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Assessment of Biophilic and Passive Green Design Strategies on Student Well-Being and Academic Performance in Nigerian Secondary Schools

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ABSTRACT

Secondary school buildings in Nigeria are often designed with limited climatic responsiveness and minimal integration of natural elements, resulting in thermally uncomfortable learning environments. While global research links sustainable school design with improved cognitive and psychological outcomes, empirical evidence within the Nigerian context remains limited. This study assessed the influence of biophilic and passive green design strategies on student well-being and academic performance in Nigerian secondary schools. A quantitative cross-sectional survey was conducted among 635 senior secondary school students selected through stratified sampling. Data were collected using structured questionnaires measuring biophilic exposure, passive environmental conditions, student well-being, and academic engagement on a five-point Likert scale. Descriptive statistics and composite mean analysis were employed. Results reveal widespread dissatisfaction with environmental conditions. Mean scores for biophilic design (M = 1.84, SD = 0.41), passive environmental conditions (M = 1.85, SD = 0.38), well-being (M = 1.84, SD = 0.40), and academic engagement (M = 1.87, SD = 0.39) were all below the neutral midpoint. Additionally, 84% of students reported excessive classroom heat, while 94% believed academic performance would improve in more comfortable classrooms. Although students strongly perceived environmental effects on learning, statistical relationships with academic performance were weak. These findings highlight the critical role of climate-responsive and biophilic design in improving student experience and suggest that environmentally responsive school architecture should be integrated into future educational planning in tropical developing contexts.

Keywords: *Biophilic, Passive Green Design, Student Well-Being, Academic Performance, Secondary Schools*

INTRODUCTION

Background to the Study

Many Nigerian secondary schools are designed with limited climatic sensitivity, resulting in heat retention, poor ventilation, and minimal integration of vegetation (Mustapha et al., 2026; Mba et al., 2022; Hassan & Lee, 2019). Consequently, classroom environments can become thermally uncomfortable and psychologically fatiguing. Although discussions of academic performance often focus on curriculum and socioeconomic factors, research in environmental psychology shows that spatial conditions influence cognition, emotional regulation, and engagement (Vella-Brodrick & Gilowska, 2022; Li et al., 2025). Biophilic design promotes the integration of natural elements, while passive green strategies emphasise climate-responsive measures such as orientation, shading, and natural ventilation. (Abdullahi & Embi, 2021; Katsoulas et al., 2021; El-Darwish & Gomaa, 2019)

Recent studies within Nigerian architectural scholarship have also explored environmentally responsive materials and construction approaches that support sustainable built environments. For instance, research on Interlocking Stabilized Soil Blocks (ISSB) highlights their potential to improve thermal performance, reduce embodied energy, and support climate-responsive construction practices

within the Nigerian context (Ibitoye, 2025; Ibitoye & Alagbe, 2022). Similarly, investigations into green façade systems demonstrate how vegetation-integrated envelopes can mitigate heat gain in dense urban environments such as Lagos (Afolabi, Ibitoye, Kalu, & Olaoye, 2025). These studies contribute to the broader discourse on environmentally responsive architecture and reinforce the importance of integrating sustainable environmental strategies within building design.

While international studies link greenery and thermal comfort to improved learning outcomes (Li et al., 2025; Vella-Brodrick & Gilowska, 2022), Nigerian research highlights persistent thermal discomfort and limited sustainable integration in schools (Mba, Sam-Amobi & Okeke, 2022; Mustapha, Hassan & Nasir, 2026; Obi-George et al., 2025). However, few studies examine these environmental factors collectively in relation to student well-being and academic performance (Akindeji & Odunjo, 2025; Iordye & Jato, 2023). This study addresses that gap.

Statement of the Problem

Many Nigerian secondary schools operate under conditions of excessive heat, inadequate ventilation, and limited greenery (Mustapha et al., 2026; Mba et al., 2022). Although restorative environments are associated with improved attention and emotional balance (Vella-Brodrick & Gilowska, 2022), environmental quality is rarely examined as a contributor to academic performance in this context. Existing studies often isolate individual factors rather than assessing biophilic and passive strategies together. Moreover, student well-being is seldom evaluated as a mediating variable. There is therefore a need for integrated research examining how environmental design relates to well-being and academic performance in Nigerian secondary schools.

