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Research Article

Comprehensive Review of Noise Pollution Sources, Health Impacts, and Acoustic Environments Affecting College and University Students

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ABSTRACT

The present paper provides a comprehensive literature review of the effects of noise pollution on college and university students through evaluating research articles, surveys, and questionnaires on this imperative problem. Interference such as noise pollution in learning institutions has now acted as a major menace owing to the resultant health complications, learning handicaps and general well-being of students. The study provides an understanding of the major sources of noise on campuses; outdoor noise, which may feature traffic noise, construction noise, and industrial noise within the vicinity as well as indoor noise inclusive of electrical generator noise, laboratory equipment and students accompanying noise amongst others. These noise sources add extra noise to the background noise levels in classrooms, lecture halls, and educational labs. The paper also discusses the effects of noise on the health of students generally and particularly on the cerebral and sensory skills including concentration, learning, memory and speaking and hearing. Also, it overviews the impact of noisy environments on the human ear and health, such as stress, changes in sleep patterns, and cardiovascular disease. Classrooms and laboratory acoustic environments are also discussed, and how factors such as reverberation time, sound insulation, and background noise affect the quality of learning spaces are considered. The review focuses on noise control in the learning environment and recommends that noise should be controlled through effective noise control acoustic design, noise control through zoning and controlling noise through technology for the benefit of effective learning and student health. Presenting examples from various universities, this paper therefore encourages the development of sound management approaches in campus environments in a bid to create a healthier learning environment.

1. INTRODUCTION

Environmental noise has therefore been defined as a major form of pollution that affects the health of man and other living creatures. It has over the recent past been established and highlighted the likelihood of having negative impacts on academic outcomes and emotional wellbeing particularly among students in higher learning institutions. With increased population density and expansion of more and more colleges and universities operating in urban environments, the inherent noise produced by various sources of road traffic, industries, construction sites, and even the activities taken within the colleges and universities themselves has increased significantly. This has in turn resulted in literature on noise level and its effects on students' thinking abilities and health as well as performance. According to the WHO, if children are exposed to noise levels over 55 dBA for a long time this leads to speech interference and distraction that hinders children's learning directly [1][2].

Among the main sources of noise identified within campuses, the most significant is traffic with road, rail and air around the campuses. A considerable number of universities and colleges are situated in urban areas or close to highways which leads to high noise pollution in the vicinity. Campus studies carried out at the University of Dammam in Saudi Arabia University of York in the UK, and the University of Technology in Iraq reveal that road traffic especially during morning and evening peak hours forms a high source of noise pollution in campuses [3][4]. Such studies have led to a heightened demand for finer noise mapping in academic institutions other than passive noise mapping based on octave bands. Also, what contributes to noise levels especially in rapidly growing campuses are construction activities that are frequent in such growing institutions.

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A second major source of campus noise production can be attributed to the noise generated inside the actual educational structures, as well as the facility grounds which occupy structures such as classrooms, laboratories, and libraries. Educational laboratories, for example, always produce constant noise from different devices such as centrifuges, ventilation, and power tools. For instance, studies at King Abdulaziz University in Saudi Arabia show that the Labs especially the engineering and technical classes noisy environments that are beyond the acceptable limit for academic institutions [5]. These high noise levels interfere with students' concentration, receive instructions from their tutors effectively, and may develop headaches or hearing discomfort. Furthermore, where the classroom or lab design is unsuitable or the lab acoustics lack a proper treatment then students get fatigued and stressed which negatively affects their performance [6].

The effects of noise on student health are unfortunately well established in the scholarly literature. Longtime constant exposure to noise has been described to cause undesirable health impacts such as sleep disorders, boosted anxiety, stress, and in some cases cardiovascular illness for instance hypertension amongst the assessment populace [7][8]. Non-ear-specific noise-disrupted sleep is associated with a reduced ability to consolidate information and poor academic performance because students have poor sleep and cannot remember information or perform tasks well. Sadhra et al. (2002) found out that students studying in noisy environments complained of stress as well as low concentration levels than those in a quiet area [9]. This then calls for a need to control noise pollution in higher education settings as a major public health problem. Although noise pollution is not an emergent problem, awareness concerning this issue along with the integration of noise control measures in institutions of learning is still in its infancy. This means that one should have good knowledge of the sources and effects of noise, noise effects on the student's health and academic performance, and ways of minimizing noise exposure to develop healthier learning environments. These effects of noise pollution are the reason why many universities including the University of Nottingham and Leeds have integrated noise pollution students into their health surveillance programs [10][11]. They are some of many attempts to include environmental health issues in the complexity of managing academic campuses. Therefore, it is necessary to extend such initiatives on the international level to promote a moderate level of noise pollution and enhance students' quality and educational process consequently. Figure 1 outlines traffic noise, construction noise, indoor noise recreation noise, and compound noise that is usually prevalent in colleges. Exceeded traffic noise, construction noise added to traffic noise, interior noise from HVAC systems, recreational noise from students and cumulative noise. The students from these sources influence each other in their physical and mental health by emphasizing and amplifying the issue of noise management.

