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RESEARCH ARTICLE

Environmental Pollution and Teaching-Learning Effectiveness in Nigerian Tertiary Institutions: Implications and Sustainable Management Strategies

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ABSTRACT

Environmental conditions are an important but often neglected determinant of teaching and learning in tertiary institutions. Nigerian campuses commonly experience noise from generators, traffic and social activities; emissions from fossil-fuel-powered electricity generation and vehicles; inadequate solid-waste collection; blocked drainage; and unsafe water supplies. This narrative review synthesizes evidence on how these exposures affect educational processes, health and institutional performance in Nigerian universities, polytechnics and colleges of education. The literature base was updated in July 2026 using peer-reviewed studies and reports from relevant national and international organisations. Evidence from Nigerian campuses shows that measured noise levels frequently exceed limits recommended for educational settings. Campus-based studies also document weaknesses in waste segregation and collection, microbial risks in stored water and localised exposure to generator-related pollutants. These hazards interfere with speech communication and concentration, contribute to respiratory and waterborne illness, disrupt sleep, increase psychological stress and absenteeism, reduce staff productivity and accelerate the deterioration of campus infrastructure. However, the Nigerian evidence remains dominated by cross-sectional, single-institution studies, and direct causal evidence linking measured pollution exposures with grade point average, attendance and staff performance is still limited. Sustainable improvement therefore requires institution-wide environmental governance rather than isolated sanitation exercises. Priority actions include functional environmental health and safety units, routine monitoring and public reporting, cleaner and more reliable energy, integrated waste management, water-safety planning, acoustic zoning, improved drainage and enforceable campus standards. A healthy campus should be treated as a core academic resource and a measurable component of institutional quality assurance.

Keywords: *Environmental Pollution; Noise; Air Quality; Solid Waste; Water Contamination*

1. INTRODUCTION

Tertiary institutions are central to national development because they produce advanced knowledge, professional skills, research and innovation. In the International Standard Classification of Education, tertiary education includes academic, vocational and professional programmes beyond secondary education, covering short-cycle tertiary, bachelor's, master's and doctoral levels (UNESCO Institute for Statistics, 2012). In Nigeria, universities, polytechnics, monotechnics and colleges of education are expected to advance teaching, research and community service while developing the skilled workforce required for social and economic progress (Federal Republic of Nigeria, 2013).

The effectiveness of these functions depends not only on curricula, lecturers and instructional facilities, but also on the physical conditions in which staff and students work. Teaching requires intelligible communication, sustained attention and opportunities for interaction. Learning requires concentration, memory, motivation, health and regular participation. These conditions are difficult to maintain in environments characterised by intrusive noise, polluted air, accumulated waste, offensive odours, unsafe water and recurrent flooding. Environmental quality should therefore be considered part of the educational infrastructure, rather than a separate housekeeping concern.

The issue is particularly important in Nigeria, where unreliable electricity supply encourages extensive generator use, rapid enrolment growth places pressure on existing facilities, and environmental services often fail to expand at the same pace as campus populations. Studies at the University of Ilorin and the University of Nigeria have documented excessive campus noise, while research at Nigerian universities has identified deficiencies in waste management and concerns about the microbiological and physicochemical quality of campus water supplies (Agaja & Akande, 2024; Bello et al., 2020; Egbenta et al., 2024; Ifegbesan et al., 2017; Ogeleka & Emegha, 2021; Ugwu et al., 2020). These studies provide direct evidence that environmental risks are present in tertiary institutions, although the strength of evidence varies by pollutant and outcome.

Previous discussions have often treated noise, air pollution, waste and water contamination as separate campus problems. Such separation can obscure their combined effects. Generator use, for example, can simultaneously produce noise, particulate matter and gaseous emissions. Poor waste disposal can block drainage, promote flooding, contaminate water and create breeding sites for disease vectors. Illness, disturbed sleep and psychological discomfort can then affect attendance, concentration and productivity. An integrated review is therefore necessary to explain the pathways through which environmental pollution influences teaching-learning effectiveness and to identify management strategies that are realistic for Nigerian tertiary institutions.

