International Journal of Sustainability and Advanced Integrated Research
Volume 2, Issue 2 (April-June 2026) | ISSN: 3107-7854
DOI: https://doi.org/10.65339/ijsair.V2.I2.249

A Multi-Tiered Framework for School-Based Thermal Comfort Strategies and Student Well-Being

Bai Donna R. Pagrangan
Doctor of Education, Cotabato Foundation College of Science and Technology,
Doroluman Arakan, Cotabato, Philippines
Master Teacher II, Alamada High School, Alamada Cotabato

Publication history: Received: January 12, 2026; Revised: March 10, 2026; Accepted: April 18, 2026
Email of Corresponding Author: baidonna.pagrangan@deped.gov.ph

Abstract

This explanatory sequential mixed-methods study investigated the implementation of school-based thermal comfort strategies and their influence on the multi-dimensional well-being of students within the Department of Education (DepEd) Cotabato Division, specifically in Alamada, North Cotabato. Data were gathered from 527 across ten secondary schools during the 2025–2026 school year. Quantitative results revealed a "High Extent" of implementation in administrative domains such as flexible learning and health monitoring, but only a "Moderate Extent" in classroom infrastructure. Despite these interventions, students reported "Low" levels of physical and social well-being. Spearman's rho and multiple regression analyses indicated no significant positive relationship between current mitigation strategies and student well-being outcomes, highlighting a critical implementation-impact gap. Qualitative thematic analysis of in-depth interviews and focus group discussions uncovered the "Hot Air Paradox," where standard electric fans proved ineffective or detrimental during peak heat. Teachers reported a "Vertical Heat Penalty" for upper-floor classrooms and chronic burnout, while students experienced "hygiene stress" and social withdrawal. The study concludes that passive cooling and administrative adjustments have reached their physiological limits. Findings led to the development of a Multi-Tiered Framework for School-Based Thermal Comfort Strategies, recommending a systemic pivot toward "hard" infrastructure investments, including solar-powered active cooling, architectural retrofitting, and de-privatized climate adaptation funding through updated maintenance allowances.

Keywords: Thermal Comfort, Student Well-Being, Climate Adaptation, Educational Management, Mixed-Methods, Philippines, Active Cooling

1. Introduction

Globally, escalating temperatures are fundamentally disrupting education. In 2024, UNICEF reported that extreme heatwaves forced hundreds of millions of students to miss school. Beyond the immediate loss of instructional time, research indicates that perceived thermal discomfort is a primary driver of cognitive decline. Specifically, heat indices exceeding 42°C have been shown to significantly impair learning and retention, particularly in complex tasks like mathematics (Park et al., 2020; Garcia, 2024).

In the Philippine context, this crisis is acutely manifested by temperatures reaching a "feels like" heat index of 45°C (Garcia, 2024). Consequently, the classroom environment has become a barrier to holistic well-being. According to Save the Children Philippines (2024), children are particularly susceptible to heat-related illnesses, respiratory problems, and exhaustion because their developing bodies cannot regulate internal temperatures as effectively as adults. As a result, nearly 4,000 schools were forced to shift to Alternative Delivery Modes (ADM) in early 2024 to protect students from these "danger" category temperatures.

In response to these risks, the Department of Education (DepEd) reiterated Department Order 037 (s. 2022), authorizing school heads to suspend in-person classes. While intended for safety, these suspensions often trigger a "secondary crisis" of inequity. Furthermore, advocates note that students from lower socioeconomic backgrounds frequently transition from hot classrooms to homes lacking adequate cooling or digital infrastructure, halting educational momentum (Garcia, 2024; Save the Children, 2024).

Despite these policies, a significant gap remains between national directives and the lived experience of students. In the Cotabato Division, teachers describe an "oppressive" atmosphere where students become restless, ill, and unable to concentrate (Save the Children, 2024). Moreover, many classrooms remain overcrowded and ill-equipped, forcing a reliance on localized, often underfunded, cooling efforts. Accordingly, this study bridges the research void by proposing A Multi-Tiered Framework for School-Based Thermal Comfort Strategies. By investigating a hierarchy of interventions within secondary schools of Cotabato Division ranging from hydration protocols to infrastructural adjustments this research aims to determine if systematic reductions in perceived discomfort can safeguard student well-being and sustain learning continuity.

