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Assessment of Illumination Levels in Large Educational Spaces: A Case Study of University of Ilorin Lecture Theatre

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ABSTRACT

Lecture theatre is one of the large educational buildings that requires adequate illumination to aid visual comfort and thus, academic performance of the students. This paper, on hourly basis, assessed the illumination levels of the 600-capacity New Science Lecture Theatre, University of Ilorin, Ilorin, Kwara State, Nigeria. Readings of illumination levels were taken using lux meter and analysed using Time series analysis. The results of this study showed that the average illumination level of the New Science Lecture Theatre for 19th October, 2019 is 120.5lux, which was far below the standard and international benchmark illumination levels of 500lux for lecture theatre. This study concluded that the lighting system in the 600-capacity New Science Lecture Theatre, University of Ilorin, Nigeria needs to be redesigned, so it can meet the standard and international illumination levels benchmark for the lecture theatres, and effectively performs its modern statutory functions, and aids the health and academic performance of the students.

Keywords: *Illumination level, Educational buildings, Lecture theatre, Academic performance, International benchmark.*

1.0 Introduction

Light is an important element that has major impact on building occupants. It is also very essential to human vision and general biological systems of humans. (Shishegar and Boubekri, 2016). Lighting design was primarily based on the concept of visual and economic needs of the building occupants. Lighting quality was not given major attention before, until when recent studies show connection between lighting and building occupants' health and well-being. This recently make lighting quality one of the major environmental concerns in architectural design (Bellia, *et al.*, 2011). However, despite numerous researches on lighting design, little attention is paid to lighting design and illumination in educational buildings. According to Shishegar and Boubekri (2016), poor lighting design in educational building can adversely affect the cognition and learning in students. Due to physiological effect of

lighting on human, inadequacy in light can reduce the student's learning ability (Edward and Torcellini, 2002).

Therefore, this study is set out to determine the illumination levels in large educational buildings, using the 600-capacity New Science Lecture Theatre in the University of Ilorin, Nigeria as a case study, and compare the illumination level gotten with the international benchmarks.

2.0 Literature Review

Light is basically produced from two sources; natural and artificial sources (Oyeleye, 2019). Natural light is produced from the sun, while artificial light is produced from the electric light fixtures. To achieve good lighting design in educational building, there should be a balance natural and artificial lighting, adequate for the visual tasks in the educational building (Barret and Zhang, 2009).

Liberman (1991), affirmed that visual stress can result to decrease in information processing and learning ability in students.

2.1 Measurement of Daylight in Indoor Spaces

In order to obtain suitable visual comfort in large educational buildings, two variables are needed to be measured:

i. Illuminance (E); and
ii. Daylight factor (DF).

Illuminance is the total illumination on a bright surface. It is regarded as the luminous flux. The standard unit for illuminance is lux which is lumens per square meter (lm/m^2) (Muhammad, *et. al.*, 2017). The illuminance of a space can, thus, be calculated using the formular below:

$E = F/A.$

Where;
E = illuminance of a surface (lm/m^2 or lx);
F = luminous flux incident on the surface (lumen); and
A = the area of the surface (m^2).

Muhammad, *et. al.* (2017), stressed further that daylight can be measured in two calculations:

i. Using luminous quantities (flux, illuminance), i.e by a set of outdoor conditions and calculating the resulting interior illuminances.

ii. Using relative values (the DF) that compare indoor to outdoor regarding illuminance. For a given position, this factor is constant under widely varying outdoor lighting condition.

The DF is the relation between the indoor illuminance at a point on working plane (E_i) and the outdoor horizontal illuminance (E_o) (Commission Internationale de I'Eclairage (CIE), 1970). Therefore, the formular for calculating DF can be written as follows:

DF = (E_i/E_o) x 100%

According to Muhammad, *et. al.* (2017), the DF can be affected by various parameters such as:

i. size and orientation of the glazing;
ii. the dimensions of the space;
iii. the reflectance of the surfaces; and
iv. the external obstruction.

During the day, a space with an average DF of 5 percent or more is considered well-lit and need no artificial lighting, while a space with an average DF of 2 percent or less needs more artificial lighting (CIBSE, 2002).

3.0 RESEARCH METHODOLOGY

3.1 Research Instrument

A hand-held lux meter was used as a research instrument to measure the illumination levels in the 600-capacity New Science Lecture Theatre.

