



Correlation Between Physical Classroom Environment Temperature, Humidity, Noise and Students Learning Concentration Levels

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ABSTRACT

The classroom physical environment plays a critical role in shaping students' learning concentration. Suboptimal conditions of temperature, humidity, and noise can reduce comfort and impair students' ability to maintain focus during instructional activities. This study aimed to examine the relationship between classroom environmental factors (temperature, humidity, and noise) and learning concentration among senior high school students. An analytic observational study with a cross-sectional design was conducted involving 120 students from grades X and XI, selected through simple random sampling. Temperature and humidity were measured using a thermohygrometer, while noise levels were assessed with a sound level meter. Learning concentration was evaluated using a structured questionnaire. The questionnaire had been tested for validity and reliability (Cronbach's alpha > 0.70), and ethical approval along with informed consent was obtained prior to data collection. Data were analyzed using univariate and bivariate approaches, with the Chi-square test applied at a significance level of 0.05. The findings indicated that most classroom conditions did not meet recommended standards, including temperature (58.3%), humidity (55.0%), and elevated noise levels (60.0%). Furthermore, the majority of students demonstrated low levels of learning concentration (56.7%). Bivariate analysis showed that temperature was not significantly associated with learning concentration ($p = 0.231$), whereas humidity ($p = 0.002$) and noise ($p = 0.001$) were significantly associated. In conclusion, humidity and noise are key determinants of students' learning concentration, while temperature appears to have no significant effect. These findings underscore the importance of optimizing classroom environmental conditions to support effective learning.

Keywords: *Temperature, Humidity, Noise, Learning Concentration, High School Students*



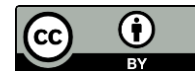
INTRODUCTION

The physical environment of the classroom plays a crucial role in supporting the teaching and learning process. Factors such as temperature, humidity, and noise can affect students' comfort and concentration (Wargocki et al., 2017). Suboptimal environmental conditions can lead to physiological and psychological disturbances, such as fatigue, stress, and reduced ability to focus, which impact the effectiveness of learning. According to the World Health Organization (2018), the quality of the learning environment is closely linked to students' cognitive performance, including memory, attention, and problem-solving skills. An unhealthy learning environment can lead to a 10–15% decline in cognitive function compared to optimal conditions (Cedeño-Laurent et al., 2018). This underscores that the quality of the physical environment is a critical determinant of the success of the educational process.

In Indonesia, environmental health aspects are regulated by Law Number. 36 of 2009 on Health and Regulation of the Minister of Health of the Republic of Indonesia Number. 2 of 2023 on the Implementation of Environmental Health (Ministry of Health of the Republic of Indonesia, 2023; Republic of Indonesia, 2009). These regulations emphasize the importance of controlling environmental factors such as temperature, humidity, and noise in indoor spaces. However, in practice, classroom conditions in Indonesia still do not fully meet these standards. Various empirical studies indicate that the physical environment has a significant impact on students' concentration and motivation to learn. Research by Rizkiwati et al. (2025) indicates that environmental and physiological factors significantly influence students' learning concentration. Additionally, a literature review by Meiliani et al. (2025) notes that school physical environments such as lighting, ventilation, temperature, and cleanliness play a major role in creating a conducive learning atmosphere.

Specifically, classroom temperature is a key factor in thermal comfort. Research indicates that the majority of respondents reported that temperature affects learning concentration (Nurfajriyani et al., 2020). However, the impact of temperature on concentration is not always consistent across various studies. Air humidity also affects learning comfort. Poor ventilation can cause classrooms to become stuffy, thereby reducing student concentration (Sari et al., 2025). These conditions indicate that indoor air quality plays a vital role in supporting the learning process. Noise is one of the most significant factors affecting concentration during learning. Research indicates that noise levels in school environments often exceed established thresholds (Ambarawati et al., 2016). This can disrupt communication during instruction and reduce students' concentration. Other studies also indicate that suboptimal thermal and noise conditions cause discomfort and disrupt learning concentration (Ananda, 2023). Furthermore, a review by Simbolon et al. (2025) confirms that physical environmental factors such as temperature, lighting, and noise simultaneously influence students' learning concentration. An optimal learning environment also contributes to improved student learning outcomes (Nursidik et al., 2024).

