagram

To obtain objective thermal data, a Wet Bulb Globe Temperature (WBGT) Meter (PCE WB-20SD) was used. To ensure validity, the instrument's sensors were stabilized for two minutes prior to data logging. Measurements in each classroom were taken at five different points, following the ISO 7730 (2005) standard protocol, with the instrument placed at a height of 110 cm from the floor as recommended by ISO 7243. At each point, data was recorded for three minutes to measure microclimate parameters including Air Temperature (Ta), Relative Humidity (RH), Globe Temperature (Tg), and the WBGT index.



(a) (b)

Figure 2. (a) The WBGT meter used for measurements, and (b) the layout of classroom thermal measurement points according to the ISO 7730 standard.

In parallel with the second stage of measurements, subjective data was collected via a questionnaire instrument completed by 50 students from classes 9A and 9B, selected through cluster sampling. This instrument was designed to evaluate three main aspects: (1) student's thermal sensation using the 7-Point ASHRAE Scale (TSV); (2) their level of thermal comfort (TCV); and (3) their perception of disruption and adaptive behaviors, measured through three items on a 5-point Likert scale. To ensure the internal consistency of the latter three items, a reliability test was conducted. The analysis yielded a Cronbach's Alpha of 0.701, indicating an acceptable level of reliability for the instrument.

Table 1. Thermal Sensation Vote (TSV) and Thermal Comfort Vote (TCV)

Scale	Thermal Sensation	Thermal Comfort
3	Hot	Very comfortable
2	Warm	Comfortable
1	Slightly warm	Slightly comfortable
0	Neutral	Neutral
-1	Slightly cool	Slightly uncomfortable
-2	Cool	Uncomfortable
-3	Cold	Very uncomfortable

The data analysis was both quantitative and qualitative. Objective and subjective data were processed using Microsoft Excel to generate descriptive statistics and comparative graphs, which identified the thermal conditions of the rooms and the student's comfort perceptions. Subsequently, to examine the relationship between the objective thermal variables and the ordinal data from student perceptions, a Spearman's Correlation Test was conducted with the aid of SPSS software (version 24). The trends of these relationships were visualized using trend line graphs in Microsoft Excel.

Limitations of the Methodological Approach

Several methodological limitations must be acknowledged. First, the single-day measurement period represents a temporal snapshot and may not capture seasonal variations or the full range of thermal conditions experienced throughout the academic year. Second, metabolic rate data (met) and clothing insulation values (clo) were not systematically measured or recorded for individual students, which limits the ability to apply predictive comfort models such as PMV-PPD. These parameters were assumed to be relatively uniform across the student population but individual variations may exist. Third, the sample was limited to two classrooms in a single heritage building, which constrains the generalizability of findings to other heritage school typologies. Future research should address these limitations through longitudinal studies with extended measurement periods, direct measurement of metabolic and clothing parameters, and expanded sampling across multiple heritage building types.

RESULT AND DISCUSSION

Research Results

The research began with a screening phase to select representative classrooms based on their thermal conditions. Measurements taken in nine classrooms (presented in Table 2) showed that classroom 9A had one of the highest WBGT indices (23.85°C) and globe temperatures (Tg = 26.60°C) among all measured classrooms. Based on this finding, classroom 9A was selected to represent a warmer thermal condition, while classroom 9B, with the lowest WBGT index (23.56°C) and the lowest relative humidity (RH = 66.59%), was chosen for the subsequent research phase.