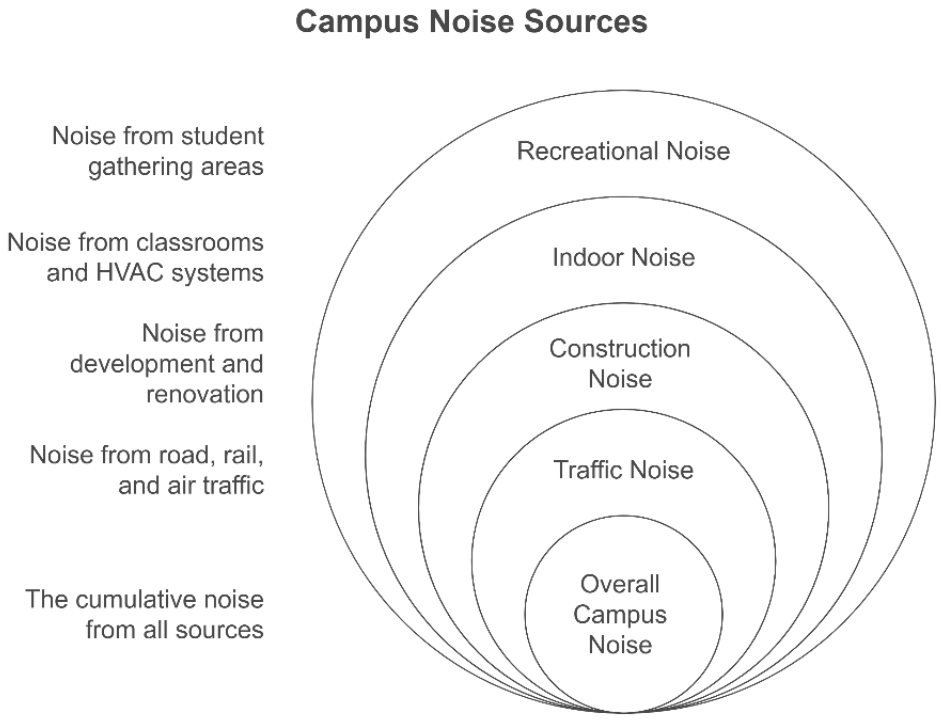

Fig. 1. Sources of noise on college and university campuses.

2. SOURCES OF NOISE ON COLLEGE CAMPUSES

Hearing pollution in colleges is also one of the challenges that affect the environment, especially in the lives of learners. Since students spend so much time within and around campus both indoors and outdoors it is important to identify some of the noise sources that pollute learning spaces and cause stress. Outdoor and indoor noises must be distinguished, as the presence of sounds originating from outdoors and indoors necessarily influences the health, studying abilities and academic performance of students.

2.1 Outdoor Noise Sources

Outdoor noise on college campuses includes road traffic noise, construction noise, and noise from weather events and natural disasters. Of all these sources, the sound arising from road traffic is the most famous. A study which was conducted in previous work highlighted that noise Pollution from the transport system in roads adjacent to university sites can be highly irritating during rush hours. For instance, research being carried out at the University of Dammam, Saudi Arabia and the University of York, UK found that traffic noise regularly reaches 70 dBA and above, which is above the WHO recommended limit of 55 dBA in education zones [12][13]. This noise can distract students from getting their work done effectively they have poorer grades and experience stress [14]. Further, road traffic is perceived not to be safe for students only in proximity to major roads but even on quiet campuses if noise can cross open spaces or inadequate buildings.

Construction noise is another typical source of outdoor noise pollution in campus areas of colleges and universities. Construction noise is present within university environs especially at new or undergoing <c> redevelopment through destruction, digging and the use of Mechanical commuters. Similarly, a study carried out at the University of Technology in Iraq and King Abdulaziz University in Saudi Arabia established that construction noise ranges from 75 dBA to as high as 100 dBA depending on the type and number of machinery and personnel at [15][16]. Such noise is mostly constant throughout the day, especially during academic hours and can have a negative effective in a learning environment for students attending classes or working on assignments. The WHO has recognized for quite some time now that exposure to such high levels of noise may lead to chronic hearing impairment and stress-derived disorders such as hypertension and sleep disorders [17].

As a result, outdoor noise pollution becomes a problem due to noise generated from recreation areas such as the_grp_Colicy sports fields and students' convergence areas. Outdoor areas in many university campuses with large grounds increase noise from students chatting, exercising or having fun, and during events or during their highest traffic times. These zones can get up to 70 dBA during the period of most use, interrupting other academic classrooms and zones. Thus, the universities are prompted to mitigate these recreational noise levels by appraising better acoustics, space arrangement and timing [18]. Figure 2 depicts a classification of various noise sources within the campus to have a better understanding of how each noise source plays its part in causing campus noise pollution.