The state of the art shows that many studies have highlighted the importance of the physical environment in supporting the learning process. However, most of these studies tend to examine environmental factors separately, rather than considering their combined effects. In addition, findings regarding the role of temperature in influencing learning concentration are still inconsistent. In the Indonesian context, studies that simultaneously analyze temperature, humidity, and noise in relation to students' learning concentration, particularly at the high school level, are still limited. This indicates a need for more comprehensive research that reflects actual classroom environmental conditions. Therefore, this study aims to examine these three environmental factors simultaneously using direct measurements, in order to provide a more integrated understanding of how classroom environments



influence students' learning concentration within the framework of current environmental health standards.

METHODS

This study used an analytical observational design with a cross-sectional approach to examine the relationship between classroom physical environment factors and students' learning concentration. This approach was chosen because it allows the relationship between variables to be observed at a single point in time without any intervention. The study was conducted in 2026 at a senior high school (SMA). The population consisted of all 10th and 11th-grade students who were actively participating in learning activities. A total of 120 students were selected as the sample using simple random sampling, ensuring that each student had an equal chance of being included. Students who were present and willing to participate were included in the study, while those who were ill or not attending classes during data collection were excluded.

The independent variables in this study were classroom temperature, humidity, and noise, while the dependent variable was students' level of learning concentration. Temperature and humidity were measured using a thermohygrometer, and noise levels were measured using a sound level meter during the learning process. To obtain more representative data, measurements were taken at three points in each classroom (front, middle, and back) at a height of approximately 1.1 meters from the floor, corresponding to the students' breathing zone. Measurements were conducted during active learning hours and repeated, with the results averaged to better reflect actual classroom conditions. Noise levels were measured for approximately 10–15 minutes and expressed in dB(A).

The measurement standards referred to environmental health guidelines, including temperature ranging from 18–28°C, humidity between 40–60%, and noise levels not exceeding 55 dB(A). Students' learning concentration was assessed using a structured questionnaire developed based on indicators such as attention focus, resistance to distraction, and ability to understand the material. The questionnaire had been tested for validity ($r\text{-count} > r\text{-table}$) and reliability, with a Cronbach's alpha value greater than 0.70, indicating acceptable internal consistency. The data were analyzed using univariate and bivariate methods. Univariate analysis was used to describe the distribution of each variable, while bivariate analysis was performed using the Chi-square test to examine the relationship between environmental factors and learning concentration, with a significance level of 0.05. Ethical considerations were carefully addressed by informing respondents about the purpose of the study, ensuring the confidentiality of their data, and obtaining informed consent prior to participation. Ethical approval was also obtained from the institutional ethics committee before the study was conducted.

RESULTS

1. Univariate Analysis

a) Results of Physical Classroom Environment Measurements

Table 1. Results of Physical Classroom Environment Measurements

Parameter	Front Point	Middle Point	Back Point	Average	Min	Max	Standard
Temperature (°C)	28.4	28.1	28.6	28.37	28.1	28.6	18–28
Humidity (%)	73	71	72	72.0	71	73	40–60
Noise (dB(A))	66	67	68	67.0	66	68	≤55



The measurement results indicate that classroom temperature was slightly above the recommended range, while humidity and noise clearly exceeded acceptable standards. This pattern suggests that humidity and noise are more dominant environmental factors influencing students' learning concentration.

b) Classroom Temperature Distribution

Table 2. Classroom Temperature Distribution

Temperature Category	Frequency	Percentage (%)
Meets requirements	50	41,7
Does not meet requirements	70	58,3
Total	120	100

According to Table 2, the majority of classrooms had temperatures that did not meet the standards 70 respondents (58.3%) while 50 respondents (41.7%) reported temperatures that did meet the standards. These data indicate that classroom temperature conditions predominantly fall into the non-compliant category, which, in the context of environmental health, is associated with thermal comfort.

c) Humidity Distribution

Table 3. Humidity Distribution

Humidity Category	Frequency	Percentage (%)
Meets requirements	54	45,0
Does not meet requirements	66	55,0
Total	120	100

