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ENVIRONMENTAL CONSIDERATIONS TOWARD THE PROVISION OF CONDUCIVE LEARNING ENVIRONMENTS IN NIGERIAN SCHOOLS

A. J. Adeyemi[1*], S. A. Yusuf [1], O. B, Ezekiel[2]

([1]*Department of Mechanical Engineering, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria*
[2]*Department of Mechanical and Biomedical Engineering, Bells University of Technology, Ota, Nigeria*)
[*]Corresponding author's e-mail address: folashademola@gmail.com

Abstract
Learning, which is the expected outcome of any educational institution, can be influenced by many factors that include environmental factors. This study is aimed at comparing the learning environment of junior secondary schools, in a North-western state of Nigeria, with established standards in some other countries. Four government-owned and four private owned schools participated in the study. Environmental variables such as classroom temperature, noise level, lighting and classroom size were all evaluated using standard equipment. Using statistical analytical tools, such as descriptive and comparison of means, the result shows that classroom lighting, noise and temperature do not meet the established standards. The noise level in all the schools was above the recommended maximum comfort noise level of 40 dB(A) but still below noise harmfulness level of 85dB. The lighting in the classes was also not sufficient based on international recommendations of 300 Lux. The temperature in the classrooms is significantly higher than the acceptable level of 18-28°C. Although public schools have significantly larger classrooms than private schools, they have a smaller space/pupil ratio because of larger population. There is need to improve the building design of schools so that they might aid learning among the children.
Keywords: Learning, noise, light, schoolchildren, environment

1. Introduction

Human factor engineers and ergonomists have highlighted the significant effect of environmental conditions on productivity or overall performance of humans. The school, where children spend most time outside their homes serves as their workplace (Adeyemi *et al*., 2014; Bakó-biró *et al*., 2012).Learning, which is the outcome of schools as an educational centre, has been categorised as a measure of performance and well-being (Benedyk *et al*., 2009; Dul *et al*., 2012). The school environment therefore plays vital role towards achieving the learning objectives.

Environmental factors such as lighting, noise, temperature, air quality and wall colour have been identified as factors that affects learning (Krüger and Zannin, 2004; Stone, 2008).These variables interact to determine the optimal level for performance. Acoustic design has been documented to be vital as its affect both teaching and learning (Kristiansen *et al*., 2011; Zannin and Marcon, 2007). Excessive noise from background or design are serious impediment to learning (ANSI, 2010) and need to be guided against in designing schools. It disrupts effective communication between teachers and children. Light has physical and psycho-physiological effects on humans and therefore affects children's level of activities, behaviour and performance in the classrooms (Barkmann *et al*., 2012; Bellia *et al*., 2011a). Adequate lighting improves vision, thereby enhancing the children's ability to recognise and understand visual information (Van Bommel *et al*., 2004). Also, high temperature that causes sweating may lead to lack of concentration and reduce productivity (Song *et al*., 2012).

Educational models such as the hexagonal spindle model (Benedyk *et al*., 2009; Woodcock *et al*., 2009) and social cybernetic model (Smith, 2007)have highlighted the contributions of these environmental factors towards the provision of a conducive learning environment. The relationships described in these models applied both to the micro and macro ergonomic levels (Roman-Liu, 2013). The importance of these models has further been justified by the recent call for systematic application of Human Factors/Ergonomics (HFE) principles to problem solving (Dul *et al*., 2012; Wilson, 2014). This is because HFE problems are complex and involve investigating the interactions of multiple factors (Adeyemi *et al.*, 2017). For example, while daylight serves as an energy saving strategy in schools, it also affects the thermal conditions of the school, necessitating need for balancing (Bellia *et al*., 2011b). These models provide explanation and highlight the multiple interactions existing in the complex environment children live in. As illustrated in the hexagon-spindle model by Woodcock *et.al*. (2009), the learning environment plays a vital role towards effective learning. Similarly, the social cybernetic model (Smith, 2007) also identifies factors such as class design and classroom/buildings as influential in the achievement of the learning objective. A major issue highlighted by Smith (2007) and Woodcock *et al*. (2009) is the limited ability of children to control feedbacks from most of the factors affecting them. Rather than children being in control, the various design factors mediate in the children's learning ability by sending sensory feedback to them.