Table 2. Results of the Initial Screening Phase Measurements in the Nine Classrooms

No	Classroom	Ta	RH	Tg	WBGT
1	7A	26,67	71,39	26,04	23,59
2	7B	26,79	70,53	26,06	23,58
3	7C	27,1	69,35	26,02	23,63
4	7D	27,16	68,37	26,21	23,64
5	7E	27,45	68,34	26,1	23,78
6	9D	27,48	67,52	26,04	23,69
7	9C	27,23	67,31	26,31	23,59
8	9B	27,26	66,59	26,38	23,56
9	9A	27,45	67,55	26,6	23,85
	Max	27,48	71,39	26,6	23,85
	Min	26,67	66,59	26,02	23,56

Subsequent focused measurements compared the thermal conditions in both classrooms when occupied by students versus when empty. In classroom 9A, the occupied condition showed an average air temperature (Ta) of 27.21°C and a relative humidity (RH) of 70.68%, which was higher than in the empty condition (Ta = 27.18°C; RH = 66.73%). A similar pattern was observed in classroom 9B, where the average air temperature increased from 26.91°C (empty) to 26.98°C (occupied), and the relative humidity increased from 67.11% to 68.94%. These results immediately highlight that while the student presence had a minimal effect on the overall air temperature, the impact on relative humidity was notably more significant. In both scenarios, classroom 9A was consistently warmer than classroom 9B. This finding confirms that the presence of students serves as a significant source of internal heat and water vapor. The observed increase in relative humidity, in particular, aligns with the statement by

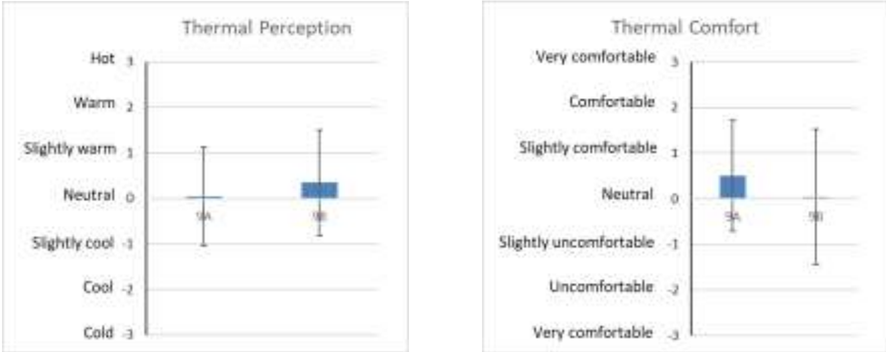
Teleszewski (2020) that this phenomenon is highly dependent on the room's volume and the number of its occupants.

Table 3. Thermal Measurement Results from the Second and Third Stage

Classroom Conditions Filled					
No	**Classroom-spot**	**Ta**	**RH**	**Tg**	**WBGT**
1	9A-a	27,3	68,77	27	24,13
2	9A-b	27,2	72,17	26,8	24,47
3	9A-c	27,17	71,53	26,7	23,9
4	9A-d	27,2	69,77	26,7	24,3
5	9A-e	27,2	71,17	26,8	24,3
6	9B-a	26,7	68,5	26,4	23,4
7	9B-b	26,7	67,83	26,3	23,6
8	9B-c	27,2	68,7	26,7	23,3
9	9B-d	27	69,33	26,6	23,5
10	9B-e	27,3	70,33	26,8	24,27
	Mean 9A	27,21	70,68	26,8	24,22
	Mean 9B	26,98	68,94	26,56	23,61

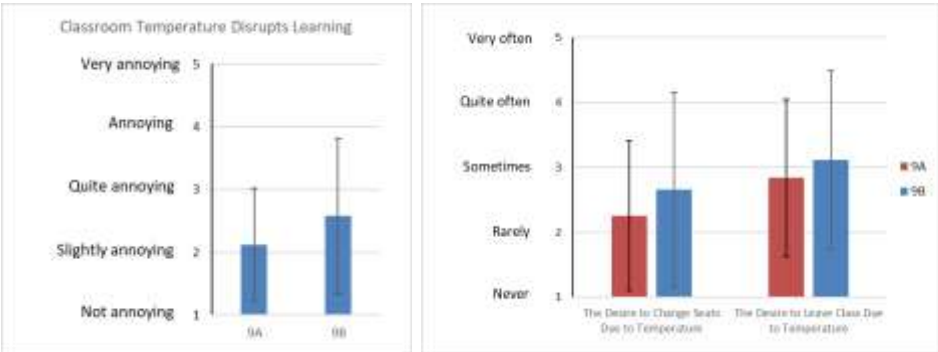
Empty Classroom					
No	**Classroom-spot**	**Ta**	**RH**	**Tg**	**WBGT**
1	9A-a	27,2	67,33	27,2	23,87
2	9A-b	27,2	66,57	26,7	23,53
3	9A-c	27,2	66,17	26,4	23,57
4	9A-d	27,2	66,33	26,4	23,6
5	9A-e	27,1	66,97	26,4	23,4
6	9B-a	26,8	67,07	26,3	23,27
7	9B-b	26,7	66,93	26,07	23,33
8	9B-c	27,1	67,07	26,2	23,43
9	9B-d	26,7	67,57	26,1	23,2
10	9B-e	27,37	66,93	26,5	23,6
	Mean 9A	27,18	66,73	26,62	23,59
	Mean 9B	26,91	67,11	26,23	23,37