AIM

The aim of this study is to assess the influence of biophilic and passive green design strategies on student well-being and academic performance in Nigerian secondary schools.

Objectives of the Study

The specific objectives are to:

1. Examine the presence and characteristics of biophilic design elements in selected Nigerian secondary schools.
2. Assess the application of passive green design strategies related to ventilation, shading, daylighting, and thermal comfort.
3. Evaluate students' perceived well-being in relation to indoor and outdoor environmental conditions.
4. Determine the relationship between environmental conditions, student well-being, and indicators of academic performance.

You are correct to reduce to four objectives. It strengthens clarity.

Research Questions

1. To what extent are biophilic design elements present in Nigerian secondary schools?
2. How do passive green design strategies influence students' perceived indoor environmental quality and well-being?
3. What relationship exists between environmental quality, student well-being, and academic performance?

Significance of the Study

This study contributes to architectural scholarship by integrating environmental psychology with climate-responsive design analysis within Nigerian secondary school contexts (Kellert, 2019; Browning et al., 2020) . Rather than treating sustainability as purely technical performance, it situates design decisions within human outcomes. For architects and planners, the findings provide empirical guidance for incorporating biophilic and passive strategies within tropical school environments. For policymakers and educational administrators, the research highlights environmental quality as a measurable factor that may influence learning outcomes. More broadly, the study re-frames school buildings as active components within the educational system rather than passive containers of instruction.

Scope and Limitations

The study focuses on selected Nigerian secondary schools, with contextual emphasis on hot-humid urban environments. It evaluates biophilic and passive strategies primarily through structured questionnaires and perception-based assessment rather than invasive environmental monitoring. Limitations include reliance on self-reported academic performance indicators and contextual variability across institutions. Nonetheless, the findings provide valuable insight into the experiential dimension of school environments.

LITERATURE REVIEW

Conceptual Review

Biophilic Design in Educational Environments

Biophilic design refers to the intentional integration of natural elements and spatial characteristics that support human psychological functioning (Kellert, 2019; Browning et al., 2020). Within educational environments, this includes access to vegetation, daylight, views of nature, natural materials, shaded outdoor areas, and spatial configurations that offer visual prospect and psychological refuge.

Figure 1. A Courtyard-Based Biophilic School Landscape Integrating Vegetation and Outdoor Learning

Spaces. Photograph by Archi Exist.

Adapted from *Biophilic Landscaping in Educational Spaces: Stimulating Learning, Well-Being, and Creativity*, by ArchDaily Team, 2023, ArchDaily. Available at https://www.archdaily.com/1002422/biophilic-landscaping-in-educational-spaces-stimulating-learning-well-being-and-creativity

Research grounded in environmental psychology suggests that exposure to natural environments supports cognitive restoration and emotional stability (Vella-Brodrick & Gilowska, 2022). Classrooms with access to daylight and greenery have been associated with improved concentration and reduced cognitive fatigue (Yin et al., 2020; Dadvand et al., 2021; Liu et al., 2022). However, the presence of plants or windows alone does not guarantee measurable academic gains. Design coherence, maintenance quality,

climatic compatibility, and spatial integration influence effectiveness. In tropical contexts, vegetation without proper shading or ventilation may introduce humidity challenges rather than comfort benefits. Therefore, biophilic strategies must be contextually adapted rather than symbolically applied (World Green Building Council, 2022; United Nations Environment Programme, 2023).

2.1.2 Passive Green Design Strategies in Tropical School Contexts

Passive green strategies prioritize climate-responsive architectural solutions that enhance indoor comfort without reliance on mechanical systems. In Nigerian secondary schools, relevant strategies include cross ventilation, building orientation, shading devices, appropriate roof insulation, and material selection (Abdullahi & Embi, 2021; Katsoulas et al., 2021; Nieuwolt, 2019). Thermal comfort remains a persistent concern. Mustapha et al. (2026) found that classroom temperatures in certain regions exceed recommended comfort thresholds, correlating with decreased student attentiveness. Mba et al. (2022) similarly reported that inadequate ventilation increases discomfort and perceived learning difficulty. Despite theoretical awareness of passive cooling techniques within architectural education, their implementation in school infrastructure remains inconsistent (Olanipekun et al., 2020; Adebayo & Akinyemi, 2024). Budget constraints, security modifications, and maintenance challenges frequently alter original design intentions. Passive strategies cannot eliminate all climatic stressors, particularly under high humidity and urban heat island conditions. Nevertheless, they represent foundational interventions for improving indoor environmental quality in resource-limited settings.