2. Material and methods

2.1 Research Design

The study employed a mixed-methods sequential explanatory research design. This approach commenced with a quantitative phase to identify and statistically measure the relationships and influence among the variables. Following this, a qualitative phase was implemented using Focus Group Discussions (FGDs) to explain and interpret the initial quantitative findings with deeper context. Quantitative Component. A descriptive-correlational research design was used to systematically describe the thermal comfort strategies implemented by teachers and to determine the relationship between these strategies and the well-being of students. Qualitative Component. A descriptive phenomenological approach was used to explore and understand the lived experiences and perceptions of both teachers and students regarding thermal discomfort in their school environments.

2.2 Locale of the Study

This study was conducted within the Cotabato Division of the Department of Education (DepEd), specifically situated in the SOCCSKSARGEN region (Region XII) of the Philippines. The primary geographical and administrative focus encompassed the network of public secondary educational institutions within the Municipality of Alamada. This specific locale was selected as it represents a diverse educational demographic, making it an ideal setting to evaluate the division-wide implementation and efficacy of thermal comfort strategies.**2.3 Respondents of the Study**
Material and methods, Material and methods, Material and methods, Material and methods, Material and methods, Material and methods, Material and methods, Material and methods, Material and methods, Material and methods.

2.4 Sample and Sampling Procedure

This study will employ a stratified random sampling technique to ensure a representative sample of teachers and students from the population within the Cotabato Division. This approach is essential for guaranteeing that findings on thermal comfort strategies are reflective of the diverse educational environment across different school levels and communities.
The sample size (n) for the study will be determined using Slovin's Formula, a widely accepted method for calculating a statistically representative sample from a large, finite population. To ensure that each subgroup is adequately represented, the population will be divided into relevant strata or subgroups. For this study, the primary strata will be based on the type of respondent (teachers and students) within the Cotabato Division. The total sample size (n) will then be distributed proportionally across these strata. This means that if a particular stratum constitutes 30% of the total population, it will also account for 30% of the final sample.
Once the number of respondents to be drawn from each stratum is determined, simple random sampling will be employed to select the individual participants. A list of all eligible teachers and students within each stratum will be compiled, and a random number generator will be used to select the required number of respondents. This final random selection process ensures that every member of the population has an equal and fair chance of being included in the study, thereby eliminating selection bias.

2.5 Research Instrument

The study will use a combination of quantitative and qualitative instruments to collect data.
Quantitative Instrument. A two-part survey questionnaire will serve as the primary tool for quantitative data collection. Part I (for teachers) will measure the implementation of thermal comfort strategies, with questions focused on flexible scheduling, classroom environment, and health monitoring. Part II (for students) will measure student well-being across the four factors: *physical, emotional, academic, and social well-being. The instrument's content and face validity will be established through expert review. Its reliability will be confirmed via a pilot test using a statistical measure such as Cronbach's Alpha. Qualitative Instrument. A semi-structured interview guide or FGD guide will be used to facilitate in-depth discussions with both teacher and student respondents. The open-ended questions will be designed to explore the "why" and "how" behind the survey results, and to elicit rich narratives about personal experiences and perceptions of thermal discomfort in the school setting.

2.6 Data Gathering Procedure

The researcher will first secure official approval from the Department of Education (DepEd) and the relevant school authorities to conduct the study. After obtaining informed consent from teachers and parents/legal guardians of students, and **assent** from minor students, the surveys will be distributed and collected from both groups. Following a preliminary analysis of the quantitative data, respondents for the qualitative phase will be selected via purposive sampling. Semi-structured interviews or FGDs will then be conducted in a private setting, audio-recorded with explicit consent, and transcribed verbatim. All collected data will be systematically organized, ensuring respondent anonymity and data confidentiality throughout the research process.

2.7 Data Analysis Techniques

A comprehensive, mixed-methods approach was implemented for the data analysis, integrating both statistical processing and deep thematic examination. Quantitative data processing and analysis were conducted using IBM SPSS Statistics. Descriptive statistics, including frequency counts, percentages, means, and standard deviations, were first computed to provide a detailed profile of the respondents and to detail both the extent to which thermal comfort strategies were implemented and the prevailing levels of student well-being.

Subsequently, inferential statistics were utilized to test the specific research objectives: Spearman's rank correlation coefficient (rho) was computed to rigorously examine the relationship between the teacher-reported thermal comfort strategies and student-reported well-being, evaluating the strength and direction of associations across different strategies and well-being dimensions, while acknowledging the potential non-normal distribution or ordinal nature of some data. Multiple linear regression analysis was also performed to determine which specific thermal comfort strategies significantly predicted overall student well-being and to quantify their relative influence, with standardized coefficients being utilized to compare predictor impact.