3.2 Area of the Study

University of Ilorin is located in Ilorin-South Local Government Area in Ilorin, Kwara State, Nigeria. The 600 capacity New Science Lecture Theatre (NSLT) is located within the university. The six hundred capacity lecture theatre has a floor area of 1397.863m^2, with external dimension of 37.39m by 37.39m. The lecture theatre has a racked seating arrangement with the highest floor to ceiling dimension being 5.60m and the lowest dimension as 4.47m. The 600-capacity lecture theatre has projected aluminium windows, with each bay measuring 3m by 0.985m, having an area of 2.955m^2. Each side of the building has ten numbers of these windows. Windows to the lecture hall are located in the north and south elevations of the building. The walls are painted with cream colour emulsion paint and Amolar UPVC lining was used for the ceiling is made up. The artificial lighting system has forty-six compact fluorescent lamps (CFL) each of 85watts capacity. The New Science Lecture Theatre is bounded in the north by Postgraduate School building and old Faculty of Art building (47m), in the south by Microbiology building (32m), in the west by phase iv and phase v Life Sciences buildings (52m), the New Science Lecture Theatre is located 75m from the access road.

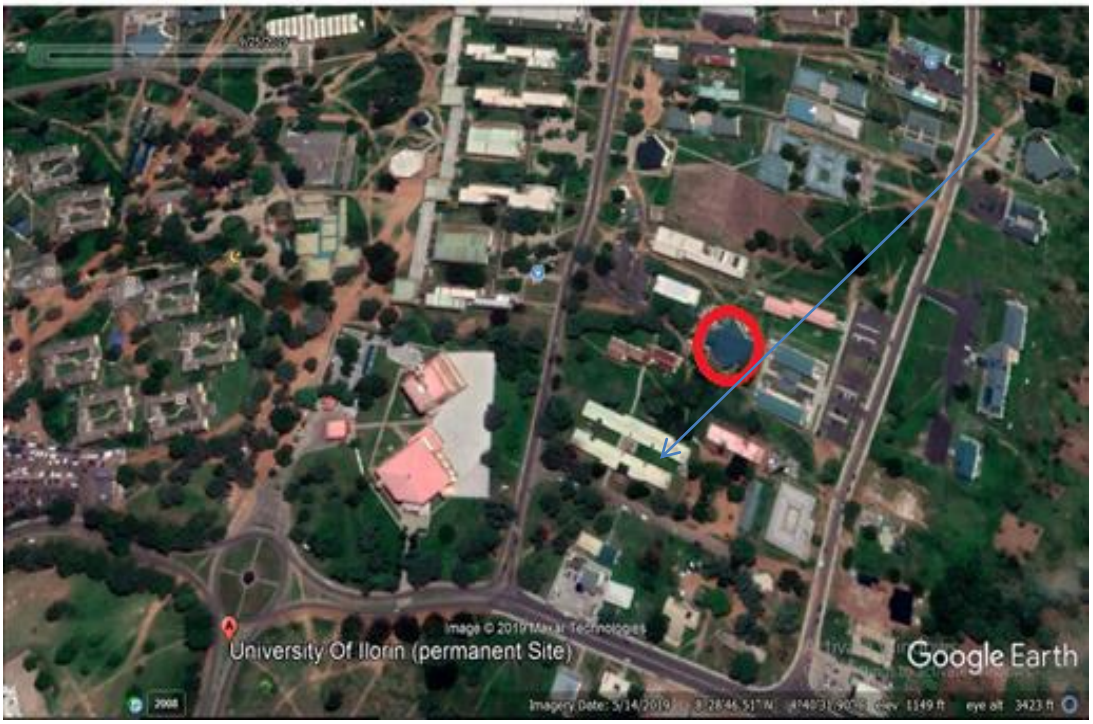


Plate 3.1: The Site Location Plan of the 600-Capacity New Science Lecture Theatre, University of Ilorin, Ilorin, Kwara State, Nigeria. (Source: Google Earth, 2019).

3.3 Data Collection Procedure

The illumination levels in the 600-capacity New Science Lecture Theatre (NSLT) was measured and readings were taken at interval of an hour from 7am to 7pm on a cloudless and very bright day, using a lux meter.