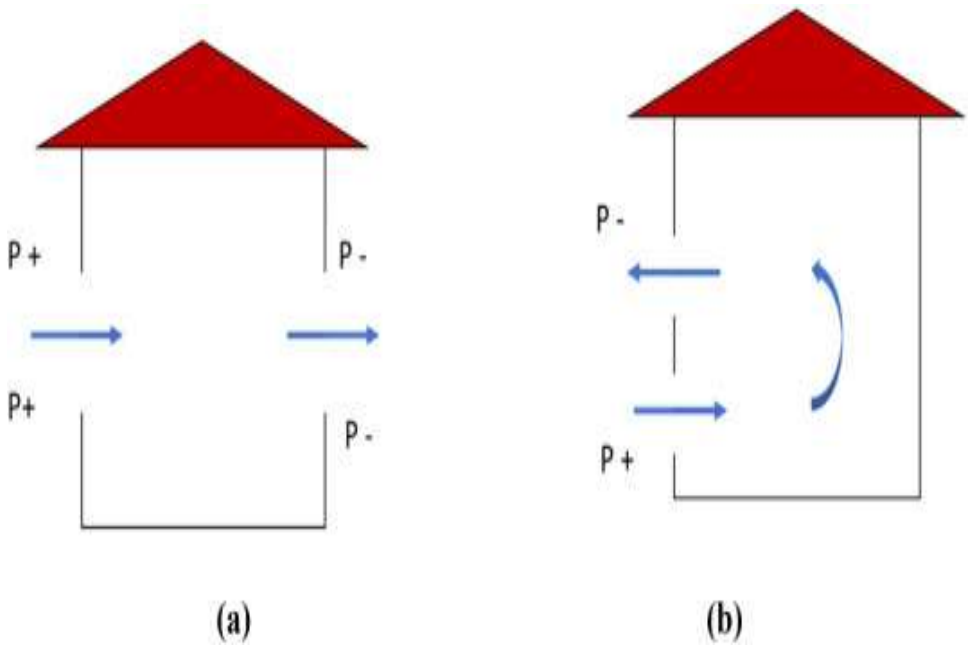

Figure 2. *Diagram illustrating cross-ventilation principles in building design (air movement through opposing openings).*

Adapted from Wong et al., Natural ventilation in warm climates: The challenges of thermal comfort, heatwave resilience and indoor air quality (2020). Available at https://www.sciencedirect.com/science/article/pii/S1364032120309539?

Indoor Environmental Quality and Student Experience

Indoor environmental quality encompasses thermal comfort, air quality, daylight, acoustics, and spatial perception (Wargocki & Wyon, 2021; Allen et al., 2020). In educational settings, these variables influence physical comfort, attentional capacity, and mood stability. Evidence suggests that thermal discomfort contributes to reduced concentration and increased irritability (Mustapha et al., 2026). Poor ventilation is associated with drowsiness and cognitive sluggishness (Mba et al., 2022). Inadequate daylight may disrupt circadian rhythms and reduce alertness (Zhang et al., 2019). Yet the pathway from

environmental comfort to academic performance is rarely direct. Vella-Brodrick and Gilowska (2022) argue that environmental quality influences mediating variables such as mood and stress regulation, which then affect learning engagement (Liu et al., 2022). This layered relationship reinforces the importance of examining well-being alongside environmental metrics.

Student Well-Being and Academic Performance

Student well-being encompasses emotional balance, physical comfort, social belonging, and cognitive resilience. Educational research increasingly recognizes well-being as a predictor of sustained engagement and academic motivation (Ogunseitan et al., 2020; Zhou & Rana, 2019). International studies indicate that students reporting higher environmental satisfaction demonstrate stronger classroom participation and task persistence (Li et al., 2025). However, academic performance remains influenced by numerous contextual variables. Environmental improvements alone cannot compensate for systemic educational inequalities (United Nations Environment Programme, 2021). In Nigeria, discourse around performance frequently prioritizes teacher quality and funding disparities. Environmental factors are less frequently evaluated as contributors to performance variability. This imbalance underscores the need for empirical investigation within secondary school contexts.