Transitioning to the qualitative phase, transcribed qualitative data, derived from Focus Group Discussions (FGDs) with teachers and students, were systematically analyzed using Thematic Analysis, which was meticulously executed according to the six recursive phases outlined by Braun and Clarke (2006): familiarization with the data through repeated reading, generation of initial codes, searching for potential themes, reviewing potential themes in relation to both coded extracts and the entire dataset, defining and naming themes, and finally, producing the comprehensive final report. This deep thematic analysis facilitated the derivation of rich descriptions of lived experiences, identification of specific challenges, and interpretation of deeper meanings, thereby providing crucial contextual depth and insight, which were subsequently utilized to explain, interpret, and triangulate the initial quantitative findings.

2.8 Ethical Considerations

Ethical standards were strictly followed throughout the entire duration of the study to protect the rights, dignity, and overall well-being of all participants, with specific attention directed toward the student respondents aged 15 to 18. In relation to this, clear and concise informed consent was obtained from all adult participants, including teachers and students who had already reached their 18th birthday. All participants were oriented about the purpose, procedures, duration, potential risks, and benefits of the study. They were explicitly informed that their participation was entirely optional and that they retained the right to refuse to answer any specific question or to withdraw from the investigation at any given moment, without any negative consequences or penalties. Strict protocols were implemented to guarantee the confidentiality and anonymity of all collected data; personal identifying information was removed from all transcripts, analyses, and finalized reports, with alphanumeric codes used to reference individual respondents.

Furthermore, due to the inclusion of students who had not yet attained the legal age of majority, a distinct and rigid dual-consent protocol was enforced to ensure their protection. For all 15 to 17-year-old students, formal written Informed Consent was obtained directly from their parents or legal guardians, granting permission for their child's participation in the study. Simultaneously, the minor was required to sign a tailored Student Assent Form (SAF). This form described the study, their role, and their rights in plain, appropriate language, ensuring they understood the nature of the research and voluntarily chose to participate, even if parental permission had been granted.

3. Results and Discussion

3.1 Flexible Learning and Scheduling

A detailed examination of the indicators reveals that the most widely adopted measure is the relaxation of uniform policies. Item 5, "The school allows students to wear light, breathable, and comfortable attire instead of their school uniform," obtained the highest weighted mean of 3.81 (High Extent). This finding suggests that school administrators prioritize immediate, low-barrier interventions that directly alleviate physical discomfort. The high implementation of this measure reflects a pragmatic approach to student well-being, acknowledging that rigid adherence to uniform codes becomes secondary to health safety during thermal discomfort events.

Furthermore, the schools demonstrate a strong capacity for instructional adaptation. Item 1, regarding the proactive shift to Alternative Delivery Modes (ADMs), secured the second-highest mean of 3.54 (High Extent), followed closely by Item 4, the presence of documented contingency plans for ADMs (3.45, High Extent). These results imply that the post-pandemic educational landscape has sufficiently equipped schools with the infrastructure and readiness to transition between face-to-face and remote learning modalities when environmental conditions necessitate it.

Conversely, indicators requiring structural changes to the school timetable or autonomous decision-making received comparatively lower ratings. Item 3, which refers to modifying class schedules to cooler parts of the day, resulted in a mean of 3.27, falling within the Moderate Extent range. Similarly, Item 2, regarding the school head's exercise of authority to suspend classes based on on-site conditions without formal declarations, garnered the lowest mean of 3.21 (Moderate Extent). This disparity underscores a critical gap in the mitigation framework: while schools are highly effective at implementing adaptive strategies, they are less agile in executing structural or decisive strategies. The moderate scores in these areas likely reflect bureaucratic constraints, the complexity of altering standardized logistical schedules, or a hesitation among school heads to act without explicit directives from higher offices or local government units.