3.4 Data Analysis Procedure

The readings taken was analysed using time series analysis. The average of the readings of the lux meter was calculated to determine the average illumination level of the 600-capacity New Science Lecture Theatre, and then compared it with the IES illumination levels benchmark for lecture theatre.

4.0 RESULTS AND DISCUSSION

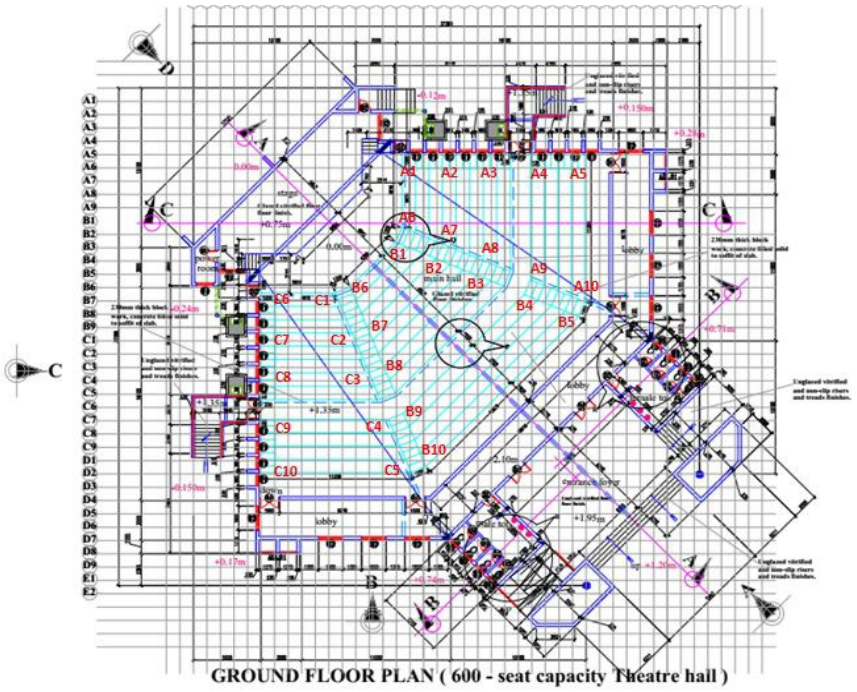


Figure 4.1: Illumination Level Assessment Positions of the 600-Capacity New Science Lecture Theatre, University of Ilorin, Ilorin, Kwara State, Nigeria. (Source: Researcher's field work, 2019).

5% of the capacity of the lecture theatre (600) was taken as the assessment points. The A1 to C10 are the thirty positions, which represents 5% of the lecture theatre capacity, where the lighting assessment was carried out. Each point of assessment was placed at the extreme ends of the reading tables of each aisle. The row for the assessment is systematically selected; at every fourth row of each aisle from the podium, including the first row. The lighting positions were the first row, fourth row, seventh row, tenth row and thirteenth row, all from the front of each aisle. The first aisle is represented with A; which range between A1 to A10, second aisle with B; which range between B1 to B10 and third aisle with C; which range between C1 to C10. Readings are taken in thirty various positions and the average illuminance of the lecture theatre (floor area of 1397.863m^2) was taken.

The illuminating Engineering Society, IES benchmark light level for a lecture theatre is 500lux (IES, 2017).

The measured illumination level hourly basis from 7am to 7pm is attached in the appendix (Table 1). The average illumination level peaked at 12:00pm with 208.1lux while the lowest

was at 7:00pm with an average illumination of 0lux (Figure 4.2). The overall average illumination of the lecture theatre for 19th October, 2019 is 120.5lux.