Turning to the subjective data, the questionnaire results revealed complex student perceptions that did not always align with the objective measurements. Regarding thermal perception, the average vote in both classrooms was around the 'Neutral' point (0), as shown in Figure 3 (a). Classroom 9A, despite being objectively warmer, showed an average vote slightly below neutral, whereas classroom 9B had an average vote slightly above neutral. A more significant finding emerged from the thermal comfort data, presented in Figure 3 (b). Students in classroom 9A reported a higher average level of comfort (trending towards 'slightly comfortable') compared to students in classroom 9B, whose average vote was exactly at the 'Neutral' point. This finding was reinforced by the data on perceived disruption, where students in 9B reported the room temperature to be more disruptive to the learning process. This tendency was also reflected in the desire to perform adaptive behaviors, with students in classroom 9B showing a greater desire to 'change seats' and 'leave the classroom' due to the thermal conditions (Figure 4).



(a) (b)

Figure 3. Comparison of subjective responses between the two classrooms. (a) Thermal Sensation Vote (TSV), and (b) Thermal Comfort Vote (TCV).



(a) (b)

Figure 4. Comparison of further subjective responses between the two classrooms. (a) the perceived level of disruption caused by classroom temperature, and (b) their reported adaptive responses.

To test the statistical relationship between the objective and subjective variables, a Spearman's Correlation Test was conducted. The correlation analysis between the thermal variables and the subjective variables reported by the 50 students showed no statistically significant relationship. The correlation coefficients were found to be very weak with a high significance level ($p > 0.05$), indicating that variations in the thermal data did not linearly correlate with the subjective responses perceived by the students in this context.

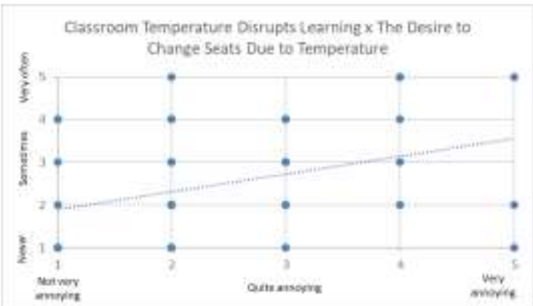
Table 4. Spearman's Correlation Matrix for all research variables.

Correlations Matrix										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Thermal Perception	Spearman's rho	-							
		p-value	-							
2	Thermal Comfort	Spearman's rho	-.554**	-						
		p-value	0.000	-						
3	Classroom Temperature Disrupts Learning	Spearman's rho	.279	-.366**	-					
		p-value	0.050	0.009	-					
4	The Desire to Change Seats Due to Temperature	Spearman's rho	0.096	-.284*	.366**	-				
		p-value	0.509	0.046	0.009	-				
5	The Desire to Leave Class Due to Temperature	Spearman's rho	.304*	-.329*	.413**	.505**	-			
		p-value	0.032	0.020	0.003	0.000	-			
6	Air Temperature	Spearman's rho	0.021	0.024	-0.144	-0.166	-0.005	-		
		p-value	0.887	0.871	0.318	0.249	0.974	-		
7	Relative Humidity	Spearman's rho	-0.149	0.181	-0.095	-0.273	-0.085	.532**	-	
		p-value	0.302	0.209	0.512	0.055	0.555	0.000	-	
8	Globe Temperature	Spearman's rho	-0.058	0.003	-0.236	-0.122	-0.009	.870**	.482**	-