Table 1. *Level of implementation of schools' thermal comfort strategies in terms of flexible learning and scheduling.*

Factors	Mean	Description
1. The school proactively shifts to Alternative Delivery Modes (ADMs) to avoid exposing students to peak heat hours.	3.54	High Extent
2. The school head exercises the authority to suspend face-to-face classes based on on-site heat conditions, even without a formal declaration.	3.21	Moderately Extent
3. The school modifies its daily class schedule to hold sessions during cooler parts of the day.	3.27	Moderate Extent
4. The school has a clear, documented contingency plan for implementing ADMs during heat-related class suspensions.	3.45	High Extent
5. The school allows students to wear light, breathable, and comfortable attire instead of their school uniform.	3.81	High Extent
Weighted Mean	**3.45**	**High Extent**

Legend:

Level	Range	Description
5	4.21 – 5.00	Very High Extent
4	3.41 – 4.20	High Extent
3	2.61 – 3.40	Moderate Extent
2	1.81 – 2.60	Low Extent
1	1.00 – 1.80	Very Low Extent

3.2 Classroom Environment and Infrastructure

Table 2 illustrates the level of implementation of thermal comfort strategies concerning classroom environment and infrastructure. The data reveals a Grand Mean of 3.35, which corresponds to a Moderate Extent. This lower composite score, compared to the previous domain on flexible learning, suggests that while schools are administratively adaptive, they face significant challenges in terms of physical facilities and structural resilience against heat.

Analyzing the specific indicators, the schools performed best in providing passive, outdoor cooling solutions. Item 4, "There are sufficient shaded areas on school grounds for student use during breaks," obtained the highest mean of 3.56 (High Extent). This indicates that school campuses generally possess adequate natural or constructed cover such as trees, covered courts, or gazebos which serves as the primary refuge for students during peak heat hours.

However, the effectiveness of the indoor classroom environment appears to be less consistent. Item 2, regarding classrooms designed to maximize natural ventilation and airflow, yielded a mean of 3.40, which sits at the upper limit of Moderate Extent. More critically, Item 3, concerning the provision and maintenance of required cooling devices as mandated by DepEd, resulted in a relatively lower mean of 3.23 . This finding highlights a resource gap: while school grounds are well-adapted, the classrooms themselves may struggle with airflow and lack sufficient mechanical cooling aids to counteract rising temperatures.

It is also worth noting the variance in the assessment of infrastructure resilience. While Item 5 suggests a high extent of improvement efforts (3.47), Item 1 reflects a much lower evaluation of infrastructure assessment (3.06). This discrepancy may imply that while some targeted improvements are visible, a comprehensive, proactive system for assessing overall heat resilience is not uniformly established.

In synthesis, the data paints a picture of schools that rely heavily on outdoor shaded areas to mitigate heat, while the indoor learning environments remain vulnerable due to insufficient ventilation design and a lack of adequate cooling appliances. This points to a need for capital outlay or "hard" infrastructure investments, which are often more difficult to implement than policy changes due to budgetary constraints.

Table 2. *Level of implementation of schools' thermal comfort strategies in terms of classroom environment and infrastructure.*

Factors	Mean	Description
1. The school's overall infrastructure is regularly assessed and improved to enhance its resilience to high temperatures.	3.06	Moderate Extent
2. Classrooms in the school are designed to maximize natural ventilation and airflow.	3.40	Moderate Extent
3. The school provides and maintains the required number of cooling devices (e.g., electric fans) in its classrooms as mandated by DepEd.	3.23	Moderate Extent
4. There are sufficient shaded areas on school grounds for student use during breaks.	3.56	High Extent
5. The school's overall infrastructure is regularly assessed and improved to enhance its resilience to high temperatures.	3.47	High Extent
Weighted Mean	**3.35**	**Moderate Extent**

Legend:

Level	Range	Description
5	4.21 – 5.00	Very High Extent
4	3.41 – 4.20	High Extent
3	2.61 – 3.40	Moderate Extent
2	1.81 – 2.60	Low Extent
1	1.00 – 1.80	Very Low Extent

3.3 Health and Safety Monitoring

Table 3 details the level of implementation of thermal comfort strategies concerning health and safety monitoring. The data indicates a Grand Mean of 3.48, interpreted as High Extent. This favorable composite score suggests that schools have successfully established protocols for information dissemination, hazard awareness, and communication regarding heat-related risks. The most effectively implemented measure in this domain is the conduct of educational interventions. Item 3, "The school conducts periodic drills or orientations for students and staff on what to do during thermal discomfort events," garnered the highest mean of 3.57 (High Extent). This suggests that schools have integrated heat safety into their standard Disaster Risk Reduction and Management (DRRM) activities, ensuring that the student body is cognitively prepared for extreme weather conditions.