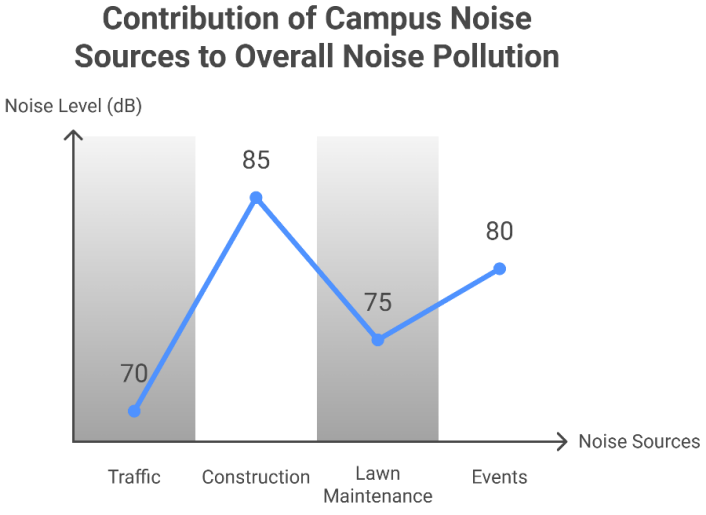

Fig. 2. Campus Noise Sources - Categorization of noise based on source types.

2.2 Indoor Noise Sources

Outdoor noise can be considered as very problematic, but indoor noise can be also seen as much more related to student disruptions, as it influences the context in which students are Found most of the time. Internal classroom noise configurations originate from students, instructors, heaters and ventilators, as well as from background residues from adjacent rooms. Today it is more focused and interferes with speech intelligibility and concentration, which is typical of the indoor environment. Different authors revealed that classrooms with noise levels above 55 dBA impact the students' ability to hear and understand the lectures reducing overall learning effectiveness [19][20]. Air conditioning and heating systems are essential in a home, but they introduce indoor noise too. The work [21] highlighted that neglected HVAC systems are one of the primary sources of increased noise in classroom environments and therefore exacerbate concerns of distraction for students and teachers.

In educational laboratories, noise can include sound resulting from scientific and technical equipment typically utilized in a laboratory. Moreover, general learning areas and laboratories which are common in subject areas like Chemistry, Biology and engineering mostly exemplify noisemakers like centrifuges, mixers, and mechanical apparatus touch 90 dBA but rarely exceed 100 dBA. This is more so, where the institutions belong to technical colleges or institutions where practical and experimentation features are inherent part of the curriculum. In literature, Atatürk University in Turkey and the University of York have described how noise from laboratory equipment not only impinges on student concentration but also the students' work [22, 23]. Noise above these levels can also affect hearing permanently, which is additional stress to the acoustic environment in such labs and other academic settings.

However, the architectural characteristics of structures and learning spaces affect indoor noise in particular to a great extent. Lack of proper soundproofing is another consideration which can aggravate the deficiencies of the learning environment: inadequate design of classrooms, auditoriums, and other educational facilities affecting acoustics. For example, any classroom close to the cafeteria or hallway is always affected by sound interference, which increases distraction. Some acoustic investigations that have taken place at the University of Leeds [24] as well as in other universities concluded that substandard building designs, insufficient acoustic insulation, and high reverberation times render classroom learning uncomfortable and less effective. Since classroom acoustics is critical to the learning process since students are more sensitive to sounds in classrooms, educational facilities have to adopt good acoustic design and apply sound-damping solutions.

Besides, class and lab noise and noise that students produce themselves, can cause indoor pollution. Administrative activities of students, group discussions, and movements within and around the compound often interfere with quiet study places like libraries, Laboratories and studies. Academic environmental studies conducted by Ricciardi and Buratti [25] revealed another source of noise; students' groups in rehearsal or between classes and showed that open and expansive areas including lecture theatres gave rise to most distractions. This form of noise is most of the time amplified as students move around within the compound, especially during their classes.

Therefore, college campus noise pollution can be internal and external sources, which condition negatively affects the health and academic performance of learners. Noise pollution from car horns, construction work, and recreational activities is particularly disruptive when sounding outdoors, while noise generated indoors such as from classrooms, HVAC systems, laboratories and group studies makes the problem worse. Noise pollution is so rampant and disruptive to learning that its management cannot be overemphasized. To combat such impacts, universities and other institutions of learning should begin to embrace the idea of proper means of noise control proper building acoustics and even policies on noise control. Consequently, as research findings have revealed noise has the potential to affect the health of the students as well as their performance in their academics; this is why noise control should be encouraged and supported for the improvement of the situation amongst students as well as in the delivery of education.