Hence, school environment has been under investigation since it is believed to directly affect human comfort and concentration during learning (Yildirim *et al*., 2011). When properly appropriated, the application of HFE to school environment can greatly enhance the learning experience of the children (Stone, 2008) and also influence their academic performance (Park *et al*., 2011).Towards achieving this objective, international standard organisations have also recommended suitable standards for school environment. European union countries has identified safe and healthy school environment for both children and teachers as a priority in all member states (Augustyńska *et al*., 2010).

Therefore, there is need for developing countries such as Nigeria to adapt measures that will ensure schools are conducive for learning. Presently, the standard of education is not uniform across the country with some regions categorised as educationally-disadvantage states, which is a measure of child wellbeing (Adamson, 2013). The northwest region has been identified as one of the lowest region in terms of education in the country (NPC and RTI, 2011). Also, the proximity of the states in the region to the Sahara Desert exposes them to high temperature and least amount of rainfall in the country. Therefore, as efforts are being made to improve the level of education in this region, there is need to ensure that school environment do not hamper the government's set goal of improving the standard of education in the region. Hence, this study is aimed at evaluating the level of conformity of some environmental factors that affect learning in Kebbi, a state in Northwest Nigeria, to global standards. The variables considered in this study include temperature, noise level, lighting and classroom size.

2. Materials and Methods

Invitation to participate in the study was sent to twelve public and private junior secondary schools in Birnin Kebbi, the capital of Kebbi State, Northwest geopolitical zone of Nigeria. Junior secondary schools (JSS) correspond to grade 9 to 12 and consist of children whose age ranged from 12 to 15 years. The schools were assured of privacy and that data collected will be strictly for research purposes. After multiple visits, eight schools gave approval for the study to be conducted in their schools. They comprised of four public schools and four private schools. Two classes were evaluated in JSS 2 and 3 in two of the public schools. Table 1 shows the sampling distribution of the three grades of junior secondary schools used for this research.

Table 1: Sample Distribution of Classrooms used for the Study

		Type of school		Total
		Public School	Private school	
Class	Jss 1	4	4	8
	Jss 2	6	4	10
	Jss 3	6	4	10
Total		16	12	28

The study was conducted in the month of June and each school was visited for five consecutive days. Data was collected in the morning (between 8am and 9am) and afternoon (between 12 noon and 1pm). Data were only collected when teachers are in the pupils' classes. This is to limit data collection to periods when learning is expected to take place. Before measurement, both teachers and pupils were informed of the purpose of the visit and consents were obtained from the participating teachers and pupils. The windows were also opened for proper ventilation and maximum day lighting since none of the schools visited was air-conditioned. The combined effects of day lighting, energy saving and fluorescent bulbs were studied because it will be difficult to validate the ratings and some parameters of the sources of lighting in the schools. Both light intensity and sound level measurements were collected randomly three to four times within each lesson, which lasted for 45-60 minutes. Light intensity was measured using a digital lux meter with accuracy of ±(4%rdg+2d) and test rate of 2 times/seconds. The sound level was measured with a CEM digital sound level meter with an accuracy of ±3.5dB@1kHz. The classroom dimensions (length and breadth) were measured with a CP-3007 ultrasonic distance measurer with an accuracy of ±0.5mm.

Statistical Package for Social Science (PASW) Statistic 18 was used to analyse the data. Descriptive statistics such as frequency, mean, standard deviation was used to summarised and examine the behaviour of the variables. In addition, box-plot and bar graph were examined to provide graphic visual of the differences. The comparison of means to determine the degree of association between two variables were investigated using t-test while analysis of variance (ANOVA) was used whenever the variables were more than two. Levene's test of equality was used to determine if there is homogeneity of variance during the t-test while Turkey HSD post hoc test was used to identify which of the locations around the classrooms is responsible for the significant difference in the ANOVA. All the analyses were carried out at 0.05 significant levels. Thereafter, the measured values were compared with regional and National standards which include:

British standard (BS) and European (EN) standard BS EN 15251:2007: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality , thermal environment , lighting and acoustics (BSI, 2008).

American National Standard Institute (ANSI) and the Acoustical Society of America (ASA) ANSI/ASA S12.60-2010/Part 1 American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools (ANSI, 2010).