Complementing this high level of awareness is the existence of feedback mechanisms. Item 4, regarding the establishment of a clear reporting system for students feeling unwell, obtained a mean of 3.53 (High Extent). Furthermore, the external communication loop is also functioning well, with Item 5 (communicating changes to parents/guardians) receiving a mean of 3.48 (High Extent). Collectively, these indicators point to a strong administrative framework where information flows effectively between the school, the students, and the community.

However, a critical gap emerges when examining the capacity for medical response. Item 2, "The school's clinic or designated health personnel are prepared to identify and respond to heat-related illnesses," received the lowest mean of 3.34, falling within the Moderate Extent range. This disparity reveals a significant contrast between prevention and intervention. While schools are highly proficient at educating students on what to do (drills) and monitoring the environment (Item 1, Mean 3.47), they appear less equipped to medically manage actual cases of heat exhaustion or heat stroke when they occur. This "Moderate" rating likely reflects a shortage of school nurses, insufficient medical supplies, or a lack of specialized training for personnel in handling thermal injuries compared to other common school accidents.

In summary, the schools exhibit a robust "soft" infrastructure for health safety characterized by strong vigilance, communication, and education but face limitations in the "hard" infrastructure of medical responsiveness and clinical preparedness.

Table 3. *Level of implementation of schools' thermal comfort strategies in terms of health and safety monitoring.*

Factors	Mean	Description
6. The school regularly monitors the local heat index and temperature levels to inform its decisions on class management.	3.47	High Extent
7. The school's clinic or designated health personnel are prepared to identify and respond to heat-related illnesses.	3.34	Moderate Extent
8. The school conducts periodic drills or orientations for students and staff on what to do during thermal discomfort events.	3.57	High Extent
9. The school has established a clear and accessible reporting system for students and staff to report feeling unwell due to heat.	3.53	High Extent
10. The school communicates changes in learning modalities and schedules to parents/guardians in a timely and effective manner.	3.48	High Extent
Weighted Mean	**3.48**	**High Extent**

Legend:

Level	Range	Description
5	4.21 – 5.00	Very High Extent
4	3.41 – 4.20	High Extent
3	2.61 – 3.40	Moderate Extent
2	1.81 – 2.60	Low Extent
1	1.00 – 1.80	Very Low Extent

Students' Well-Being During thermal discomforts

This section evaluates the status of students' well-being during periods of thermal discomfort. It assesses the impact of high temperatures across four distinct dimensions: physical, emotional and psychological, academic, and social well-being. The data reflects the students' self-reported experiences regarding discomfort, health symptoms, and functional impairment due to thermal stress.

3.4 Physical Well-being

Table 4 presents the assessment of students' physical well-being during thermal discomfort. The data yields a Grand Mean of 2.51, which falls within the range of Low Well-being. According to the legend, this interpretation suggests that students' physical well-being is poor, with negative symptoms or distress being experienced with considerable frequency.
Detailed analysis of the indicators reveals that the most prevalent issue is general physical discomfort. Item 1, "To what extent do you feel physically uncomfortable (e.g., sweating, feeling hot) in your classroom," obtained the highest mean of 2.89. While this score sits at the threshold of "Moderate" intensity, it stands out as the primary stressor, indicating that the immediate classroom environment is a consistent source of thermal discomfort for the learners.

The data further highlights that this discomfort translates into specific physiological symptoms. Items 2 and 3, regarding physical symptoms (headaches, dizziness) and dehydration, both resulted in a mean of 2.55 (Low Well-being). Similarly, Item 4, concerning lethargy or low energy, scored a mean of 2.54. These clustered scores suggest a systemic physical reaction to the heat: students are not just feeling hot; they are experiencing a cascade of physiological responses including dehydration and fatigue that compromise their physical state. Interestingly, despite the prevalence of symptoms, the utilization of medical services remains low. Item 5, "How often do you feel the need to go to the clinic or rest due to physical discomfort," received the lowest mean of 2.04.

This discrepancy between the higher reporting of symptoms (2.55) and the lower reporting of clinic visits (2.04) implies a normalization of heat stress. Students may be enduring headaches and lethargy in the classroom rather than seeking formal medical attention, possibly because they perceive these symptoms as unavoidable aspects of the school day or because the clinic capacity (as noted in previous findings) is viewed as limited. This "endurance" behavior is critical, as it suggests that the actual physical toll on students may be underreported if administration relies solely on clinic logs.