3. HEALTH EFFECTS OF NOISE ON STUDENTS

Noise interferes with students not just by irritating them, but important aspects of their living, learning and even physiological well-being are damaged by its incomparable abilities to concentrate and learn and also have physiological stress. Exposure to noise pollution in the school environment affects thinking ability, physiological health as well as psychological health and the impacts could either be short-term or chronic. It is, therefore, useful to unravel these effects, if not to eliminate noise pollution in academic settings, then to enhance students' quality of life.

3.1 Concentration and Learning

Noise in the learning environment particularly where and when it is above a certain level hurts learning concentration. Exposure to high-intensity noises interferes with students' learning process, concentration, and attention span during lessons. Research has indicated that noise degrades speech communication and mortifies the ability of students learning in call centres to hear their trainers and engage in conversation. Following the WHO's recommendations, it must be pointed out that noise levels over 55 dBA can interfere with speech intelligibility, while noise levels of 65 dBA and above necessitate additional vocal effort from the speaker [26]. To measure the noise level, they asserted that the noise level interferes with students' concentration and performance on assigned tasks and collaborative work among a group of students [27].

The effects of noise on learning are particularly destructive to children and young adults because noise disrupts the developing brains of learners. Concluded from the previous in schools and universities that students living with constant sounds, close to traffic or construction, for example, have slower responses and poorer academic performance. For example, a study carried out at the University of York in the UK revealed that learners in classrooms which had a noise level above 60 dBA received poorer test results than the learners in quiet rooms [28]. Similar to this study, a similar study done at the University of São Paulo in Brazil learned that students found it hard to concentrate and complained of high-stress levels as a result of noisy classroom environments [29]. The problems associated with noise and interference are aggravated by the stress and discomfort that distorted concentration creates on the learners.

3.2 Cardiovascular and Stress Impacts

There are several physiological effects proven to be caused by noise exposure such as General effects that include stress levels and cardiovascular. It has been argued that continuous exposure to high levels of noise can lead to the following physiological changes: raise blood pressure, increase the rate of heartbeat, and increase the level of cortisol a stress hormone. The WHO has also brought out how environmental noise is associated with cardiovascular health including hypertension, ischemic heart disease and stroke [30]. Noise exerts its deleterious effects as a stressor due to its ability to elicit the sympathetic nervous system response. The above translates to other noise pollution-related chronic illnesses Thus, they lead to other noise pollution-related chronic diseases.

The number of students who experienced noise levels higher than 65 dBA were found to have higher blood pressure than their counterparts in low-noise environments [31]. Like as a similar study was done at the University of California, where the students living in noisy dorms or near noisy roads were found more stressed and such stress, in turn, caused the students to suffer from stress-related physiological and emotional health problems [32]. The stress caused by noise-induced loudness hence suggesting long-time exposure to key noise types results in chronic health effects such as anxiety and depression that directly affect the effort, concentration, and general performance of students.

3.3 Sleep Disturbance

A further effect of noise on students' health is sleep disruption in this regard, the study. The noise from traffic and construction are recognized as noisy sources that interfere with sleep leading to short, or low quality. The WHO has therefore categorized noise as one of the causes of sleep disorders, especially in cities where noise pollution is frequent because of traffic and industrial activities [33]. Lack of sleep impairs the ability to reason, hurt the human body's immune system and vice versa, expose the patient to mental illness and distress.

A university-based study done at the University of Dammam in Saudi Arabia revealed that students who lived close to highways had disrupted sleep due to noise pollution from traffic hence they were always tired during their day [34]. Equivalent research carried out at the University of York found that learners who slept in halls close to noisy zones recorded poor sleep quality, therefore leading to sleeping during the day and hence constant yawning during lectures. In addition, stress and anxiety reduce sleep, and lack of sleep again increases the level of stress and anxiety affecting students' performance and health [35].

3.4 Acoustic Environment of Classrooms

Of particular importance is the acoustic condition in the classroom because it determines how students relate to noise. When the background noise in classrooms comprises, for instance, poor sound insulation or high reverberation, external acoustic sources are further amplified. Experience suggests that difficult classroom acoustics, in terms of high background noise or unsatisfactory acoustic quality generally, result in increased fatigue, misunderstanding and stress among students. According to [36] classrooms that lack soundproofing and have high reverberation times inevitably mean that students have to work harder to hear their instructor, and therefore become fatigued much faster, and learn less efficiently.

Studies by Rob Glover of the University of Leeds have also focused on the acoustic design of learning environments where classrooms with enhanced acoustical treatment look Meilleur to learn in and diminish the adverse impacts of outside noise [38]. The latter can be minimized with modifications in the classroom acoustics, for instance, by introducing noise-insulating in the form of lead-lined or FIR-treated materials, and proper checking of the windows about their weeping. These changes not only make speech sound better intelligible but also make the learning environment better for students, equally reducing the physical and mental fatigue caused by noise.