3. Results and Discussion

The mean temperature in the classrooms was 31.08(±1.71)°C in the morning and 35.73(±2.91)°C in the afternoon. The minimum and maximum temperatures recorded in the morning during the period of study were 30°C and 34°C respectively. In the afternoon, the minimum and maximum temperatures were 30°C and 40°C. Classes that are too hot or cold will cause discomfort to both teachers and the children (Krüger and Zannin, 2004). Although, 18-28°C has been documented as human comfortable temperature range, acceptable indoor temperature differs according to geographical location, race or culture (Song *et al*., 2012). From all ramifications, the temperature in the classrooms is significantly higher than the acceptable level.

The minimum and maximum class areas recorded for all schools were 32.72 m^2 and 60.04m^2 respectively. The study shows that public schools have significantly larger classrooms than private schools in Birnin Kebbi metropolis of Kebbi State. The mean area was 51.71(±4.46) m^2 for public schools and 42.28(±9.84) m^2 for private schools. The size of the public schools was within the recommended area of 60m^2 for secondary schools and should be ideal for 30 pupils (BB98, 2014). The independent sample t-test shows that this difference in area between public and private schools is significant (t(14.403)=3.089, p=0.008). The Levene's test for equality of variance was significant (F=46.019, p<0.0001), hence, equal variance was not assumed. Also, the boxplot in Figure 1 shows that the size of the classrooms in private schools varies significantly when compared with that of the public schools. This is an indication of lack of standardization in the sizes of private school buildings when compared with public schools. The minimum and maximum number of pupils per class was 24 and 80 respectively. The number of pupils per unit area was 1.1 (±0.24) per m^2 for public school and 0.77 ((±0.02) for private school, which was also significantly different (t(15.383)=5.645, p<0.0001). This translates to a space of 0.94±0.18m^2 per child in the public school and 1.30±0.04m^2 per child in the private school. Hence, the larger classroom size in the public schools do not translate to bigger space for the children, as density indicates that a child in the private schools has more space to himself because of the lower population compared to his counterpart in the public schools.

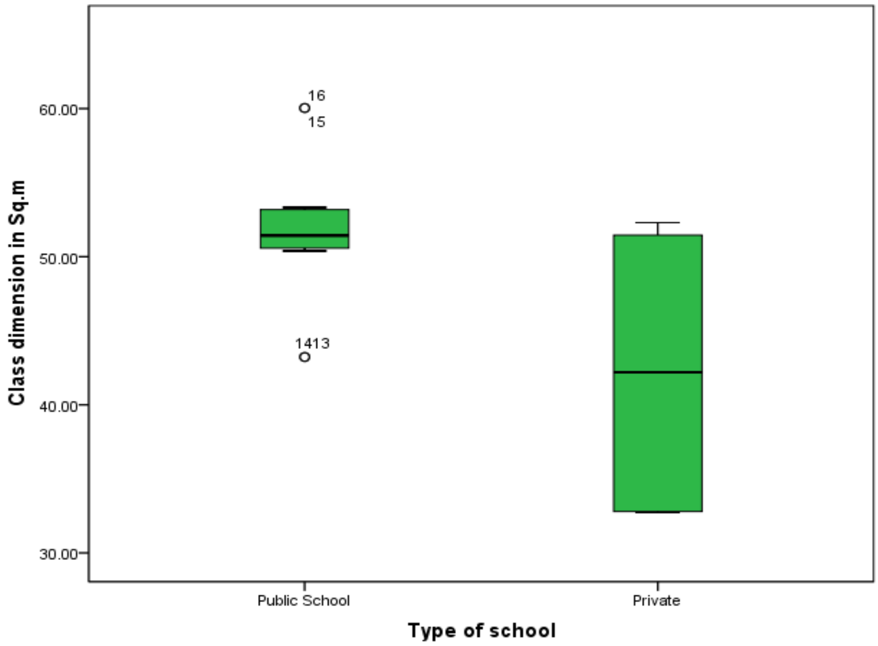

Figure 1: Boxplot showing the variation in the size of classrooms in public and private schools

Figure 2 shows the light intensity at different positions of the classroom for public and private schools. Figure 2 indicates that the classrooms are poorly lit and this can disrupts the children's attention during learning (Krüger and Zannin, 2004). The centre of the classrooms was better illuminated than the other positions inside the classrooms because the light sources were located at the centre of classrooms. The surrounding environment to the classrooms, which refers to the area close to the windows and the corridor are better lit than the interior of the classrooms. ANOVA shows that the difference in lighting quality at different positions in the interior and the surrounding environment of the classroom is significant ($F(4,135)=66.604$, $p<0.0001$). The post hoc analysis highlighted this difference to be among the interiors (front, centre and back of the classroom) and the surrounding environment (window and corridor). The significant difference between the surrounding environment and the interior of the classrooms is an indication that daylight positioning was not effectively utilised in school design despite Nigeria's location in the tropics.