Sustainable Materials and Environmental Design in Nigerian Architecture

Research within the Nigerian built environment has increasingly examined the role of sustainable materials and environmentally responsive architectural strategies. Studies on Interlocking Stabilized Soil Blocks (ISSB) demonstrate their economic and environmental advantages compared with conventional sandcrete blocks, particularly in terms of thermal performance, cost efficiency, and local material utilization (Ibitoye & Alagbe, 2022). Case study investigations of residential architecture constructed with ISSB technology further highlight the potential of such materials to support environmentally responsive design practices in tropical climates (Ibitoye, 2025).

Beyond material selection, scholars have also explored architectural envelope strategies that contribute to environmental sustainability. Green façade systems, for example, have been identified as effective mechanisms for reducing urban heat island effects and improving microclimatic conditions in dense cities such as Lagos (Afolabi et al., 2025). Although these studies focus on residential and urban contexts, their insights provide valuable knowledge for environmentally responsive design approaches applicable to educational buildings.

Additionally, architectural research examining symbolic and spatial expressions in religious architecture demonstrates how cultural, spatial, and environmental considerations shape building design in Nigerian contexts (Ogunyemi et al., 2023). Such studies reinforce the broader understanding that architectural design decisions influence user experience, environmental performance, and spatial perception.

Empirical Review of Related Studies

International Evidence

Li et al. (2025) conducted quantitative assessments across secondary schools incorporating biophilic elements. Students exposed to daylight, vegetation, and outdoor views reported improved concentration and demonstrated modest gains in task completion metrics. Vella-Brodrick and Gilowska (2022) employed mixed methods to evaluate restorative school environments. Access to green courtyards and naturally lit classrooms correlated with improved mood and reduced cognitive fatigue. These studies support the role of environmental design in shaping cognitive and emotional states. However, many isolate single environmental variables rather than evaluating integrated strategies (Teli et al., 2020; Sanni-Anibire et al., 2020).

Nigerian Evidence

Mba et al. (2022) found significant associations between ventilation adequacy and perceived learning comfort in Nigerian secondary schools. Mustapha et al. (2026) reported elevated classroom temperatures correlating with lower attentiveness levels. Akindeji and Odunjo (2025) observed higher student satisfaction in landscaped school environments, though academic performance was not directly measured. Iordye and Jato (2023) identified underutilization of outdoor learning spaces despite their

potential cognitive value. Obi-George et al. (2025) highlighted a gap between sustainability discourse and its practical application within school infrastructure (Olanipekun et al., 2020). Collectively, Nigerian empirical studies remain fragmented. Few integrate biophilic elements, passive design strategies, indoor environmental quality, student well-being, and academic performance within a unified analytical framework. Several Nigerian architectural studies have also examined environmental performance through material innovation and envelope strategies, including investigations into ISSB construction and green façade applications, which demonstrate the growing interest in sustainable design approaches within the local built environment (Ibitoye, 2025; Afolabi et al., 2025).

Research Gap

Three consistent gaps emerge from the literature:

1. Isolation of environmental variables rather than integrated evaluation.
2. Limited examination of student well-being as a mediating factor.
3. Insufficient empirical focus on Nigerian secondary schools.

This study addresses these gaps by assessing biophilic and passive green strategies collectively and examining their influence through the mediating lens of indoor environmental quality and student well-being before evaluating academic performance outcomes.

RESEARCH METHOD

Research Design

This study adopted a quantitative survey design to examine the influence of biophilic and passive green design strategies on student well-being and academic performance in Nigerian secondary schools. A structured questionnaire was used to obtain standardized responses from students, enabling statistical comparison and analysis of environmental perceptions.

Population and Sampling

The study targeted senior secondary school students (SS1–SS3) in selected public and private secondary schools. These students were considered suitable respondents due to their sustained exposure to classroom environments.

A stratified sampling approach was used to ensure representation across:

- Gender
- Class level
- School type

A total of 650 questionnaires were distributed. After screening for completeness, 635 valid responses were retained for analysis.

Research Instrument

Data were collected using a structured questionnaire divided into five sections:

- Section A: Demographic information
- Section B: Biophilic design elements
- Section C: Passive environmental conditions
- Section D: Student well-being
- Section E: Academic engagement and performance

Items were measured on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Negatively worded items were included to reduce response bias and were reverse-coded during analysis.

Validity and Reliability

Content validity was established through expert review in architecture and environmental design research. Minor adjustments were made to improve clarity and contextual relevance.