3.5 Potential Solutions

In this view, ways of minimizing the adverse impact of noise should be adopted by colleges and universities to minimize noise pollution on campus. One approach is to adapt the design of classrooms and study areas where the noisy students will sit by the use of soundproof methods like Acoustic panels, carpets adulated curtains all called absorbers. Also, construction activities during the non-super tasking time, restriction to construction equipment use near schooling resources, and the use of barriers are some of the ways of controlling external noise. The literature review of several other similar interventions has revealed that the reduction of noise levels and the quality of life among students is perhaps notably enhanced by such interventions [38][39]. Figure 3 also connects the noise levels, their health implications, and possible action plans, including the central idea of maintaining an equitable as well as noiseless learning climate.

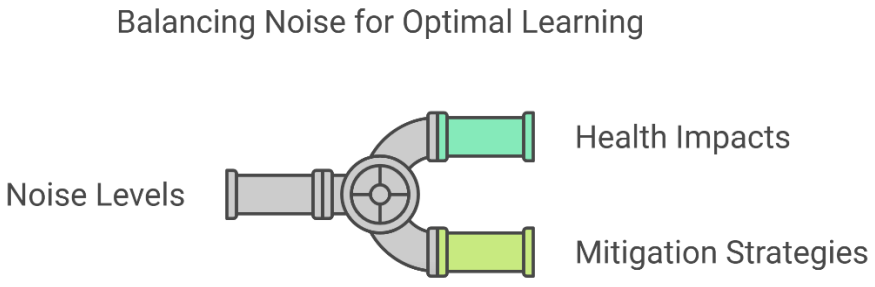

Fig. 3. Impact of Noise on Student Health and Potential Mitigation Strategies

The outcomes presented prove how noise pollution affects students' health and academic performance. It adversely affects concentration, learning and sleep apart from causing stress and cardiovascular diseases. In addition, background noise interference on learners' performance is compounded by poor classroom acoustics. Hence, sufficient methods should be put in place for minimizing noise pollution in universities such as designing appropriate classrooms, provision of noise control policies and regulation of construction noise at appropriate times. With an enhanced acoustic environment on campuses, educational facilities can promote a healthier learning climate for the learners.

4. ACOUSTIC ENVIRONMENT OF CLASSROOMS AND LABS

Classrooms and education labs' acoustic environment are central to student learning and health. Thus, well-chosen sound levels and room and equipment design in a classroom or laboratory make it easier for students to understand speech, eliminate distractions and improve their concentration and performance. While the good acoustic conditions improve listening, speaking and understanding, the poor ones result in listening, communication, and comprehension problems that hinder the student's performance. In this section, the author delves into the concept of acoustic design particularly reverberation control, speech clarity and more importantly the consequences of acoustics in learning institutions.

4.1 Reverberation and Speech Intelligibility

Reverberation is the continuation of sound in a closed place, caused by the echo effect when sound strikes the surfaces of walls, ceiling and floor and reflects. In classrooms and labs, reverberation is a major problem in that speech intelligibility can be greatly affected in such space, resulting in poor student-instructor communication. WHO advises that speech intelligibility is impaired by background noise and where the reverberation time exceeds 0.6 seconds, a standard typical of poorly designed classrooms [40]. Disabilities affecting the hearing or other faculties can occur, with the result that learners fail to hear or follow certain instructions given.

Generally, investigations revealed that reverberation times of between 0.6 and 0.7 sec are appropriate for most educational purposes; nevertheless, if the reverberation exceeds this range, students' ability to understand speech is affected,

particularly in crowded classes or laboratories. For instance, a study done at the University of Sydney showed that lessons taught in class with long reverberation periods attracted less attention and understanding from the learners than lessons conducted in classrooms with good acoustics [41]. This study also established that classrooms with favourable acoustic characteristics of sound reinforced enhanced communication flow and improved student engagement. Consequently, in a study at the University of Hong Kong, investigations revealed that speeches' intelligibility was reduced by 30 per cent at longer reverberation times in the classroom, especially for the students in the back rows of large lecture halls [42].

Minimizing such problems requires the use of blankets, carpets, acoustic panels, and ceiling tiles to lower reverberation time in the classrooms and labs. These materials enable one to avoid echoing and hence help in clarity of communication by binding sound to avoid making round trips on the walls. Additionally, there are acoustics of the room and how it should be designed, for example, the ceiling of the rooms should be low and there must be few hard surfaces that reflect sound.

4.2 Impact of Acoustic Design

Thus, the acoustic design of students' classrooms and educational laboratories is of great importance for creating the necessary conditions. Correct room sound management ensures that the habitat has an understanding of speech sounds and any room requires that any intermittent sound should not interfere with the messages conveyed. Some considerations of acoustic design include the shape and size of the rooms; the construction material; insulation; and background noise [43].

However, it is important to look beyond the shape of the room, the type of material used to construct the room influences the flow of sound in the room. For this reason, reinforcement bars and boxes can be made from materials that either transmit or absorb sound preferring hard surfaces like concrete glass and tiles which transmit sound waves back to the room and soft materials like fabric wood and foam which trap sound waves in the room. There is a work, which reveals that the presence of hard surfaces in classrooms leads to increased reverberation time hence limiting students' ability to hear and understand the instructor conducted at the University of York [44]. Classrooms with acoustic panels and soundproofing materials on the other parts had smaller reverberation times and the general speech clarity was better.