These observations were common to both the public and private schools as there was no significant difference in lighting intensity between public and private school ($t(138)=0.513$, $p=0.609$). Moreover, Table 2 shows that apart from the sufficient illuminance at the windows and corridors as a result of daylighting, the lighting intensity in the classes do not meet the recommendation by European/British standard body. The amount of light at the corridors and the windows is an indication that school designers can utilise the availability of sufficient daylight in the country. When properly annexed, daylight can provide sufficient light needed in the classroom (Bellia *et al.*, 2011b). Hence, daylighting is an energy saving strategy (Bellia *et al.*, 2011b) capable of saving cost and providing sufficient illumination in schools, especially with the insufficient power available in the country. Sufficient lighting improves reading performance and children's concentration in class (Barkmann *et al.*, 2012).

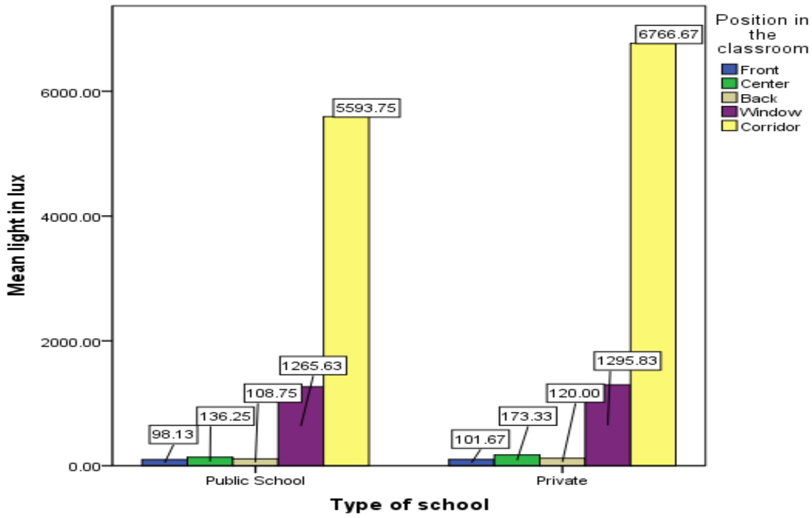

Figure 2: Mean light intensity at different positions in the classrooms

Table 2: Conformance of Lighting Illuminance (in lux) with the British and European Standards

Class	Lighting	EN/BSI15251 (300lx/0.8m)
Front	99.64	No
Centre	152.14	No
Back	113.57	No
Window	1278.57	Yes
Corridor	6096.43	Yes

Figure 3 shows the sound level at different positions of the classroom. There was neither any significant difference in noise level at different position of the classrooms (F(4,135)=0.511, p=0.728) nor between private and public schools (t(138)=0.269, p=0.789). However, noise level significantly increases from morning to afternoon (r=0.214, p=0.011). Noise was also not significantly associated with the class population (r=0.068, p=0.497).
Table 3 shows that the noise at every position in the classroom was more than the recommended level by the European/British, American and Brazilian standards bodies.