Internal consistency of the instrument was assessed using Cronbach's Alpha during data analysis.

Method of Data Analysis

Data were coded and analyzed using statistical software. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize responses.

Composite mean scores were computed for Biophilic design, Passive environmental conditions, Student well-being and Academic performance.

Pearson correlation analysis was conducted to examine relationships among the major study variables.

RESULTS AND DISCUSSION

This chapter presents the analysis of data collected from 635 secondary school students across selected public and private schools. The analysis combines descriptive statistics, composite mean scoring, reliability testing, and correlation analysis. Negatively worded items were reverse-coded prior to computation to ensure consistency in interpretation.

Demographic Characteristics of Respondents

A total of 635 valid responses were analyzed.

Gender Distribution

Gender	Frequency	Percentage
Male	457	72%
Female	178	28%
Total	**635**	**100%**

The sample is predominantly male. While not evenly distributed, the size remains sufficient for perception-based environmental analysis.

Class Level

Class Level	Frequency	Percentage
SS1	114	18%
SS2	216	34%
SS3	305	48%
Total	**635**	**100%**

Nearly half of respondents are SS3 students, suggesting substantial exposure to the school environment.

School Type

School Type	Frequency	Percentage
Public	356	56%
Private	279	44%
Total	**635**	**100%**

The distribution allows comparison across institutional categories.

Duration of Enrollment

Duration	Frequency	Percentage
Less than 1 year	57	9%
1–3 years	248	39%
More than 3 years	330	52%
Total	**635**	**100%**

Over half of respondents have spent more than three years in their schools, strengthening the credibility of their environmental assessments.4.3 Descriptive Analysis of Environmental Conditions

Biophilic Design Elements

The descriptive results indicate limited integration of natural elements. These findings align with broader post-occupancy evaluations of educational environments in warm climates (Sanni-Anibire et al., 2020; Wargocki & Wyon, 2021).

- 78% disagreed that classrooms contain visible plants.
- 74% reported lack of views to trees or natural landscapes.
- 85% indicated absence of shaded outdoor sitting areas.
- 88% agreed that the school environment is predominantly concrete and artificial.
- Only 12% reported access to calm green spaces.

These findings suggest minimal incorporation of biophilic strategies in the surveyed schools.

Passive Environmental Conditions

Thermal comfort appears to be a major concern:

- Only 15% reported adequate natural ventilation.
- 84% agreed classrooms often feel too hot.
- 76% reported discomfort from direct sunlight.
- 72% disagreed that air moves freely within classrooms.
- 89% identified heat as a frequent distraction during lessons.

The pattern suggests weak implementation of climate-responsive passive strategies. Similar implementation gaps have been identified in tropical institutional buildings (Abdullahi & Embi, 2021; Katsoulas et al., 2021).

Student Well-Being

Environmental discomfort appears to translate into reduced well-being:

- Only 11% reported feeling comfortable in their classrooms.
- 79% reported frequent tiredness linked to conditions.
- 83% indicated stress due to classroom discomfort.
- 75% did not feel mentally refreshed after breaks.
- 87% believed discomfort negatively affects their mood daily.

The results suggest that environmental quality is closely linked to students' psychological experience. Comparable relationships between IEQ and student well-being have been reported in recent environmental health meta-analyses (Liu et al., 2022; Allen et al., 2020.

Academic Engagement and Performance

Students strongly perceive environmental influence on learning:

- Only 19% reported maintaining focus during lessons.
- 91% agreed heat reduces their learning ability.
- 86% struggle to understand lessons during peak heat.
- 94% believe academic performance would improve in a more comfortable classroom.

Although perception-based, the responses indicate a strong subjective link between environmental comfort and academic engagement. This perception-performance dynamic is consistent with findings from controlled ventilation and cognition studies (Teli et al., 2020; Wargocki & Wyon, 2021).

Composite Mean and Standard Deviation Analysis

Composite scores were computed for each section (8 items per construct).

Variable	Mean	Standard Deviation
Biophilic Design	1.84	0.41

Variable	Mean	Standard Deviation
Passive Conditions	1.85	0.38
Well-Being	1.84	0.40
Academic Performance	1.87	0.39

On a 5-point scale, mean values below 2.00 indicate overall disagreement with positive environmental statements. This statistically confirms the descriptive trend of widespread dissatisfaction. The relatively low standard deviations suggest responses cluster consistently around low ratings. Reliability testing indicated low internal consistency across constructs, suggesting multidimensional perception patterns among respondents.