Acoustic design also involves noise control within the classroom and this involves isolating the classroom from noises outside. For instance, classes exposed to play areas or noisy areas such as business corridors or construction areas are most likely to be affected by high noise levels. To this end, the Facade and window can still be fitted with acoustic material that can limit external noise that penetrates the interior of the building. On the same note, internal noise sources were identified as factors, which should be regulated to curb noises which often disrupt learning such as those from air conditioning and ventilation systems. A study done at the University of Cambridge proved that better noise control measures improve the satisfaction level of the students as well as their performance [45].

4.3 Acoustic Comfort and Student Well-being

Acoustic comfort is a broad term that goes beyond the ability of individuals in a given environment, in this case, students in classrooms and laboratories, to understand speech. The issue of acoustic comfort is of particular concern since it plays an important role in shaping people's well-being as well as the efficiency of the learning process. The concept of environmental stressors also varies with the frequency and duration of exposure levels of the students to uncomfortable acoustic classroom environments like background noise and sound clarity. Per the WHO, poor classroom acoustics could cause physical health effects such as headaches, overtime ear discomfort, and at worst; hearing loss [46].

Examined a correlation between acoustic comfort and student classroom well-being specifically in university. The research concluded that students who learn in classrooms with good acoustics have less stress, better concentration and improved students' performance than those students learning in temporal environments with poor acoustics [47]. Acoustic comfort is not only helpful in enhancing or reducing students' abilities to learn and think but also helpful in their moods and health. Children within noisy or other challenging acoustic environments are more prone to stress, anger, and even depression which reduce their performance.

Classroom acoustics need to be done in such a way that will favour not only speech intelligibility but also the well-being of the students. It covers noise level management such as avoiding loud noise levels, enhancing sound quality and ensuring comfortable acoustic space. The application of sound softening or sound insulation, noise protection, and selection of appropriate building materials make the learning environment favourable for the students and improve their performance.

4.4 Acoustic Performance Standards for Educational Spaces

To create the checklist of features of classrooms and educational labs several organizations and guidelines for the classification of a building were created to indicate which acoustic level is acceptable for each kind of a building. ANSI

and ISO have set standards for classroom acoustics regarding the reverberation, noise and speech transmission measures. Based on ANSI and ISO, classroom RT should range from 0.4 to 0.6 s depending on the size and its usage [48, 49].

These standards are adopted by architectural designers, educational facilitators and acoustical engineers to create a better learning environment for students and educator. The standards also offer a reference that enables an evaluation of the existing classroom acoustic conditions, and any potential enhancements thereto. Thus, it could be expected that those colleges and schools which work at the indicated standards would help the child create the conditions for the formation of intellectual and emotional personality.

Additionally, universities are also urged to periodically rate or evaluate the acoustic performances of specific classrooms and erect necessary alterations so as to conform to corresponding specifications. Sustainable arrangements where the aspect of acoustics is taken seriously avails a favourable context that empowers students educationally and socially.

4.5 Recommendations for Improving Acoustic Environments in Classrooms

Based on the findings above, the following recommendations are proposed to enhance the acoustic conditions in classroom and lab settings. Presumably, first, universities need to apply acoustically treated materials in new classrooms and when reconstructing previous ones. Alliance by organisations and institutions have been adopted through the incorporation of acoustic panels, carpets, and fabric-based furniture to reduce reverberation and enhance speech clarity.

Further, universities should consider the distribution pattern of the classroom in as much as concern distribution of sound in the classroom is concerned. It should avoid areas where sounds may not reach, by reducing noise absorption in the room, and it must provide good acoustics for those students who are at the back of the class to hear the instructor. To minimize noise from the external environment, the university should ensure that it uses soundproof items like; the use of double glass windows and insulated walls due to excessive traffic within the university compound and construction activities.

Last but not least, universities can make some regular acoustic inspections that point to the necessity of creating classrooms with an accountable level of sound and noise control. In this way, constant control over acoustics and changes to it will help institutions create classrooms that in the long run contribute positively to students' speech and success. Figure 4 reveals classrooms with different patterns of acoustic treatment and how they influence speech intelligibility, student performance across the classroom and how acoustic design offers a significant importance in education.

