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ASSESSMENT OF NATURAL AND ARTIFICAL LIGHTING LEVELS IN LECTURE ROOMS (A CASE OF SUNYANI TECHNICAL UNIVERSITY)

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***Abstract*— Lighting association recommended lighting level suitable for lecture halls was brought to the frontage in this research. The study sought to measure the average light levels in the lecture halls and compare with the international lighting standard for the lecture hall. A handheld photometer was used to measure the illuminance of sixteen halls at 6 am and 7 pm hours for three different days. It was observed that the average illumination in the hall around 6 am was as low as 0.01Lux. The average artificial light level was also determined using the calculation method, and it recorded 300.8Lux. The results show that the lecture halls architectural design has contributed to the achievement of the desired illumination level in a day.**

***Index Terms*— illuminance, illumination, Lux, Lecture halls, Natural-light, Artificial-light**

I. INTRODUCTION

Lighting is an essential element in modern life with a high impact on three basic human needs: visual comfort to provide a sense of wellbeing, visual performance to allow the carrying out of visual tasks, even under challenging circumstances and for long periods, and security, reducing the risk of suffering an accident [1].

The presence of light is everywhere, and it is the first thing an individual experience on earth. Light almost controls everything in the universe; individual daily activities are scheduled around the existence of daylight. The waking call of almost all living things is light. Almost every activity is performed in a place occupied with light.

Adequate lighting in buildings is a primary functional requirement [1]. Architecture light levels are an objective assessment that determines the illumination of space, and visual comfort involves the perception of building users concerning such values a to how bright or how dark building interiors

Illuminance is governed by lighting standards specified by various regulatory bodies [2,3]. These standards are for guidance only, because depending on other factors, better visibility may be achieved with lower illumination, or even the standards mentioned may give inadequate lighting. Illumination indirectly affects visibility.

The quantity of light replicated from the object to be seen, i.e. its brightness level is of direct importance.

An increase in lumen output probably means an increased surface brightness. The brightness of the surface is mainly depending upon the incident illumination falling on the surface and also on its reflection factor.

The source of illumination can be natural (daylight) or artificial [2]. The natural source includes the sun, observable stars, radio stars, lightning, and, in fact, anybody that exists at a temperature over absolute zero. Reports in the area of medicine and biology reveal the benefits of daylight exposure to human wellbeing and physiology [4].

The artificial (human-made) sources of radiation include incandescent, and fluorescent lights, heaters, lasers, masers, radio and television antennas, radars, and X-ray tubes source include [5].

Despite the many regulations which aim to ensure a correct lighting level, in many cases it can be reduced or inadequate for users.

Literature reveals that bad lighting can cause eye strain, which may involve problems in the eyes (dryness, itching, or burning), headaches, tiredness, irritability, moodiness, among others [1,6,7]. Consequently, correct lighting allows the distinguishing of shapes, colours, and objects in movement and the appreciation of the relief, and furthermore, allow everything to be done quickly and without fatigue, that is to ensure visual comfort permanently.

Symptoms of this include headaches, lethargy, irritability and poor concentration. It is, therefore, crucial to estimate the level of illumination of premises to aid the functioning of machines as well as humans. Hence this paper seeks to examine the state of illumination in lecture hall among universities in the Bono region of Ghana; by measuring luminous intensity in lecture halls; and compare the measured values to the actual values and determine the error and propose a solution to remedy the error

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The remaining section of the paper is categorized into four sections. Section II gives a review of lighting standards and related studies. Section III outline the materials and methods used. Section IV discusses the results from the study, and section V presents the conclusions, recommendation and direction for future studies.

II. Literature Review

A. Standard illumination levels

The major international organisation responsible for harmonising the administration of standards, references, and technical information in the field of lighting is the Commission Internationale de l'Eclairage (CIE). The commission (CIE) has made available quite a lot of references for indoor lighting and has added to a united ISO-CIE standard ISO 8995-1 (CIE, 2001/ISO 2002) concerning indoor working places [8]. Table I shows the illumination standard by CIE. Illumination can be accessed using the following methods;

1. The use of light meters such as luxmeter, photometer or Vernier Emissions Spectrometer.
2. Survey to evaluate the comfort levels concerning lighting.
3. Used a data logger attached to a photovoltaic cell to record the times of light usage
4. The use of questionnaires to collect data.
5. The use of Retroreflectometer to collect data.