According to Table 3, the majority of classrooms had humidity levels that did not meet the standards 66 respondents (55.0%) while 54 respondents (45.0%) reported levels that did meet the standards. This indicates that classroom humidity conditions were more frequently in the non-compliant category, which is related to indoor air quality.

d) Noise Distribution

Table 4. Noise Distribution

Noise Category	Frequency	Percentage (%)
Low	48	40,0
High	72	60,0
Total	120	100

Based on Table 4, most classrooms have high noise levels, with 72 respondents (60.0%) reporting high noise levels, while 48 respondents (40.0%) reported low noise levels. These data indicate that noise conditions are predominantly in the high category, which, in studies of the learning environment, is considered a physical factor that can influence the learning atmosphere.

e) Distribution of Study Concentration

Table 5. Distribution of Study Concentration

Level of Concentration	Frequency	Percentage (%)
Good	52	43,3
Poor	68	56,7



Total	120	100
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Based on Table 5, the majority of students have a poor level of concentration, totaling 68 respondents (56.7%), while those with good concentration total 52 respondents (43.3%). These data indicate that students' concentration levels are predominantly in the poor category, which is generally related to the ability to focus attention during the learning process.

2. Bivariate Analysis

a) Relationship Between Temperature and Concentration During Learning

Table 6. Relationship Between Temperature and Concentration During Learning

Temperature	Good Concentration	Poor Concentration	Total	p-value
Meets requirements	24	26	50	0,231
Does not meet requirements	28	42	70	
Total	52	68	120	

Based on Table 6, it is found that in classrooms with temperatures meeting requirements, there were 24 students (48.0%) with good concentration and 26 students (52.0%) with poor concentration. Meanwhile, in classrooms with temperatures that did not meet the criteria, there were 28 students (40.0%) with good concentration and 42 students (60.0%) with poor concentration. The results of the Chi-square test showed a p-value of 0.231 (>0.05), indicating that there is no significant relationship between temperature and students' concentration.

b) Relationship Between Humidity and Concentration During Learning

Table 7. Relationship Between Humidity and Concentration During Learning

Humidity	Good Concentration	Poor Concentration	Total	p-value
Meets requirements	30	24	54	0,002
Does not meet requirements	22	44	66	
Total	52	68	120	

Following on Table 7, it is found that in classrooms with humidity meeting requirements, there were 30 students (55.6%) with good concentration and 24 students (44.4%) with poor concentration. Meanwhile, in classrooms with humidity levels that do not meet the criteria, there were 22 students (33.3%) with good concentration and 44 students (66.7%) with poor concentration. The results of the Chi-square test showed a p-value of 0.002 (<0.05), indicating a significant relationship between humidity and students' concentration.

c) Relationship Between Noise and Concentration During Learning

Table 8. Relationship Between Noise and Concentration During Learning

Noise	Good Concentration	Poor Concentration	Total	p-value
Low	30	18	48	0,001
High	22	50	72	
Total	52	68	120	

Referring to Table 8, it is known that in classrooms with low noise levels, there are 30 students (62.5%) with good concentration and 18 students (37.5%) with poor concentration. Meanwhile, in



classrooms with high noise levels, there are 22 students (30.6%) with good concentration and 50 students (69.4%) with poor concentration. The results of the Chi-square test show a p-value of 0.001 (<0.05), indicating that there is a significant relationship between noise levels and students' learning concentration.

DISCUSSION

The findings of this study indicate that classroom environmental conditions were generally not optimal, particularly in terms of humidity and noise. However, the impact of each environmental factor on students' learning concentration varied.

1. Univariate Analysis

a) Temperature

The univariate analysis results indicate that the majority of classrooms have temperatures that do not meet the required standards (58.3%), suggesting that the thermal environment is not yet optimal. Temperature is a fundamental component of thermal comfort and is directly associated with human physiological responses (Wargoeki et al., 2017). From a theoretical perspective, elevated temperatures may increase body heat, induce fatigue, and reduce alertness, whereas low temperatures can cause discomfort and impair concentration. Thermal comfort standards established by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) emphasize that optimal thermal conditions are essential for supporting cognitive performance.