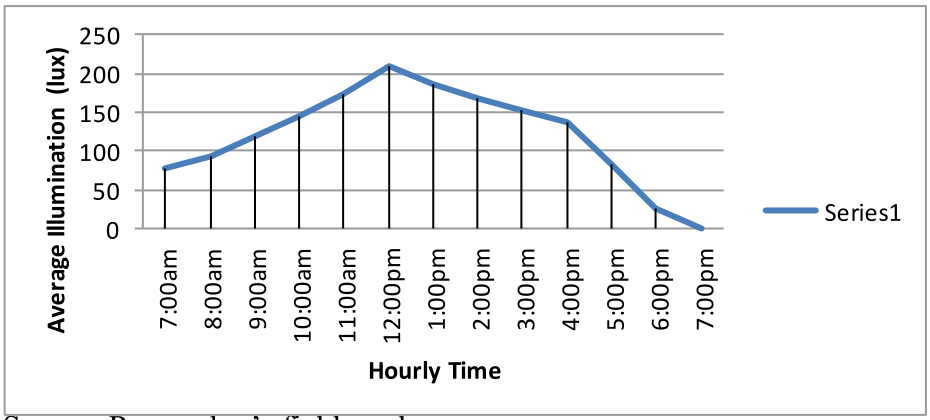
Time	Gridline	A	A	B	B	C	C	Avg. Illum. (lux)
7am	Row 1	95	83	78	73	79	87	82.5
	Row 4	92	74	68	65	72	87	76.3
	Row 7	88	71	63	62	67	82	72.2
	Row 10	97	82	74	72	75	93	82.2
	Row 13	79	67	65	63	63	72	68.2
								76.3
8am	Row 1	114	100	94	88	95	104	99.2
	Row 4	110	89	82	78	86	108	92.2
	Row 7	106	85	76	74	80	98	86.5
	Row 10	116	98	89	86	90	112	98.5
	Row 13	95	80	78	76	76	88	82.2
								91.7
9am	Row 1	148	130	122	114	124	135	128.8
	Row 4	143	116	107	102	111	140	119.8
	Row 7	138	111	99	96	104	127	112.5
	Row 10	151	127	117	112	117	146	128.3
	Row 13	124	101	105	99	100	114	107.2
								119.3
10am	Row 1	178	156	146	137	149	162	154.7
	Row 4	172	139	128	122	133	168	143.7
	Row 7	166	133	119	115	125	152	135.0
	Row 10	181	153	140	134	140	175	153.8
	Row 13	149	121	170	118	120	137	135.8
								144.6
11am	Row 1	214	187	175	164	179	194	185.5
	Row 4	206	167	154	146	159	202	172.3
	Row 7	199	160	143	138	150	182	162.0
	Row 10	217	184	168	161	168	174	178.7
	Row 13	179	145	204	142	144	164	163.0
								172.3
12pm	Row 1	278	224	210	197	215	233	226.2
	Row 4	247	200	185	175	191	242	206.7
	Row 7	239	192	172	166	180	218	194.5
	Row 10	260	221	218	193	202	209	217.2
	Row 13	215	174	245	170	173	197	195.7
								208.1
1pm	Row 1	250	202	189	177	194	210	203.7
	Row 4	222	180	167	158	172	218	186.2
	Row 7	215	173	155	149	162	196	175.0
	Row 10	234	199	196	174	182	188	195.5
	Row 13	194	157	221	153	156	177	176.3
								187.3
2pm	Row 1	225	182	170	159	175	189	183.3
	Row 4	200	162	150	157	155	196	170.0
	Row 7	194	156	140	134	146	176	157.7
	Row 10	211	179	176	157	164	169	176.0
	Row 13	175	141	199	138	140	159	158.7
								169.1
3pm	Row 1	203	164	153	143	158	170	165.2
	Row 4	180	146	135	141	140	176	153.0

	Row 7	175	140	126	121	131	175	144.7
	Row 10	190	161	158	142	148	152	158.5
	Row 13	158	127	179	124	126	143	142.8
								152.8
4pm	Row 1	183	148	138	129	142	153	148.8
	Row 4	162	131	122	127	126	158	137.7
	Row 7	158	126	113	109	118	157	130.2
	Row 10	171	145	142	128	133	137	142.7
	Row 13	142	114	161	112	113	129	128,5
								137.6
5pm	Row 1	109	89	83	77	85	92	89.2
	Row 4	97	79	73	76	76	95	82.7
	Row 7	95	76	68	65	71	94	78.2
	Row 10	102	87	85	77	80	82	85.5
	Row 13	85	68	97	67	68	77	77.0
								82.5
6pm	Row 1	33	27	25	23	26	28	27.0
	Row 4	29	24	22	21	23	29	24.7
	Row 7	29	23	20	20	21	28	23.5
	Row 10	31	26	26	18	24	25	25.0
	Row 13	26	20	29	20	20	23	23.0
								24.6
7pm	Row 1	0	0	0	0	0	0	0
	Row 4	0	0	0	0	0	0	0
	Row 7	0	0	0	0	0	0	0
	Row 10	0	0	0	0	0	0	0
	Row 13	0	0	0	0	0	0	0
								0
	Avg. Illum.							**120.5lux**

Source: Researcher's field work.