TABLE 1
RECOMMENDED ILLUMINATION LEVELS

Location	**Illumination Level Lux**
Classrooms and offices	500
Electronic components assembly	1000
Study room	300
Living room	300
Dining room	150
Sewing room	700
Bedroom	200

B. Related Studies

A survey by [9] aimed at determining average light levels in a 750-capacity lecture theatre using a Precision Gold N21FR, a handheld multimeter, it was discovered that the average illumination compares with international benchmarks was as low as 0.01lux [9].

The effect of indoor lighting on Students' learning performance was examined by [6]. The study concluded that in an environment where the lighting system is efficient, students tend to perform well academically.

In another work, the effect of illuminance in a classroom on students concentration performance was studied. The study revealed that a high percentage of students in non-green graded school nagged of stress, tiredness and sleepiness [7].

A survey investigating the performance of natural lighting of the natural learning environment in Cyprus was performed by [10].

The above works of literature point out the effect of poor illuminance, which justifies the need for an evaluation of the state of illumination in lecture halls within tertiary institutions in Ghana.

III. Materials and Methods

A. Instrument

A photometer was used as the main instrument for this study. The meter was used to measure the illumination levels. The photometer detects the light with a photoresistor or light dependent resistor. In the analysis of the light, the photometer will measure the light after it has passed through a filter or monochromator for determination defined wavelengths.

B. Measurement of lecture-hall illuminance

The focus of the current study is centred on the comparison of the measured lux values, and the standard lux values provide by the Illuminating Engineering Society of North America.

Three separate blocks (block G, F and HCIM) were randomly selected from the Sunyani Technical University. Ten (10) lecture hall from block F, thirteen (13) from block G and three (3) from HCIM block.

The illumination measurement was done in two-phase, thus during the day (8:00 am) to measure the natural lighting illuminance and in the evening (7:00 pm) to measure the artificial lighting illuminance, within a period of 30days.

The reading was taken in three different days in each hall, and an average was computed using equation (1). The calculated average was compared with the standard classrooms illumination levels discussed in section II and determine the errors.

$$Av = \frac{d1+d2+d3}{3} \qquad (1)$$

Figure 1 shows the flowchart for the comparison between measure (M) and standard (actual-value) (T) illuminance. The results from the comparison were then categorised into three different categories based on a comparison with the actual value (T). Thus if the M > T = illuminance level above standard, if M = T implies illuminance level equal standard and if M < T implies illuminance level below standard. The error (E) was computed based on the formula:

$$Error = T - M$$

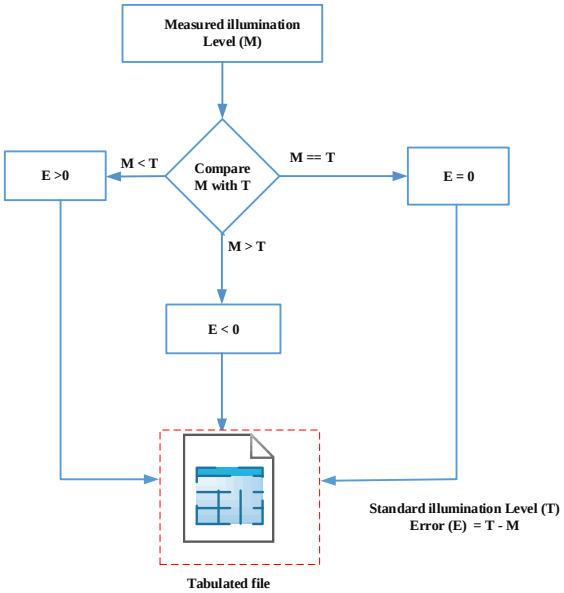

Figure 1. Flowchart for Comparison

IV. Results and Discussions

The measure illuminance was tabulated in an Excel file, and using Microsoft Excel; we analyse the data.

The study revealed the in lecture halls that had ceiling mounted tube lights as an artificial lighting source it providing well-distributed illumination on work surface. However, a lecture hall that had compact fluorescent lamps for artificial lighting source, the illuminance was not evenly distributed on the work surface the resulting in poor illumination.

The result further revealed that natural light was as low as 0lux around 6 am while the artificial light was 300.81lux. However, between the hours of 8 am to 9 am, natural light measured an average of 478.6lux, and artificial light measured 518.43 lux average at the same time. It was observed that the artificial light in the night was inadequate for teaching and learning activities in 91% of the lecture halls.