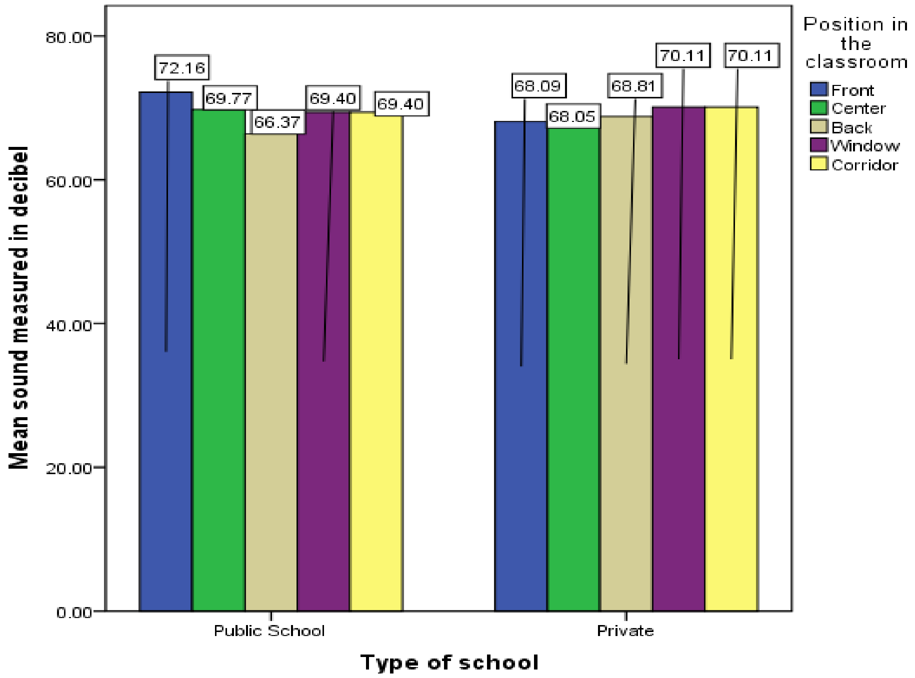

Figure 3: Mean level-A sound intensity in dB at different positions in the classrooms

Table 3: Comfortability and acceptability A-weighted acceptable sound level in each room based on the standards

Class	Noise level	Brazil (40dB)	EN/BSI 15251 30-40dB	ANSI/ASA S12.60-2010 35-55	EN/BSI 15251 Corridors 35-50dB	ANSI/ASA S12.60-2010 Corridors 45dB
Front	70.41	No	No	No	No	No
Centre	69.03	No	No	No	No	No
Back	67.41	No	No	No	No	No
Window	69.70	No	No	No	No	No
Corridor	69.70	No	No	No	No	No

Although the noise level in all the schools was above the recommended maximum comfort noise level of 40 dB(A), they are still below noise harmfulness level of 85dB (Augustyńska *et al*., 2010; Krüger and Zannin, 2004). Noise affects children's ability to understand lessons and also causes physical stress to the teachers (Krüger and Zannin, 2004). It is also the main factor responsible for teachers annoyance in school environment as teachers have to raise their voice (Augustyńska *et al*., 2010; Kristiansen *et al*., 2011). The effect can also be harmful to both teachers and children as it can also result in occupational disorders such as hearing loss and chronic voice disorders, fatigue, discomfort and hearing loss (Augustyńska *et al*., 2010). Already, voice problem has been reported to be more prevalent among teachers than other professions (Kristiansen et al., 2011).The high background and corridor noise degrades effective communication between teachers and pupils (ANSI, 2010). A major factor responsible for higher noise level in public school is their overcrowded population and the work duration (Kristiansen *et al.*, 2011). Unlike what was reported in another study (Kristiansen *et al*., 2011), noise was not associated with class population in this studies..

4. Conclusion

School environment in Kebbi is yet to conform to global standards. The noise and the temperature levels exceeded the comfort level that can aid learning while the amount of illumination in the classes is also lower than the recommended level. Although public schools have larger classrooms, they were overpopulated thereby making pupils in private schools to have more spacious classroom. While governments at all levels are making efforts to improve the quality of teaching and provision of more facilities, the desired improvement of learning condition of children should be holistic, by considering not just the quality of the teaching and learning process, but also ensuring that the school environment is also conducive and safe for learning. Ensuring a suitable learning environment for the children cannot be overemphasised because the school is the second most important facilities for children, after their homes. The environmental factors considered in the study are essential for schoolchildren's comfort and concentration during learning. The effect of these factors is not limited to their academic performance, but will go a long way in ensuring their safety and healthiness. Poor lighting can affect their sight and noise can affect their hearing ability later in life. During design stage, school designers should consider the orientation of the sun and proper dimensioning of the windows and other illumination to allow sufficient daylighting. Systematic view should also be employed in proffering solution to the problem as these variables also interact towards achieving human comfort. For example, while independently, closing of windows could be recommended as a solution to the high noise level, such steps would reduce the illumination and can increase the temperature in the room.

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