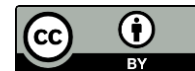
Empirical evidence from Cedeño-Laurent et al. (2018) demonstrates that suboptimal thermal environments can adversely affect cognitive functions, including attention and decision-making. Nevertheless, within learning environments, temperature does not operate in isolation. Factors such as ventilation, air circulation, occupancy density, and individual adaptation also play significant roles in shaping thermal comfort perceptions (Mendell et al., 2019). Therefore, although most classrooms do not meet temperature standards, their impact on learning outcomes may vary depending on the overall environmental context.

b) Humidity

The results of the study indicate that the majority of classrooms have humidity levels that do not meet the required standards (55.0%). Humidity is an important indicator of indoor air quality and is closely related to both comfort and health. Scientifically, high humidity levels can promote the growth of microorganisms such as fungi and bacteria, which may deteriorate air quality (Arundel et al., 2020). In addition, excessive humidity can create a stuffy and uncomfortable environment, while low humidity may lead to respiratory tract irritation. In the context of learning, suboptimal indoor air quality can reduce students' comfort and potentially impair cognitive performance. A study by Sari et al. (2025) found that poor ventilation and inadequate air quality can decrease students' learning concentration. This finding is consistent with the concept of the learning environment, which emphasizes that air quality is a critical factor in supporting effective learning activities (Simbolon et al., 2025).

c) Noise

The analysis results indicate that the majority of classrooms are exposed to high noise levels (60.0%). Noise is a significant physical environmental factor that affects the learning process, as it is directly related to the auditory system and attention. Theoretically, noise can interfere with communication between teachers and students and hinder the reception of information. It may also cause attention distraction, which can lead to a decreased ability to comprehend learning materials



(Shield & Dockrell, 2019). A study by Ambarawati et al. (2016) found that noise levels in school environments often exceed recommended thresholds, particularly due to transportation activities. Furthermore, research by Simbolon et al. (2025) identifies noise as one of the primary factors affecting students' learning concentration. Prolonged exposure to noise may also increase stress levels and mental fatigue. Therefore, noise is considered an important indicator in determining the quality of a conducive learning environment.

d) Students' Learning Concentration Level

The results of the study indicate that the majority of students have a low level of learning concentration (56.7%). Learning concentration is a critical cognitive ability in the educational process, as it determines the extent to which students can understand the material presented (Ormrod, 2020). Theoretically, concentration is influenced by various factors, including internal factors such as physical and psychological conditions, as well as external factors such as the learning environment. An unconducive environment may act as a source of distraction, thereby impairing students' ability to maintain attention. A study by Rizkiwati et al. (2025) demonstrated that environmental factors have a significant influence on students' learning concentration. In addition, research by Nursidik et al. (2024) reported that favorable physical environmental conditions can enhance both concentration and learning outcomes. Therefore, the low level of learning concentration observed among the majority of students may indicate that environmental factors have not yet been optimal in supporting the learning process

2. Bivariate Analysis

a) Temperature and Students' Learning Concentration Level

The results of this study revealed that there was no significant relationship between temperature and students' concentration on learning. This can be attributed to the relatively moderate temperature range during the measurements. The average temperature was slightly higher than the recommended standard, but close to the upper limit, and enabled students to physiologically adapt to the classroom conditions. Moreover, the narrow range of temperature variation among measurement points might have reduced its sensitivity to distinguish between students' concentration levels of learning. Temperature conditions in this study were not an extreme environmental stressor, as compared to humidity and noise, which exhibited more pronounced departures from the recommended standards. Furthermore, temperature does not act independently in influencing concentration. Other environmental factors such as humidity and noise may have a more direct and dominant effect on students' comfort and cognition. Thus, in the context of this study, temperature was not a determining factor for students' learning concentration in comparison to other environmental variables.