Table 4.1: Time series analysis of the average illumination in the New Science Lecture Theatre, University of Ilorin, Ilorin, Kwara State, Nigeria for 19th October, 2019.

The illuminating Engineering Society, IES benchmark light level for a lecture theatre is 500lux (IES, 2017).



Source: Researcher's field work.

Figure 4.2: Time series analysis of the average illumination in the New Science Lecture Theatre, University of Ilorin, Ilorin, Kwara State, Nigeria for 19th October, 2019.

5.0 CONCLUSION

The University of Ilorin 600-Capacity New Science Lecture Theatre, Ilorin, Kwara State, Nigeria was assessed for illumination levels. The study revealed that, as at 19th October, 2019, the average illumination was 120.5lux. The overall average illumination in the assessed lecture theatre was far below the Illumination Engineering Society (IES) illumination levels benchmark for a lecture theatre, 500lux (IES, 2017).

The study concluded that the average illumination level in the University of Ilorin 600-Capacity New Science Lecture Theatre, Ilorin, Kwara State, Nigeria was very low compare to the Illumination Engineering Society (IES) illumination levels benchmark for a lecture theatre. This might result to poor visual comfort in the lecture theatre under study. Therefore, the lighting system in the 600-Capacity New Science Lecture Theatre, University of Ilorin, Nigeria needs to be redesigned, so it can meet the standard and international illumination levels benchmark for the lecture theatres, and effectively performs its modern statutory functions, and aids the health and visual comfort of the users.

6.0 REFRENCES

Barrett, P. and Zhang, Y. (2009). Optimal Learning Spaces Design Implications for Primary Schools. Salford Centre for Research and Innovation in the Built and Human Environment, SCRI, England: Design and Print Group. University of Salford, Maxwell100, Salford, M145WT.

Bellia, L., *et. al.* (2011). Lighting indoor environment: visual and non-visual light sources with different spectral power distribution. Building and Environment, vol. 46, pp. 1984-1992. Retrieved January 9, 2019, from http://dx.doi.org/10.1016/j.buildenv.2011.04.007.

CIBSE (2002). Code for Lighting, Oxford: Chartered Institution of Building Services Engineers.

Edwards, L. and Torcellini, P. (2002). A Literature Review of the Effects of Natural Light on Building Occupants. National Renewable Energy Laboratory, Golden. http://dx.doi.org/10.21712/15000841.

Google Earth (2019). University of Ilorin, Permanent Site. 8º28'46.51¨N 4º40'31.90"E. Elevation 1149ft. Available at: http://www.google.com/earth/index.html. Accessed on 14th May, 2019.

Illuminating Engineering Society (IES) of North America (2017). Lighting Handbook. Available: http://epdf.pub/iesna-lighting-handbook.html.

Liberman, J. (1991). Light Medicine of the Future. New Mexico: Bear and Company Publishing.

Muhammad, A. B. O., *et. al.* (2017). Daylight Strategies for Architectural Studio Facilities: Literature Review. IOP Conference Series. Earth and Environmental Science. Retrieved January 4, 2019, from http://dx.doi.org/10.188/1755-1315/67/1/012025

Oyeleye, M. O. (2019). Illumination Evaluation of Lecture Theatre, Case Study of 1000 Seat Theatre, Federal University of Technology, Akure, Nigeria. European Journal of Engineering Research and Science, EJERS. Vol.4, No.7.

Shishegar, N. and Boubekri, M. (2016). Natural Light and Productivity: Analyzing the Impacts of Daylighting on Students' and Workers' Health and Alertness. Int'l Journal of Advances in Chemical Engg., & Biological Sciences (IJACEBS) Vol. 3, Issue 1 (2016) ISSN 2349-1507 EISSN 2349-1515. Retrieved January 19, 2019, from http://dx.doi.org/10.15242/IJACEBS.AE0416104

The International Commission on Illumination (CIE). CIE16, 1970-Daylight.