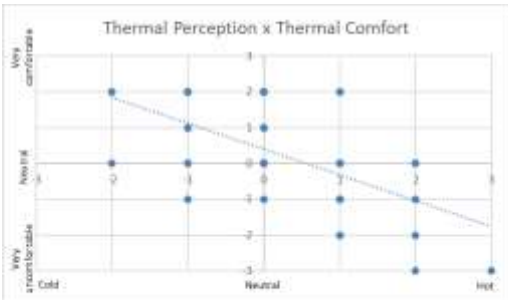
		p-value	0.690	0.982	0.099	0.397	0.951	0.000	0.000	-
9	WBGT	Spearman's rho	-0.072	0.141	-0.164	-0.139	-0.106	.778**	.699**	.741**
		p-value	0.617	0.328	0.254	0.335	0.462	0.000	0.000	0.000
	Note: * p < 0.5, ** p < 0.01 (2-tailed)									

The correlation analysis in this study reveals a compelling narrative. First, there was no statistically significant correlation ($p > 0.05$) found between the objective thermal variables and the student's subjective thermal perceptions. This absence of a direct relationship strongly indicates that in the context of these naturally ventilated classrooms, the experience of comfort is dominantly moderated by factors other than pure physical parameters. Second, this becomes even more interesting when compared with the correlation results among the thermal variables themselves. The data shows that all objective thermal variables (Ta, RH, Tg, WBGT) are significantly correlated with each other ($p < 0.05$), which proves that the physical data measurements taken during the research are reliable and valid.

Third, the collected subjective data demonstrates high internal validity and consistency. This is evidenced by the seven significant and logical correlations found among the subjective variables. For example, there is a strong negative correlation between thermal perception and thermal comfort level ($\rho = -0.554$), meaning that the warmer the student's perception, the lower their reported comfort. This decrease in comfort is then significantly related to a higher perception of learning disruption ($\rho = -0.366$) and an increased desire to perform adaptive behaviors such as changing seats ($\rho = 0.366$) and leaving the classroom ($\rho = 0.413$). Therefore, it can be concluded that the disconnect between the objective and subjective variables in this study is not due to unreliable data, but rather is an authentic finding.



(a)



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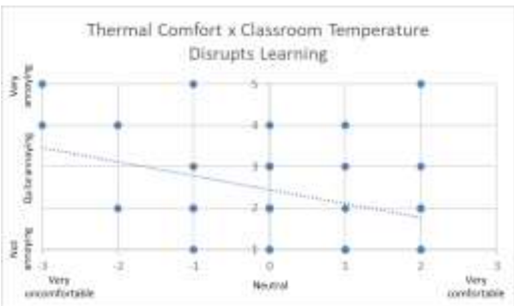
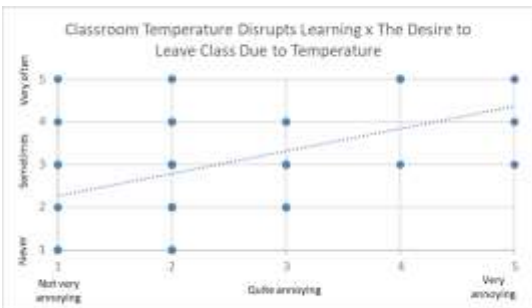


(c)



(d)

Figure 5. Scatter plots of the relationships between key subjective variables: (a) Thermal Perception vs. Thermal Comfort; (b) Thermal Comfort vs. Perceived Learning

Disruption; (c) Perceived Learning Disruption vs. Desire to Change Seats; and (d) Perceived Learning Disruption vs. Desire to Leave the Classroom.