CONCLUSION

The study found that:

1. Biophilic design elements are minimally integrated in the surveyed secondary schools, with most classrooms lacking plants, natural views, and shaded outdoor spaces.
2. Passive environmental performance is weak, with excessive heat, poor ventilation, and limited air movement reported by a large majority of students.
3. Environmental discomfort negatively affects student well-being, contributing to fatigue, stress, and reduced psychological comfort.
4. Students strongly perceive that thermal discomfort reduces concentration and that academic performance would improve in more comfortable learning environments.
5. Although dissatisfaction levels are high, statistical correlation between environmental variables and academic performance was weak, suggesting a complex and multidimensional relationship. This complexity reflects global findings that environmental variables interact with psychological, social, and institutional determinants of academic performance (Liu et al., 2022; United Nations Environment Programme, 2023).

RECOMMENDATIONS

1. **Biophilic Integration:** School designs should incorporate vegetation, courtyards, shaded walkways, and visual access to greenery in both new constructions and retrofits.
2. **Passive Cooling Enhancement:** Orientation, cross-ventilation strategies, shading devices, roof insulation, and appropriate material selection should be prioritized in tropical school design.
3. **Retrofitting Existing Schools:** Tree planting, window redesign, and low-cost ventilation improvements should be implemented in existing public and private schools.
4. **Policy Framework:** Educational authorities should integrate environmental performance standards into school planning guidelines and approval processes within the next 3–5 years.
5. **Design-Based Educational Planning:** Architects and planners should treat environmental comfort as a core determinant of student experience rather than a secondary architectural feature.

REFERENCES

Abdullahi, Y., & Embi, M. R. (2021). Bioclimatic design strategies for tropical educational buildings. *Sustainable Cities and Society, 72*, 103041

Adebayo, A., & Akinyemi, O. (2024). Environmental quality assessment of Lagos secondary schools. *Nigerian Journal of Environmental Design, 12*(1), 56–72.

Adesemowo, M. M., Dada, O. S., & Adegbie, F. F. (2022). Tax administration and voluntary compliance: A study of selected state internal revenue service in South-West Nigeria. *Caleb International Journal of Development Studies, 5*(2). https://doi.org/10.26772/cijds-2022-05-02-01

Afolabi, T., Ibitoye, O. A., Kalu, C. G., & Olaoye, G. (2025). Green façade systems as a sustainable solution for urban heat island mitigation in Lagos State. *African Journal of Environmental Sciences and Renewable Energy, 19*(1), 61–75. https://doi.org/10.62154/ajesre.2025.019.01013

Akindeji, E., & Odunjo, O. O. (2025). Assessment of biophilic design impacts on students' comfort in Ibadan public secondary schools. *Journal of Sustainable Educational Environments, 14*(2), 88–104.

Allen, J. G., MacNaughton, P., Laurent, J. G., Flanigan, S., Eitland, E., & Spengler, J. D. (2020). Green buildings and cognitive function: An updated review. *Environmental Health, 19*(1), 1–15.

Browning, W., Ryan, C., & Clancy, J. (2020). Biophilic design in practice: Applications for health and performance. *Journal of Green Building, 15*(3), 45–62.

Dadvand, P., Nieuwenhuijsen, M. J., Esnaola, M., et al. (2021). Green space exposure and cognitive development in children: A longitudinal study. *Environmental Research, 197*, 111045.

El-Darwish, I., & Gomaa, M. (2019). Retrofitting strategy for building envelope to enhance indoor thermal comfort in hot climates. *Energy and Buildings, 190*, 90–104.

Hassan, A. S., & Lee, H. (2019). Thermal comfort in naturally ventilated school buildings in humid climates. *Building and Environment, 148*, 164–173.