This article reviews four major categories of campus pollution: noise pollution, air pollution, poor solid-waste management and water contamination. It has three objectives: to synthesise evidence on their sources and educational implications; to assess the quality and limitations of the available evidence, particularly from Nigeria; and to propose sustainable institutional responses that can be incorporated into campus planning and quality assurance.

2. LITERATURE REVIEW

Teaching-learning effectiveness

Teaching-learning effectiveness refers to the extent to which instructional activities enable students to achieve intended knowledge, skills and professional competencies. It is reflected in clear communication, student engagement, concentration, attendance, successful assessment, timely course completion and effective academic support. Constructive alignment

between learning outcomes, teaching activities and assessment is important, but alignment cannot operate optimally when the learning environment repeatedly disrupts communication or compromises health (Biggs & Tang, 2011).

Environmental exposure pathways

Environmental pollution affects educational performance through several connected pathways. The first is direct interference: noise masks speech, interrupts thought and makes discussion difficult. The second is a health pathway: polluted air and water can cause or aggravate respiratory, gastrointestinal and other illnesses. The third is a neurobehavioural pathway involving annoyance, stress, sleep disruption, fatigue and reduced attention. The fourth is an attendance and productivity pathway, because illness and discomfort increase absence and reduce the quality and duration of work. The fifth is an institutional pathway through which flooding, corrosion, damaged equipment and poor campus appearance increase maintenance costs and weaken confidence in the institution.

Major forms and sources of pollution on campuses

Noise pollution is unwanted or harmful sound that interferes with normal activity. On Nigerian campuses, common sources include diesel and petrol generators, road traffic, construction, commercial activities, public-address systems, religious gatherings, election campaigns, entertainment events and high-density hostel activities. World Health Organization guidance has long indicated that classroom background noise should be kept low, with approximately 35 dB(A) commonly cited as a suitable upper level for effective teaching and learning (World Health Organization, 1999). Nigerian noise regulations also provide a legal basis for controlling excessive sound and protecting psychological well-being (National Environmental Standards and Regulations Enforcement Agency [NESREA], 2009a).

Air pollution is the presence of particulate matter, gases, and other contaminants at concentrations capable of harming health or comfort. Campus sources include generator exhaust, vehicle emissions, open burning of waste, dust from unpaved roads and construction, laboratory activities, and nearby industrial or commercial operations. The World Health Organization estimates that the combined effects of ambient and household air pollution are associated with about 6.7 million premature deaths annually, with much of the burden occurring in low- and middle-income countries (World Health Organization, 2024). Although this global figure is not specific to universities, it shows why persistent campus exposure should not be treated as trivial.

Poor solid-waste management includes inadequate storage, irregular collection, indiscriminate dumping, open burning, weak segregation and unsafe disposal of general, laboratory and health-care waste. These practices create odour, litter and visual degradation, attract vectors, generate smoke and contribute to blocked drainage. Water contamination may arise from poorly protected boreholes, leaking sewage systems, dirty storage tanks, inadequate treatment, surface runoff and cross-contamination during distribution. Microbiologically contaminated water can transmit diarrhoea, cholera, dysentery, typhoid and other infections; globally, unsafe drinking water is estimated to cause approximately 505,000 diarrhoeal deaths each year (World Health Organization, 2023).

3. MATERIALS AND METHODS

Review design and search approach

A narrative review design was used to integrate evidence from environmental health, higher education and campus-management literature. This design was appropriate because the available studies differ substantially in exposure measurement, institutional setting, population and educational outcomes. The literature search was updated in July 2026.

Searches covered Google Scholar, Scopus, Web of Science, ScienceDirect and JSTOR, with supplementary searches of institutional repositories and the websites of WHO, UNEP, UNESCO and Nigerian regulatory agencies.

Search terms were used singly and in combination, including environmental pollution, campus pollution, noise pollution, air quality, generator emissions, solid waste, waste management, drinking-water quality, sanitation, teaching effectiveness, learning, academic performance, absenteeism, staff productivity, university, polytechnic, college of education and Nigeria. Reference lists of relevant studies were also checked to identify additional sources.