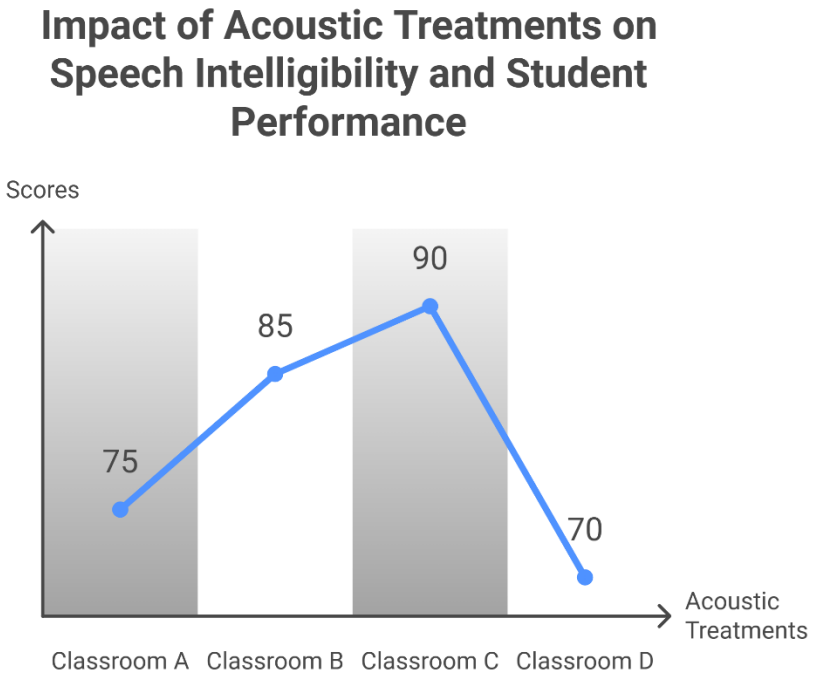

Fig. 4. Comparison of Classroom Acoustic Treatments and Their Impact on Speech Intelligibility and Student Performance.

There is evidence that the acoustic conditions in classrooms and educational labs affect students' learning and physiological state. Reverberation, speech intelligibility, and general acoustic comfort are useful parameters that determine the learning environment of students. This paper examines ways in which universities can enhance classroom design to reduce noise that hinders learning to enhance student performance through stress-free environment. It is also submitted that maintenance of proper acoustic check and compliance with standard will made it imperative for educational institutions to offer appropriate acoustic comfort for students and faculties.

5. DISCUSSION

A common worry about noise in education settings has been made for decades about its negative impact on students' learning abilities, health and well-being. This paper has revealed that noise pollution in university campuses and classrooms has dire consequences in determining the students' performance as well as their health and wellbeing. This section addresses the implication of the findings about the campus and classroom noise, and its impact on health and learning, thus the need to reverse the poor acoustics for improved quality education**.**

5.1 Impact of Noise on Student Learning

Research has time and again confirmed that noise reduces students' capacity to concentrate, understand and memorise content comprehensively. Research has shown that noise in general and in the learning, environment could cause anything from minor interference to the learning process to severe interference with brain processes. High noise sources can disrupt speech clarity and make it very hard for students to follow the lectures and instructions given by the instructors hence reducing lesson retention [50]. Additionally, high noise levels that are difficult to avoid can cause cognitive overload over time; therefore, students cannot remember much of what the lecturer has said or even focus during the lecture. For instance, there is a study done at the University of York where students who used to learn in noisy classrooms performed poorly when handling difficult content and showed lower performance compared to learners in well-sound classrooms [51]. These findings suggest that noise control measures are still wanton inadequate in especially university classrooms and laboratories to promote a better learning environment.

The enormous challenges presented by these factors require university authorities to pay particular attention to acoustic characteristics when designing or renovating classrooms, halls and lecture theatres. Some facilitative conditions which can be implemented include hanging acoustic panels, utilization of noise barriers and reduction of outside noise interferences. Moreover, training instructors to eliminate noise or use wireless microphones or amplification systems, especially in the largest rooms will help to eliminate or reduce some of the serious effects of noise by enhancing speech intelligibility for all students [52]. Enhancing classroom acoustic can enhance students' productivity and academic achievement; thus, it could be considered an important indicator of education quality.

5.2 Noise and Health Impacts

The impacts of noise pollution on students' health have been well discussed and numerous in the literature. Exposure to high levels of noise, persistent over time can lead to stress, hypertension and cardiovascular diseases [53]. You will also note that noise exposure leads to sleep disturbances and makes it difficult for student's focus and perform well academically. The WHO has reported that noise pollution is a strong risk determinant of several conditions that affect physical and mental health, such as hypertension and hearing impairment [54]. As well as showed that chronic noise, especially in dense communities, increases the number of mental disorders, including anxiety, depression, and irritability [55].

Second, noise pollution is also capable of having an impact on the health of learners; apart from those direct impacts, noise pollution can also influence their educational performance because of increased stress levels and lower overall well-being. For instance, students who read or attend class in areas with high noise levels of noise are likely to develop frustrated, exhausted emotions and limited empathy. Such health concerns can worsen learning problems and affect the performance of learners in school or the overall learning process. Hence, the reduction of noise pollution cannot be a matter of concern only for the well-being of the students but even for their results.