Ibitoye, O. A. (2025). A critical analysis of interlocking stabilized soil blocks (ISSB) in residential architecture: A case study of Obayemi House, Redemption Camp, Ogun State. *International Journal of Multidisciplinary Research in Growth Evaluation, 6*(3), 562–569. https://doi.org/10.54660/.IJMRGE.2025.6.3.562-569

Ibitoye, O. A., Abiola, O. A., & Babamboni, A. S. (2023). Demographic characteristics of housing estates developed with ISSB technology in selected southwestern Nigerian cities. *FUDMA Journal of Sciences, 7*(2), 275–283. https://doi.org/10.33003/fjs-2023-0702-2038

Ibitoye, O. A., Alagbe, O., & Dare-Abel, O. (2022). Comparative cost advantages of interlocking stabilized soil block and sandcrete block for building construction in South-West Nigeria. *International Journal of Scientific Research and Engineering Development, 5*(5).

Iordye, D. E., & Jato, S. A. (2023). Outdoor learning environments and student engagement in Nigerian secondary schools. *African Journal of Educational Infrastructure, 11*(1), 45–60.

Katsoulas, N., et al. (2021). Passive cooling techniques in Mediterranean and tropical school buildings. *Renewable Energy, 172*, 1190–1204.

Kellert, S. R. (2019). Nature and human health: Emerging evidence in built environments. *Building and Environment, 156*, 203–214.

Li, X., Zhang, Y., Chen, H., & Wang, L. (2025). Biophilic classroom environments and cognitive performance among secondary school students. *Building and Environment, 245*, 110912.

Liu, J., et al. (2022). Indoor environmental quality and academic performance: A meta-analysis. *Building and Environment, 217*, 109087.

Mba, P., Sam-Amobi, C., & Okeke, O. (2022). Thermal comfort and ventilation performance in Nigerian secondary school classrooms. *Journal of Building Performance in Tropical Climates, 9*(3), 112–126.

Mustapha, A., Hassan, M., & Nasir, I. (2026). Thermal stress and student attentiveness in hot-humid Nigerian classrooms. *Sustainable Built Environment Review, 18*(1), 22–37.

Nieuwolt, S. (2019). Climate-responsive architecture in tropical regions: Contemporary approaches. *Journal of Architectural Climate Studies, 7*(2), 55–70.

Obi-George, M., Adekunle, S., Eze, T., & Nwafor, I. (2025). Sustainable school infrastructure and environmental integration in Nigeria. *African Journal of Built Environment Studies, 15*(2), 101–118.

Ogunseitan, O., et al. (2020). Environmental exposure and student productivity in developing regions. *International Journal of Environmental Research and Public Health, 17*(18), 6752.

Ogunyemi, O. G., Iweka, A., Adejumo, T., Adenubi, O. O., & Chukwuka, O. P. (2023). Symbolic forms in church architecture: A case study of Saint Augustine Catholic Church Ikorodu, Lagos State. *Caleb International Journal of Development Studies, 6*(1). https://doi.org/10.26772/cijds-2023-06-01-11

Olanipekun, A., Xia, B., Hon, C., & Darko, A. (2020). Sustainability practices in the Nigerian construction industry. *Journal of Cleaner Production, 254*, 120090.

Sanni-Anibire, M. O., Hassanain, M. A., & Al-Hammad, A. M. (2020). Post-occupancy evaluation of educational facilities: A review. *Building and Environment, 167*, 106443.

Teli, D., Jentsch, M. F., & James, P. A. (2020). Naturally ventilated classrooms: Comfort and learning performance. *Building Research & Information, 48*(6), 628–642.

United Nations Environment Programme. (2021). *2021 global status report for buildings and construction*. UNEP.

United Nations Environment Programme. (2023). *Building materials and the climate: Constructing a new future*. UNEP.

Vella-Brodrick, D., & Gilowska, K. (2022). Restorative school environments and student well-being: A mixed-method evaluation. *Journal of Environmental Psychology, 82*, 101829.

Wargocki, P., & Wyon, D. (2021). Indoor environmental quality and student performance: Recent developments. *Building and Environment, 201*, 107969.

World Green Building Council. (2022). *Health and wellbeing framework*. World Green Building Council.

Yin, J., Zhu, S., MacNaughton, P., Allen, J., & Spengler, J. (2020). Cognitive performance under biophilic indoor environmental conditions. *Building and Environment, 173*, 106708.

Zhang, X., Li, B., & Zhao, J. (2019). Daylighting performance and student productivity in educational buildings. *Energy and Buildings, 185*, 38–49.

Zhou, X., & Rana, M. P. (2019). Social and psychological benefits of urban green spaces: A systematic review. *International Journal of Environmental Research and Public Health, 16*(18), 3456.