Eligibility and evidence appraisal

Priority was given to peer-reviewed empirical studies conducted in Nigerian tertiary institutions. Studies from other educational settings and countries were included when they provided stronger evidence on mechanisms or outcomes that had not been adequately studied in Nigeria. Authoritative reports and regulations were included to establish health guidance and management standards. Sources were excluded when they were unrelated to educational environments, lacked sufficient methodological information, or addressed non-environmental issues such as substance use without a direct connection to the review question.

Evidence was organised by pollutant and by outcome pathway. Greater weight was given to studies with objective environmental measurements, clear sampling procedures, identifiable study settings and peer-reviewed publication. Findings based mainly on perceptions were retained when they offered useful information about campus experience, but they were not treated as equivalent to measured exposure or causal evidence. Because of heterogeneity and the small number of comparable Nigerian studies, no meta-analysis was attempted.

4. RESULTS AND DISCUSSION

The reviewed evidence shows that pollution is present on Nigerian campuses and can plausibly affect teaching and learning. However, the evidence base is uneven. Noise has the clearest direct connection to classroom communication and concentration. Waste and water studies demonstrate environmental and health risks, but most do not measure academic outcomes. Air-pollution evidence from Nigerian campuses is emerging, while the strongest evidence linking air quality to cognitive performance and absence currently comes from studies outside Nigeria. Table 1 summarises representative Nigerian studies and clarifies what each study directly established.

Table 1. Representative evidence from Nigerian tertiary institutions

Study and setting	Design/exposure	Main finding	What the evidence supports
Agaja and Akande (2024), University of Ilorin	Noise measurements and survey of 396 students	Noise levels ranged from 77.4 to 95.1 dB. Students reported interference with concentration, comprehension, and academic activities.	Direct evidence of excessive noise and perceived educational effects; cross-sectional design limits causal inference.
Egbenta et al. (2024), University of Nigeria, Enugu Campus	Noise measurements at 14 campus points across different periods	Overall equivalent noise level was 70.94 dBA, above the level considered suitable for an educational environment.	Objective evidence of campus noise exposure; academic performance was not directly measured.
Ugwu et al. (2020), University of Nigeria, Nsukka	Quantification and characterisation of campus solid waste	The study demonstrated the need for integrated collection, segregation, recovery and disposal practices.	Direct evidence of waste-generation and management challenges; educational outcomes were not assessed.
Ifegbesan et al. (2017), Nigerian university	Questionnaire, focus groups and observation involving 840 students	Waste-management practices and student satisfaction were inadequate, despite generally favourable attitudes toward improvement.	Evidence of behavioural and institutional gaps that justify campus sustainability education.

Bello et al. (2020), four Nigerian universities	Microbial analysis of water from 44 storage tanks	The study identified microbial-quality concerns and emphasised treatment, tank hygiene and routine monitoring.	Direct evidence of potential exposure to unsafe utility water; illness and attendance were not measured.
Ogeleka and Emegha (2021), FUPRE	Physicochemical and microbiological assessment of untreated campus water	Some parameters did not conform to drinking-water requirements; treatment before consumption was recommended.	Direct evidence that untreated campus water may pose health risks.
Ogunkeyede et al. (2025), FUPRE generator facility	On-site monitoring of gases, particulate matter and local environmental conditions	Several pollutant levels were higher near the generator facility than at the control location.	Evidence of localised generator-related exposure; the study did not assess teaching or student outcomes.

Noise pollution and disruption of teaching

Noise is the pollutant most immediately experienced during instruction because it interferes with the spoken message before it reaches the learner. Lecturers may have to repeat explanations or raise their voices, while students may miss words, disengage from discussion or expend additional effort to understand speech. These effects are especially important in large lecture theatres, buildings with poor acoustics and practical classes that require detailed verbal instructions.