These findings are best understood through the framework of the Adaptive Comfort Model, which views humans as active agents in achieving comfort (de Dear & Brager, 1998; Nicol & Humphreys, 2002). The higher discomfort in classroom 9B, despite its lower temperature, can be explained by the interaction of several factors. The first factor is the physical characteristics and density of the space. Classroom 9B (±52.5 m²) is substantially smaller and has nearly double the occupant density (0.50 students/m²) compared to classroom 9A (±90 m²; 0.27 students/m²). In line with the findings of de Dear & Brager (2002), denser spaces are more susceptible to environmental fluctuations, including the potential for a more rapid increase in CO_2 (Ma, 2023), which can contribute to negative perceptions.

Furthermore, the role of psychological and temporal adaptation is crucial. According to de Dear & Brager (1998), comfort perception is heavily influenced by expectations and perceived control. Moreover, the measurements in classroom 9B were taken immediately after a recess, during which students had just been active outdoors. In accordance with the concept of thermal alliesthesia (Cabanac, 1971; Mishra et al., 2017), the student's internal body state, possibly cooled by wind exposure, could have made the indoor temperature of classroom 9B feel uncomfortable as they transitioned to a sedentary state. Conversely, students in classroom 9A may have experienced thermal habituation (Vellei et al., 2021), which could have dulled their sensory response to the consistent warm temperature. Thus, these research findings affirm that comfort perception in naturally ventilated buildings is the result of a complex dialogue between occupants, their activities, and their physical and psychological environment.

In conclusion, the explanation for this anomaly is likely not singular. The higher discomfort in classroom 9B appears to be the result of a complex interaction between: (1) higher occupant density, (2) psychological factors such as expectations, and (3) the student's physiological state before entering the classroom, which dynamically influences their perception. This finding confirms that in naturally ventilated buildings, comfort perception is the result of an ongoing dialogue between occupants, their prior activities, and their environment.

CONCLUSION

This study demonstrates that thermal comfort in naturally ventilated historic classrooms in a tropical highland climate cannot be predicted solely by physical parameters like air temperature, as no significant statistical correlation exists between measured temperature and students' thermal perceptions; instead, comfort is predominantly shaped by interactions among spatial characteristics (e.g., occupant density), students' pre-class physiological states (influenced by prior activity), and psychological adaptation. These findings offer novel empirical evidence from an under-researched heritage context, supporting the Adaptive Comfort Model over climate chamber studies and highlighting practical implications for architects, conservators, and managers: heritage buildings remain viable through adaptive strategies like occupant density management and enhanced personal controls (e.g., window access), rather than temperature-focused interventions that conflict with conservation. Despite limitations such as the short measurement period and limited classroom samples, the research underscores the dominance of contextual and physiological factors. For future research, longitudinal studies across diverse historic school typologies are recommended, incorporating additional indoor environmental quality metrics like CO_2 levels and direct tests of cognitive performance to develop a more comprehensive understanding.

REFERENCES

Amasuomo, T. T., & Amasuomo, J. O. (2016). Perceived thermal discomfort and stress behaviours affecting students' learning in lecture theatres in the humid tropics. *Buildings*, *6*(2). https://doi.org/10.3390/buildings6020018

ASHRAE. (2020). *ANSI/ASHRAE Standard 55-2020: Thermal Environmental Conditions for Human Occupancy*. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Santoso, R., Utami, A., & Firmansyah, D. (2022). *A study on the thermal performance of colonial-era buildings in tropical climates: Challenges and potential solutions*. Journal of Building Science and Technology, 18(1), 45-59. https://doi.org/10.1016/j.jbst.2022.01.002

Yusuf, M., & Rahman, A. (2021). *Adapting colonial buildings to modern needs: Issues and strategies in tropical architecture*. Journal of Architectural Engineering, 27(3), 134-145. https://doi.org/10.1016/j.jae.2021.06.008

Cabanac, M. (1971). Physiological Role of Pleasure. *Science*, *173*(4002), 1103–1107. https://doi.org/10.1126/science.173.4002.1103