However, this finding is not in line with the study by Nurfajriyani et al. (2020), which found that temperature significantly affects learning concentration. This discrepancy may be attributed to differences in environmental conditions, the absence of extreme temperature variations, and students' adaptive capacity to classroom thermal conditions. Physiologically, the human body possesses mechanisms to adapt to changes in environmental temperature; therefore, as long as the temperature remains within tolerable limits, its impact on cognitive function tends to be minimal. Furthermore, other environmental factors such as humidity, ventilation, and noise may interact with temperature in influencing overall thermal comfort. Thus, the lack of a significant relationship in this study may indicate that temperature is not a dominant factor compared to other environmental variables affecting students' learning concentration.



b) Humidity and Students' Learning Concentration Level

The results of this study indicate a statistically significant relationship between humidity and students' learning concentration level ($p = 0.002$). This finding suggests that humidity conditions play an important role in influencing students' concentration during the learning process. This result is consistent with the study by Arundel et al. (2020), which states that indoor humidity affects air quality and thermal comfort, ultimately impacting cognitive function. Furthermore, research by Sari et al. (2025) also demonstrates that inadequate ventilation and suboptimal air conditions can reduce students' learning concentration.

From a scientific perspective, inappropriate humidity levels can create a stuffy and uncomfortable indoor environment, thereby disrupting students' focus during learning activities. High humidity levels can increase relative moisture in the air, accelerating the growth of microorganisms, while low humidity can lead to dryness of the respiratory tract. In addition, poor indoor air quality may increase drowsiness and reduce students' alertness, which in turn affects their ability to sustain attention. Therefore, the findings of this study highlight that humidity is a crucial indicator in creating a healthy learning environment that supports students' cognitive performance.

c) Noise and Students' Learning Concentration Level

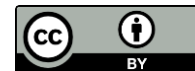
The results of this study indicate a statistically significant relationship between noise and students' learning concentration level ($p = 0.001$). This finding suggests that noise is an influential factor affecting students' concentration during the learning process. This result is consistent with the study by Shield and Dockrell (2019), which reported that noise has a direct impact on students' attention and comprehension abilities. Another study by Ambarawati et al. (2016) also found that noise levels in school environments often exceed recommended standards and can disrupt learning comfort.

Furthermore, this finding is supported by Simbolon et al. (2025), who identified noise as one of the primary factors influencing students' learning concentration. Theoretically, noise increases distraction and cognitive load, thereby hindering the process of understanding learning materials. More specifically, noise can interfere with selective attention, which is the ability to focus on relevant information while filtering out irrelevant stimuli. A noisy environment increases external disturbances, making it more difficult for students to maintain sustained attention over time. In addition, noise may trigger mild stress responses that negatively affect cognitive performance. Therefore, the findings of this study reinforce the importance of noise control as a key factor in creating an effective and conducive learning environment.

From a practical perspective, these findings highlight the importance of improving classroom environmental quality to support students' learning concentration. Schools are encouraged to optimize ventilation systems to maintain appropriate humidity levels and ensure adequate air circulation, for example by implementing cross-ventilation or adding exhaust fans where necessary. In addition, noise control measures should be considered, such as minimizing external noise sources, arranging classroom layouts away from high-traffic areas, and using simple sound-absorbing materials within the classroom. Regular monitoring of environmental conditions is also recommended to ensure that classroom environments remain within acceptable standards and are conducive to effective learning.

CONCLUSIONS

Based on the results of this study examining the relationship between the physical classroom environment (temperature, humidity, and noise) and high school students' learning concentration, it can be concluded that most classrooms have not met the recommended environmental standards.



Specifically, non-compliance was observed in temperature (58.3%), humidity (55.0%), and noise levels (60.0%). In addition, the majority of students were found to have low levels of learning concentration (56.7%). The results of the bivariate analysis indicate that there is no significant relationship between temperature and students' learning concentration ($p = 0.231$). In contrast, there are significant relationships between humidity ($p = 0.002$) and noise ($p = 0.001$) and students' learning concentration. Therefore, humidity and noise are identified as key environmental factors influencing students' learning concentration, while temperature does not show a significant association. Based on these findings, it is recommended that schools prioritize improvements in classroom environmental quality, particularly through optimizing ventilation systems to control humidity and implementing effective noise reduction strategies. In addition, routine monitoring of environmental conditions should be conducted to ensure that classrooms meet health standards. At the policy level, education authorities are encouraged to strengthen the implementation and supervision of environmental health standards in school settings to support a more conducive learning environment.

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