Two Nigerian studies provide direct evidence of excessive noise in tertiary institutions. At the University of Ilorin, Agaja and Akande (2024) measured levels of 77.4–95.1 dB across campus locations and surveyed 396 students. The dominant sources included social and political activities, generators and vehicles, and respondents associated noise with difficulty concentrating and understanding lectures. At the University of Nigeria, Enugu Campus, Egbenta et al. (2024) recorded an overall equivalent level of 70.94 dBA, with higher levels during the afternoon. Both studies indicate that educational spaces may be exposed to sound far above the low-background conditions required for effective communication.

Noise also operates beyond the classroom. Hostel exposure can disturb sleep, and chronic annoyance may increase irritability, headache and fatigue. The broader literature associates environmental noise with sleep disturbance, stress and cognitive effects, although evidence from low- and middle-income countries remains less extensive than evidence from high-income settings (Babisch et al., 2020; World Health Organization, 2018). The educational implication is cumulative: a student who sleeps poorly, struggles to hear lectures and cannot find a quiet place to study faces multiple barriers to learning even when teaching quality is otherwise high.

Air pollution, health and cognitive performance

Air pollution on campuses is closely linked to energy and transport. Generators are often positioned near offices, hostels, laboratories or lecture buildings because of space and distribution constraints. Their exhaust can contain particulate matter, carbon monoxide, nitrogen oxides, volatile organic compounds and other products of incomplete combustion. A recent study at a generator facility at the Federal University of Petroleum Resources documented higher levels of several pollutants near the generator location than at a control point, demonstrating the possibility of localised exposure within an academic environment (Ogunkeyede et al., 2025). Open waste burning and traffic further add to the burden.

The most immediate educational consequence of polluted air is illness. Respiratory symptoms, asthma exacerbation, headache, and fatigue can reduce attendance and participation. Evidence from China found that air pollution increased student illness and school absence, illustrating a pathway that is likely relevant to other settings with substantial exposure (Chen et al., 2018). Air quality may also affect performance during cognitively demanding tasks. Using data from Brazilian university entrance examinations, Carneiro et al. (2021) found that higher pollution on examination days reduced test scores.

A recent scoping review of systematic reviews likewise concluded that urban environmental exposures, including air pollution and traffic noise, have adverse implications for health and learning performance (Roche et al., 2024).

These international findings should be applied cautiously to Nigerian tertiary institutions because exposure patterns, building design, and student characteristics differ. Nevertheless, they strengthen the biological and educational plausibility of the Nigerian campus concern. The major research gap is the absence of multicampus studies that combine measured PM2.5, PM10, carbon monoxide or nitrogen dioxide with attendance records, symptom data and objective academic outcomes.

Poor waste management, sanitation and campus functioning

Solid waste affects teaching and learning through odour, smoke, visual degradation, vectors and drainage obstruction. Waste accumulated near hostels or classrooms creates an unpleasant environment and may discourage prolonged use of learning spaces. Open burning converts a waste-management problem into an air-pollution problem. Waste deposited in drains reduces hydraulic capacity and increases the risk of flooding, which can damage roads, laboratories, libraries, electrical systems and teaching equipment.

Empirical studies show that Nigerian campuses generate substantial and diverse waste streams but often lack integrated systems. Ugwu et al. (2020) quantified and characterised waste at the University of Nigeria, Nsukka and recommended coordinated segregation, recovery and treatment. Ifegbesan et al. (2017), using questionnaires, focus groups and observation, found that students were not highly satisfied with existing waste practices, although many expressed positive attitudes toward improved management. Together, these studies show that technical infrastructure and campus behaviour must be addressed simultaneously.

The educational effect of waste is often indirect but still important. Vector-borne and gastrointestinal illnesses can increase absenteeism, while offensive odours and visible dumping can reduce comfort and institutional pride. Poorly managed campuses may also weaken the credibility of environmental education when institutional practice contradicts classroom teaching. Compliance with Nigeria's sanitation and waste regulations should therefore be incorporated into university governance, procurement and contractor supervision rather than treated as an occasional cleaning campaign (NESREA, 2009b).