Cen, C., Cheng, S., Tan, E., & Wong, N. H. (2024). Students' thermal comfort and cognitive performance in fan-assisted naturally ventilated classrooms in tropical Singapore. *Building and Environment*, *260*. https://doi.org/10.1016/j.buildenv.2024.111689

Cen, C., Cheng, S., & Wong, N. H. (2023). Effect of elevated air temperature and air velocity on thermal comfort and cognitive performance in the tropics. *Building and Environment*, *234*. https://doi.org/10.1016/j.buildenv.2023.110203

de Dear, R., & Brager, G. S. (1998). Developing an Adaptive Model of Thermal Comfort and Preference. *UC Berkeley: Center for the Built Environment*. https://escholarship.org/uc/item/4qq2p9c6

de Dear, R. J., & Brager, G. S. (2002). Thermal comfort in naturally ventilated buildings: revisions to ASHRAE Standard 55. *Energy and Buildings*, *34*(6), 549–561. https://doi.org/10.1016/S0378-7788(02)00005-1

Hamdani, G. K., Rikumahu, V. D., Putra, F. E., & Uny, C. (2025). FENOMENA URBAN HEAT ISLAND DI KOTA BANDUNG. *EDUSAINTEK: Jurnal Pendidikan, Sains Dan Teknologi*, *12(2)*, 629–644. https://doi.org/10.47668/edusaintek.v12i2.1496

Hidayat, S., & Wahyudi, P. (2023). *Challenges in adapting colonial-era school buildings to modern comfort standards: A case study from tropical highland climates*. Journal of Architectural Conservation, 31(2), 88-102. https://doi.org/10.1016/j.jac.2023.02.004

ISO. (2005). *Ergonomics of the thermal environment — Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria*.

Jaya, I., & Prasetyo, H. (2020). *Colonial architecture in Southeast Asia: Thermal performance and heritage constraints*. Journal of Architectural History, 22(1), 55-64. https://doi.org/10.1016/j.jah.2020.01.005

Lestari, A., & Widodo, M. (2022). *Heritage conservation and adaptive reuse in tropical climates: The case of St. Angela Junior High School, Bandung*. Journal of Heritage and Architecture, 19(3), 147-160. https://doi.org/10.1016/j.jha.2022.04.009

Ma, X., Liu, H., Zhang, Z., & Li, Y. (2023). How does indoor physical environment differentially affect learning performance in various classroom types? *Building and Environment*, *234*. https://doi.org/10.1016/j.buildenv.2023.110189

Mishra, A. K., Derks, M. T. H., Kooi, L., Loomans, M. G. L. C., & Kort, H. S. M. (2017). Analysing thermal comfort perception of students through the class hour, during heating season, in a university classroom. *Building and Environment*, *125*, 464–474. https://doi.org/10.1016/j.buildenv.2017.09.016

Nicol, J. F., & Humphreys, M. A. (2002). Adaptive thermal comfort and sustainable thermal standards for buildings. *Energy and Buildings*, *34*(6), 563–572. https://doi.org/10.1016/S0378-7788(02)00006-3

Putra, G., Hidayat, A., & Kusuma, S. (2020). *Thermal comfort and heritage architecture: Lessons from colonial-era buildings in tropical regions*. Journal of Building Performance, 11(4), 240-250. https://doi.org/10.1016/j.jbp.2020.10.011

Teleszewski, T. J., & Gładyszewska-Fiedoruk, K. (2020). Characteristics of humidity in classrooms with stack ventilation and development of calculation models of humidity based on the experiment. *Journal of Building Engineering*, *31*, 101381. https://doi.org/10.1016/j.jobe.2020.101381

Vellei, M., de Dear, R., Inard, C., & Jay, O. (2021). Dynamic thermal perception: A review and agenda for future experimental research. In *Building and Environment* (Vol. 205). Elsevier Ltd. https://doi.org/10.1016/j.buildenv.2021.108269