5.3 Noise in Educational Labs and Workshops

Other sources of noise that incidences are found on campuses include classroom noise, educational labs and workshops that include technical and engineering fields. Most of these environments contain machinery and equipment that generate high audible noise signals such as grinders, mixers, drills, and lathes, which produce sound levels above safe standards

[56]. Such high levels of noise regularity in educational labs may pose several risks to the students and faculty who spend considerable time in those areas including; hearing loss, fatigue and stress. Moreover, the noise from these sources may interfere with other classes in neighbouring rooms which in general increases the noise level on the campus.

This is because there are various sources of high-decibel noise within learners' educational labs and workshop environments which calls for controlling noise in those areas. Administrations should look at the recommendations which include using engineered controls like soundproofing walls; moving noisy machines, or using new quiet equipment. Also, enabling students to wear protective gear like ear plugs and other gear in case of noise reduction will help in preventing listen loss while working. Universities should also integrate a noise check schedule and noise check-in areas with high noise levels to conform to health standards.

5.4 Addressing Noise Through Campus Design

With regards to bringing down noise in learning facilities, one of the chief methods is to consider the format of campuses and classroom layout. This also involves such factors as the positioning of buildings and class sections to reduce cross-transmission of noise, and ensuring that areas that are noisy like laboratories and workshops are separated from quieter areas such as study sections. For example, it is possible to avoid having classrooms and study areas in proximity with roads, parking lots or areas under construction to help combat excessive noise gain. Moreover, the development of acoustic separation measures including double-glazed windows, soundproof doors and walls to effectively exclude noise in classrooms and other learning areas in universities should also be a priority.

In addition, good architectural layout also plays an important role in selecting appropriate sound absorption and reinforcement treatments that can significantly enhance the learning environment. Other specific solutions include covering floors and walls with carpets, and installation of acoustic panels and suspended ceilings. Room size and shape should also be considered in Classroom design; irregularly shaped rooms offer poor control of the acoustics resulting in sound being dispensed unequally. Introducing and applying such principles of acoustic design may help the universities to provide the most favourable conditions for both learning and teaching that would positively affect students' performance and well-being.

5.5 Recommendations for Future Research and Improvements

Nonetheless, the current review has pointed out the main sources and consequences of noise on students and more empirical studies should be conducted to assess the chronic health and academic costs of noise pollution among learners. Subsequent studies should aim at undertaking the cross-sectional research design, in an attempt to establish the long-term effects that such noise exposure has on the students' cognitive as well as physical and mental health. Further, a need arises to understand the impact of specific noise reduction measures including sound insulation and noise attenuation on the learning compendium.

Reducing noise pollution on campuses requires architectural and engineering solutions, healthcare input and university management support. Universities need to coordinate themselves to establish noise control approaches that include noise level checking, formation of quiet areas, and acoustic treatment plans. To avoid the negative impacts of noise pollution, universities should consider the following measures to be sure that learners are given the best environment to succeed academically as well as socially. Table 1. Current sources of noise and how they affect learning spaces on campus.

TABLE I. NOISE SOURCES AND THEIR IMPACT ON CAMPUS LEARNING ENVIRONMENTS

Noise Source	Impact on Learning	Recommendations
Traffic (road, rail, air)	Distraction, reduced focus	Soundproof windows, noise barriers
Construction and Renovation	Interference with concentration	Scheduling during off-hours, acoustic barriers
Educational Labs (Machinery)	Hearing damage, stress	Personal protective equipment, machine isolation
Recreational Noise	Annoyance reduces cognitive function	Zoning, noise control policies

6. CONCLUSION

University noise pollution is real, and its effects manifest in a range of ways affecting the college student's health, learning abilities, and general wellbeing. An inferior physical environment disrupts traffic, construction and classroom noise disturbing concentration, learning ability and communication which are prerequisites for performance. This environmental factor is also important for stress, fatigue and other health problems so it is crucial to show how this factor can be dangerous in education contexts. Acoustic conditions in classrooms and educational laboratories are essential because increased external noise factors can be amplified by poor acoustics in a classroom setting; thereby decreasing learning. Elements such as echo, noise level, IAC and speech clarity distract and hamper students' learning process. When noise levels rise above tolerances, comprehension and effective communication of lessons are reduced, thus: diminishing the general

learning experience of learners. These negative effects can be reduced by adhering to the right Classroom Acoustic Design and Integrating sound absorbing materials in the classroom setting. Some of the problems arising from noise pollution include; hazards of heart diseases, hearing impairment, and other health complications physically and mentally. A lot of noise has caused stress on the bodies of the student thus reducing their productivity as well as their health. To meet these challenges, the university needs to avow a complex strategy that involves noise mapping, regulation of noise levels, and the enhancement of effective acoustic treatments. More studies into communication PR different noise control measures and architects designing environments that are healthy for the human body as well as academically productive need to be conducted. Soundproofing requires a collective approach from the policymakers, campus administrators and other teachers to design a healthier environment for the next generation of students.

Conflicts Of Interest

None

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