A. Artificial Lighting in Lecture Halls

Figure 2-5 shows the graph representation of the average luminance and their errors for artificial light illuminance. The results reveal that on an average the illuminance levels by artificial lighting in the lectures halls in blocks (G), (F) (HCIM) is excellent as compared with the acceptable value of illuminance in a classroom or lecture hall as discussed in section II. It implies that students studying in these halls with maximum daylight would not be affected with any poor illuminance related sickness such as headaches, irritability, moodiness and others. However, the effect of over-illuminance in all other rooms needs to be investigated. Again, it was observed that the illuminance in F7, G9, G11, did not meet the standard value; this we observed that some of the fittings in these rooms were not working. On the other hand, illuminance in the HCIM block was slightly below expected values, as shown in Figure 4 and 5. It was observed that these rooms size were twice that of the rooms in block G and F; however, the number of fitting was not twice that of G and F.

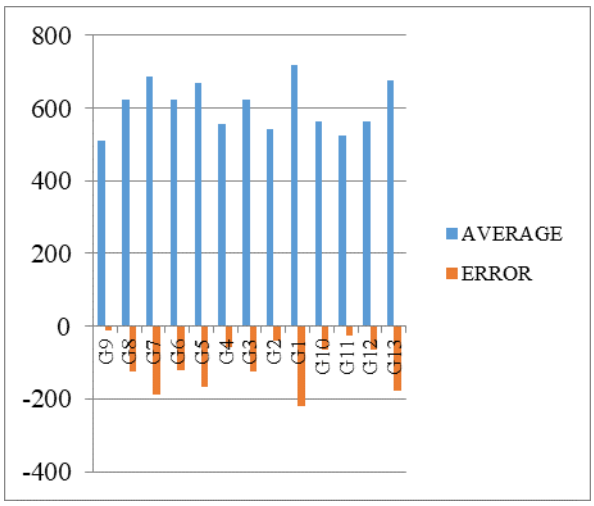

Figure 2. Artificial Illuminance in Block G

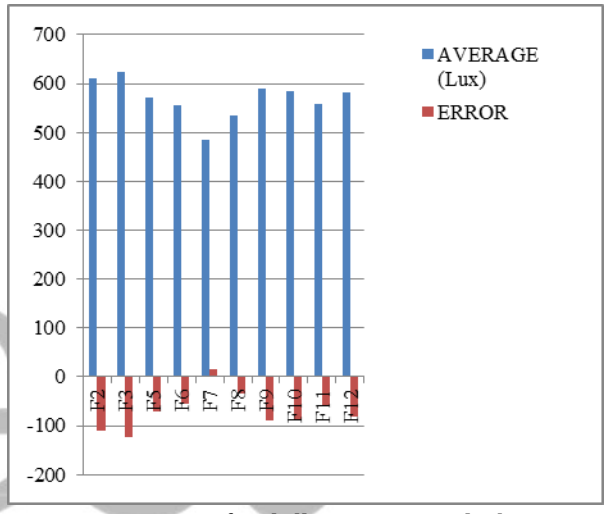

Figure 3. Artificial Illuminance in Block F

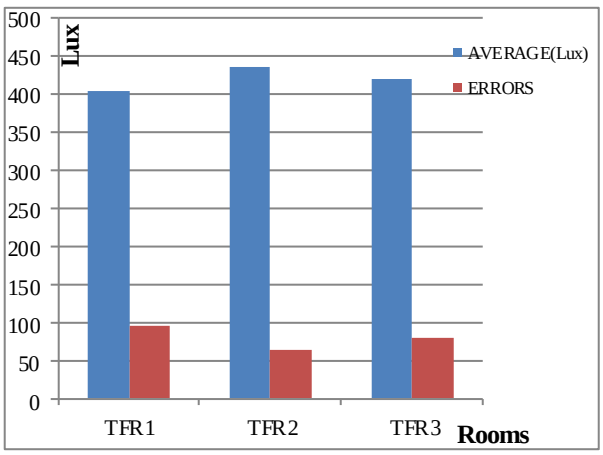

Figure 4. Artificial Illumination at HCIM block (Third Floor)