Water contamination, morbidity and academic continuity

Reliable access to safe water is necessary for drinking, food preparation, laboratory work, sanitation and personal hygiene. Where supply is intermittent, institutions may rely on boreholes and storage tanks that are vulnerable to contamination. The risk increases when tanks are poorly cleaned, sewage systems leak, or wastewater and stormwater are inadequately separated. Bello et al. (2020) analysed water from 44 storage tanks across four Nigerian universities and reported microbiological concerns that required improved treatment and storage hygiene. At the Federal University of Petroleum Resources, Ogeleka and Emegha (2021) found that some untreated water parameters did not meet drinking-water requirements and advised treatment before consumption. These studies directly support the conclusion that campus water-safety systems cannot rely on source appearance or assumed borehole purity.

Waterborne illness can interrupt lectures, practical work, examinations and administrative duties. Even when outbreaks do not lead to formal closure, repeated cases of diarrhoea, typhoid-like illness or gastroenteritis can cause missed classes and additional household expenditure. The correct institutional response is preventive: water-safety planning, scheduled tank cleaning, source protection, treatment, residual-disinfectant monitoring and documented microbiological testing.

Cross-cutting effects on students, staff and institutions

The combined evidence indicates six major consequences for tertiary education. First, pollution reduces the immediate quality of instruction through noise, odour and discomfort. Second, it contributes to morbidity and absence, limiting exposure to lectures, laboratories and assessment. Third, stress, annoyance and disturbed sleep can weaken concentration and motivation. Fourth, academic and non-academic staff may experience fatigue, illness and reduced productivity, leading to delayed teaching, supervision and administrative services. Fifth, flooding, corrosion and contamination increase maintenance costs and shorten the useful life of infrastructure. Sixth, a degraded campus environment can affect institutional reputation, student experience and the ability to attract partnerships.

These pathways are mutually reinforcing. A student may be exposed to generator noise during a lecture, exhaust near a hostel, unsafe water and flooding caused by blocked drains. Treating each incident separately can therefore miss the cumulative burden. Environmental management should be organised around campus systems, population exposure and educational continuity.

Sustainable Management Strategies

Effective management requires clear responsibility, measurable standards and sustained financing. The following priorities move beyond general recommendations by linking actions to implementation indicators.

Table 2. Priority management actions and indicators

Priority area	Core action	Lead responsibility	Suggested indicator
Environmental governance	Establish a functional Environmental Health and Safety Unit with authority to inspect, document risks and coordinate corrective action.	Vice-Chancellor/Rector/Provost; Works; Health Services	Approved policy; annual audit; percentage of corrective actions closed on schedule.
Noise control	Map noisy locations, enforce quiet zones, relocate or enclose generators, schedule construction and regulate amplified events.	Works; Security; Student Affairs; Physical Planning	Proportion of teaching spaces meeting applicable daytime limits; number of noise complaints resolved.
Clean energy and air quality	Expand solar and other cleaner energy systems; prohibit open burning; maintain generators and restrict idling near occupied buildings.	Works; Procurement; Sustainability Office	Generator operating hours; PM2.5/CO measurements at high-risk sites; share of electricity from cleaner sources.
Integrated waste management	Provide labelled bins, source segregation, reliable collection, recycling partnerships and controlled handling of laboratory and health-care waste.	Works; Environmental Unit; Contractors	Collection compliance; segregation rate; proportion of waste recovered; absence of open dumps and burning.
Water safety and sanitation	Adopt a water-safety plan, test sources and storage tanks, maintain treatment, repair leaks and improve toilets and drainage.	Works; Health Services; Laboratories	Microbiological compliance; tank-cleaning records; water-supply reliability; sanitation-facility functionality.
Campus planning and resilience	Protect drainage, separate academic spaces from high-emission activities, increase vegetation and design buildings for ventilation and acoustic performance.	Physical Planning; Works; Governing Council	Drainage functionality; flood incidents; green-space coverage; compliance in new building approvals.
Education and participation	Integrate environmental responsibility into orientation and General Studies; support	Academic Affairs; Student Affairs; Unions	Participation rates; reduction in littering and complaints; number of student-led projects.

	student-led monitoring and reporting.		
Financing and disclosure	Create a ring-fenced maintenance budget and publish annual environmental-performance results.	Bursary; Governing Council; Internal Audit	Budget execution; public environmental report; cost savings from energy and waste interventions.