Table 4. *Level of students' well-being during thermal discomforts in terms of physical well-being.*

Factors	Mean	Description
1. To what extent do you feel physically uncomfortable (e.g.,	2.89	Moderate Extent

	sweating, feeling hot) in your classroom due to the heat?		
2.	To what extent have you experienced physical symptoms (e.g., headaches, dizziness, fatigue, or nausea) due to the heat at school?	2.55	Low Extent
3.	How often do you feel dehydrated during the school day, even after drinking water?	2.55	Low Extent
4.	To what extent does the heat make you feel lethargic or low on energy during classes?	2.54	Low Extent
5.	How often do you feel the need to go to the clinic or rest due to physical discomfort from the heat?	2.04	Low Extent
Weighted Mean		**2.51**	**Low Extent**

4. Conclusion & Recommendations

The research findings indicate that while schools have achieved a high extent of implementation in administrative domains such as flexible learning, scheduling, and health monitoring, the classroom environment and infrastructure are only moderately addressed. The most successfully operationalized measures include the relaxation of school uniform policies and the integration of heat safety into standard disaster risk reduction drills. However, a significant gap exists between these administrative adaptations and the physical resilience of school facilities, as indoor ventilation and the provision of cooling devices lag behind policy changes. The primary conclusion drawn from this study is that current mitigation strategies are essentially palliative and compliance-based rather than outcome-oriented. Passive cooling and administrative flexibility have reached their physiological limits, leaving students in a state of chronic thermal stress that impairs both their health and their learning. To bridge the implementation-impact gap, educational institutions must pivot from policy-heavy adjustments to "hard" infrastructure investments, particularly active cooling, to maintain the environmental conditions necessary for cognitive and social development.

Based on the numerical data and qualitative insights, the following actions are recommended: (1)The Department of Education should introduce a specific "Climate Adaptation Allowance" within the Maintenance and Other Operating Expenses (MOOE) to subsidize higher electricity costs and potable water infrastructure. (2) The Education Facilities Division must redesign multi-story buildings to address the "Vertical Heat Penalty," prioritizing high-performance roofing insulation and cross-ventilation over simple capacity expansion. (3) Schools should pivot toward active cooling (Air Conditioning), as quantitative data proves that current fan-based interventions have zero significant impact on physical comfort. (4). To combat "utility instability" and brownouts, schools should leverage partnerships to install solar-powered systems, ensuring cooling continuity during peak heat. (5) The WASH in Schools (WinS) program must be expanded to include "Thermal Comfort" and "Potable Water Access" as key performance indicators to reduce social anxiety and preserve student dignity.

Compliance with ethical standards

Ethical standards were strictly followed throughout the entire duration of the study to protect the rights, dignity, and overall well-being of all participants, with specific attention directed toward the student respondents aged 15 to 18. In relation to this, clear and concise informed consent was obtained from all adult participants, including teachers and students who had already reached their 18th birthday. All participants were oriented about the purpose, procedures, duration, potential risks, and benefits of the study. They were explicitly informed that their participation was entirely optional and that they retained the right to refuse to answer any specific question or to withdraw from the investigation at any given moment, without any negative consequences or penalties. Strict protocols were implemented to guarantee the confidentiality and anonymity of all collected data; personal identifying information was removed from all transcripts, analyses, and finalized reports, with alphanumeric codes used to reference individual respondents.

REFERENCES

Abueva, A. A. (2020). The impact of climate change on student well-being in the Philippines. Journal of Climate and Education, 8(2), 112–125.

Alcantara, J., & Castro, M. (2021). Psychological effects of heat stress on adolescent learners in urban Philippine schools. Philippine Journal of Educational Psychology, 15(3), 45–60.

Alcantara, M., Reyes, G., & Lim, J. (2023). Mitigating heat-related learning loss: An analysis of alternative delivery modes. Journal of Educational Policy and Practice, 10(1), 22–38.

Arcenas, P., & Santos, L. (2021). Physiological responses of students to classroom heat in a tropical climate. International Journal of School Health, 4(1), 5–18.

American Society of Heating, Refrigerating and Air-Conditioning Engineers. (2020). Standard 55: Thermal environmental conditions for human occupancy.

Baughman, A., & Sather, C. (2020). School nursing in a changing climate: Addressing heat-related illnesses. Journal of School Health, 90(4), 289–295.

Bautista, R. C. (2024). Public health perspectives on thermal comfort in schools: A case study of Metro Manila. Journal of Environmental Health, 20(4), 110–125.