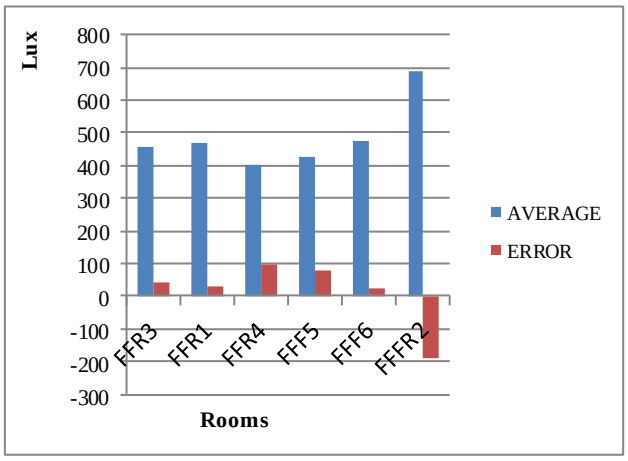

Figure 5. Artificial Illumination at HCIM block (First Floor)

B. *Natural Lighting illuminance in Lecture Halls*

Figure 6-8 shows the illuminance measure in HCIM block room (TFR1, TFR2 and TFR3), block G and block F during day time with all artificial lights OFF. The results revealed that the illuminance produces by the natural lighting was approximately the same as expected lecture room illuminance.

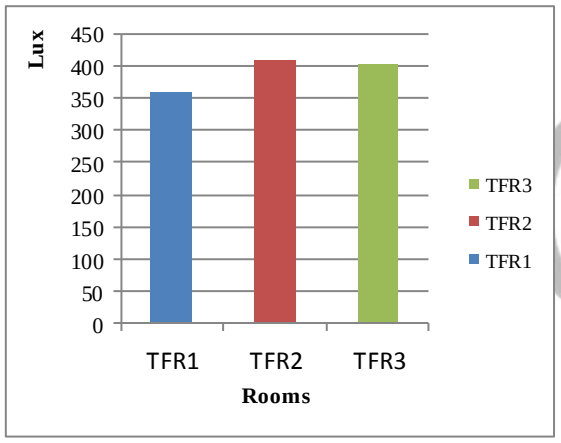

Figure 6. Natural Illuminance in HCIM Block

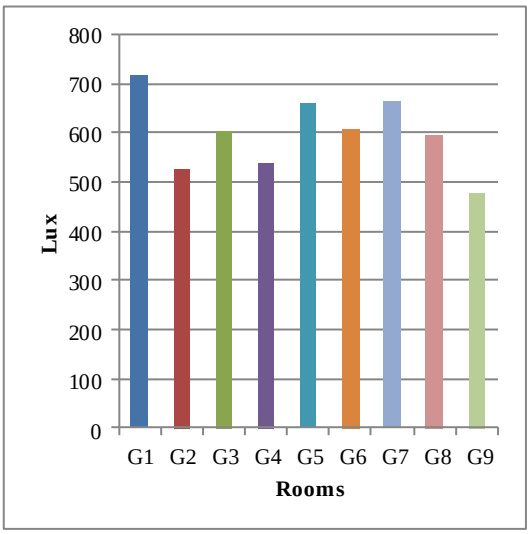

Figure 7. Natural Illuminance in Block G

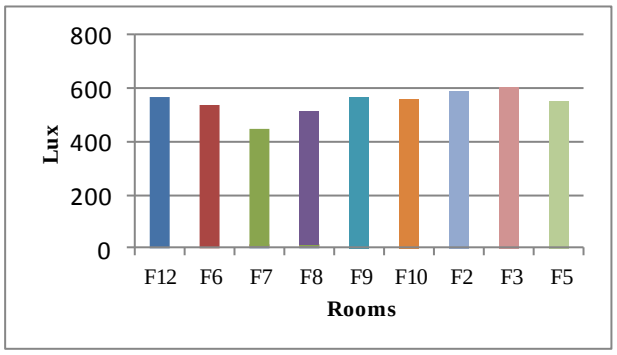

Figure 8. Natural Illuminance in Block F

V. Conclusion

This paper aimed to examine the quality of illumination in lecture halls by artificial and natural lighting. The result revealed that a high percentage of the lecturer room have illuminance bellows standard at nights when the natural light (sunlight) and earlier in the morning between the hours of 6:00 am to 7 am, this according to literature will affect students if they continue to study in those classrooms for a very long time. It was also observed that illumination design in most of the lecture hall was not based on any mathematical formula or calculation. Instead on the experience of the artisan that performed the electrical installation. Therefore it is recommended that the school electrical engineers and collaboration with the electrical and electronic department should redesign the illuminance in the affected rooms to maintain the lightening system to the standard. Future research work should include additional universities, lecture rooms and offices should be added to offer a better state of illumination in lecture rooms among universities in the country and further examine its effects on students academic performance.

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Conflicting interests

The authors of this paper declare no potential conflicts of interest concerning the research, authorship, and publication of this article

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