Limitations and Research Priorities

This review has several limitations. A narrative review is more vulnerable to selection bias than a systematic review, and the heterogeneity of the literature prevented quantitative synthesis. Many Nigerian studies are cross-sectional, limited to one institution, and based partly on self-reported perceptions. Waste and water studies often measure environmental conditions without linking them to attendance or academic records. Direct evidence on air pollution and educational performance in Nigerian tertiary institutions is particularly limited. These weaknesses mean that the review supports a strong case for preventive management, but it cannot estimate a single causal effect of campus pollution on academic performance.

Future research should use multicampus and longitudinal designs. Environmental measurements should be linked, with appropriate ethical and privacy safeguards, to objective outcomes such as class attendance, clinic visits, examination performance, staff absence and maintenance expenditure. Personal or time-weighted exposure monitoring would improve accuracy. Intervention studies should test whether generator relocation, acoustic treatment, water-safety plans, improved waste collection or solar-energy adoption produce measurable educational and health benefits. Cost-benefit analyses are also needed to demonstrate how environmental investments can reduce recurrent expenditure and protect learning time.

5. CONCLUSION

This study assessed AI awareness, usage patterns, and institutional readiness in three selected universities in South-East Nigeria. The findings conclude that awareness of AI is relatively high among architecture students and academic staff, and there is strong recognition of AI's relevance to the future of architectural education. However, actual usage of AI tools remains low, with nearly half of respondents reporting no use at all. Institutional readiness, including digital infrastructure, staff training, and curriculum flexibility, is consistently rated as inadequate. PCA revealed that institutional capacity, positive attitudes, and ethical concerns are distinct dimensions, meaning that improving one does not automatically improve the others. The major barriers to integration are curriculum rigidity and lack of trained staff, followed by funding constraints and ethical concerns. The study concludes that AI integration in architectural education in South-East Nigeria is presently constrained not by ignorance or resistance alone, but primarily by systemic and institutional weaknesses. Without deliberate investment in infrastructure, faculty development, and curriculum reform, high awareness will not translate into effective adoption.

Based on the findings and discussion, the following recommendations are made:

Curriculum Reform – Architecture programs should revise their curricula to explicitly include AI literacy, generative design tools, and digital workflows. This should be done at both undergraduate and postgraduate levels, with clear learning outcomes.

Staff Capacity Development – Universities should organise regular workshops, short courses, and certification programs to train academic staff in AI applications relevant to architecture. Partnerships with AI-driven design firms and online learning platforms (e.g., Coursera, edX) can supplement internal efforts.

Infrastructure Investment – Institutions should establish digital laboratories, AI-enabled design studios, and reliable high-speed internet access. Government and private sector partnerships could provide funding and hardware donations.

Ethical Framework Development – Each architecture school, in collaboration with professional bodies (e.g., NIA, ARCON), should develop clear guidelines on academic integrity, authorship, responsible AI use, and data privacy. These guidelines should be integrated into student handbooks and course syllabi.

Industry–Academia Collaboration – Schools of architecture should create internship and project collaborations with AI-driven architectural firms to provide students with practical exposure and real-world contexts for AI use.