Brown, A., & Patel, S. (2021). The effectiveness of educational interventions in promoting heat resiliency among pre-teens. Journal of Environmental Health, 83(4), 18–26.

Centers for Disease Control and Prevention. (2022). Guidance for schools on thermal discomfort.

Chan, T. T. (2021). Improving indoor air quality in tropical schools through natural ventilation. Building and Environment, 192, Article 107624.

Chang, L., & Wang, M. (2018). Engaging pre-teens in heat resiliency initiatives: A qualitative study. Children and Youth Services Review, 94, 32–41.

Chen, Y., Chen, J., Chen, Z., & Li, W. (2017). School-based heat resiliency measures: Impact on health outcomes of pre-teen students. International Journal of Environmental Research and Public Health, 14(4), Article 393.

Coehoorn, T., & Froom, J. (2020). Psychological stress and thermal comfort in educational settings. International Journal of Environmental Research and Public Health, 17(18), Article 6649.

Cohen, A. J., Ebi, K. L., Frumkin, H., & Bell, L. E. (2020). Climate change and mental health: Impacts, implications, and opportunities. Environmental Research Letters, 15(7), 1–9.

Cole, J. R. (2020). The efficacy of heat action plans in urban school districts. Journal of Urban Planning and Development, 146(2), Article 04020010.

Cortez, S. (2021). The effect of high temperature on student concentration and academic performance. Journal of Educational Research and Innovation, 8(3), 89–105.

De Guzman, D., & Abad, S. (2021). Classroom ventilation and student comfort: A case study of public elementary schools. Philippine Journal of Public Health, 18(2), 75–88.

De Leon, E. (2024). Fostering a sense of community in a heated environment:Challenges for school administrators. Journal of School Management, 9(2), 45–60.

Dela Cruz, R. (2022). The effect of classroom temperature on social interaction among elementary students. Journal of Social Science Research, 12(2), 55–70.

Dela Cruz, T., & Ramos, P. (2023). Cognitive strain and learning outcomes: The impact of heat stress on Filipino students. Asian Journal of Education, 21(1), 1–15.

Diaz, A., Soriano, L., & Lim, A. (2020). Temperature and student health: A longitudinal study on heat-related illnesses in schools. International Journal of Pediatrics, 14(4), 210–225.

Fajardo, S., Reyes, R., & Castro, L. (2024). The thermal environment and its effect on student academic achievement. Journal of School Climate, 19(2), 110–125.

Fikry, A. (2021). Equitable education during heat waves: A policy analysis of remote learning. International Journal of Educational Development, 80, Article 102315.

Gaoua, N., & Lee, J. (2021). The impact of high temperatures on cognitive performance and student engagement. Education and Urban Society, 53(7), 819–835.

Garcia, R. (2021). Mental health effects of heat exposure in school-aged children. Journal of Child Psychology and Psychiatry, 5(1), 1–15.

Garcia, R., Martinez, S., & Kim, L. (2018). Community engagement in heat resiliency measures for pre-teens. American Journal of Community Psychology, 61(1-2), 27–36.

Global Partnership for Education. (n.d.). Too hot to learn? The impact of climate change on education. https://www.globalpartnership.org/blog/too-hot-learn-impact- climate-change-education

Gomez, J., Ramirez, L., & Santos, P. (2019). Communication strategies for enhancing heat resiliency among pre-teens. Environmental Education Research, 25(7), 935–949.

Gonzalez, H., & Smith, J. (2018). The relationship between socioeconomic status and heat resiliency among pre-teens. Journal of Health Disparities Research and Practice, 11(1), 67–78.

Goodman, J., Goodman, M., & Smith, J. (2018). The effect of school-year temperatures on test scores. American Economic Journal: Applied Economics, 10(4), 1–32.

Gupta, P., & Rodriguez, J. (2019). Psychological effects of heatwaves on pre-teen mental health and well-being. Child Psychology & Psychiatry Review, 24(1), 23–31.

Hansen, A., Bi, P., Saniotis, A., & Nitschke, M. (2021). Thermal discomfort events and school closures in Australia: A public health perspective. Australian and New Zealand Journal of Public Health, 45(5), 452–458.

Harlan, S. L., & Ruddell, D. (2011). Climate change and health in urban areas: A review of the literature. Environmental Science & Policy, 14(6), 565–576.

Hengtgen, K. (2025). UndauntedK12 program director statement. In The Guardian news report.