6. COMPETING INTEREST

None to declare

REFERENCES

Agaja, T. M., & Akande, G. P. (2024). Impact of noise pollution on the academic performance of students in the University of Ilorin's learning environment, Nigeria. *FUDMA Journal of Earth and Environmental Sciences,* 1(2), 42–57. https://doi.org/10.33003/jees.2024.0102/05

Babisch, W., van Kamp, I., Pershagen, G., Dzhambov, A. M., Peden, M., Niemann, H., Clark, C., & Swart, W. (2020). Environmental noise and health in low- and middle-income countries: Gaps and challenges. *Environmental Research*, 184, 109224. https://doi.org/10.1016/j.envres.2020.109224

Bello, O. O., Oni, M. O., Bello, T. K., Fashola, M. O., & Oluwafemi, Y. D. (2020). Microbial quality of utility water at universities in Nigeria. *Malaysian Journal of Microbiology*, 16(5), 353–363. https://doi.org/10.21161/mjm.190534

Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university* (4th ed.). Open University Press.

Carneiro, J., Cole, M. A., & Strobl, E. (2021). The effects of air pollution on students' cognitive performance: Evidence from Brazilian university entrance tests. *Journal of the Association of Environmental and Resource Economists,* 8(6), 1051–1077. https://doi.org/10.1086/714671

Chen, S., Guo, C., & Huang, X. (2018). Air pollution, student health, and school absences: Evidence from China. *Journal of Environmental Economics and Management*, 92, 465–497. https://doi.org/10.1016/j.jeem.2018.10.002

Egbenta, I. R., Elugwaraonu, N. F., Ndukwu, R. I., & Okosun, A. E. (2024). Analysis of noise pollution level in Enugu Campus of the University of Nigeria. *SAGE Open*, 14(2), 1–15. https://doi.org/10.1177/21582440241254910

Federal Republic of Nigeria. (2013). *National policy on education* (6th ed.). Nigerian Educational Research and Development Council.

Ifegbesan, A. P., Ogunyemi, B., & Rampedi, I. T. (2017). Students' attitudes to solid waste management in a Nigerian university: Implications for campus-based sustainability education. *International Journal of Sustainability in Higher Education*, 18(7), 1244–1262. https://doi.org/10.1108/IJSHE-03-2016-0057

National Environmental Standards and Regulations Enforcement Agency. (2009a*). National Environmental (Noise Standards and Control) Regulations, 2009*. Federal Government Printer.

National Environmental Standards and Regulations Enforcement Agency. (2009b). *National Environmental (Sanitation and Wastes Control) Regulations*, 2009. Federal Government Printer.

Ogeleka, D. F., & Emegha, M. C. (2021). Characterization of water quality on university campus. *Chemical Science International Journal*, 30(4), 20–28. https://doi.org/10.9734/CSJI/2021/v30i430226

Ogunkeyede, A. O., Bankole, A. O., Bosah, A. E., Kikanme, K. N., & Isukuru, E. J. (2025). Preliminary assessment of atmospheric pollutant bioaccumulation in mushrooms exposed to generator emissions. *Studies in Fungi*, 10, e016. https://doi.org/10.48130/sif-0025-0017

Roche, I. V., Ubalde-López, M., Daher, C., Nieuwenhuijsen, M., & Gascon, M. (2024). The health-related and learning performance effects of air pollution and other urban-related environmental factors on school-age children and adolescents: A scoping review of systematic reviews. *Current Environmental Health Reports,* 11, 300–316. https://doi.org/10.1007/s40572-024-00431-0

Ugwu, C. O., Ozoegwu, C. G., & Ozor, P. A. (2020). Solid waste quantification and characterization in University of Nigeria, Nsukka campus, and recommendations for sustainable management. *Heliyon,* 6(6), e04255. https://doi.org/10.1016/j.heliyon.2020.e04255

United Nations Environment Programme, & International Solid Waste Association. (2024). *Global waste management outlook 2024: Beyond an age of waste—Turning rubbish into a resource*. United Nations Environment Programme.

UNESCO Institute for Statistics. (2012). *International standard classification of education*: ISCED 2011. UNESCO Institute for Statistics.

World Health Organization. (1999). *Guidelines for community noise*. World Health Organization.

World Health Organization. (2018). *Environmental noise guidelines for the European Region*. WHO Regional Office for Europe.

World Health Organization. (2023). *Drinking-water*. World Health Organization.

World Health Organization. (2024). *Ambient (outdoor) air pollution*. World Health Organization