

Keywords: Illuminance; Visual performance; Optotype; First year students; Study room

Background Information

Light is a radiant energy that has the ability to cause not only humans but many living creatures to see by exciting light sensitive structures in the eye (retina in the case of humans) and creating a visual sensation. Light, which is basically that aspect of radiant energy to which the eye responds as a visual experience, is called *visible radiation* [19]. Only electromagnetic radiation with a wavelength between 380 and 760 nm is visible to the human eye [22]. Human beings are continuously bombarded by electromagnetic energy, including waves from radio transmitters, infrared rays from heat lamps and ultraviolet rays from the sun and quartz lamps, without receiving any visual sensation as a result of being in contact with these sources. It is only a portion of this

be said to be a system that assimilates a lot of information primarily visual. Thus visual performance should refer to the rate at which this visual information is assimilated. Inferred changes in speed and accuracy for different adaptation levels underlie the rationale for different illuminance levels recommended by national technical societies [19]. Visual performance is looked in this study under three categories which will be visibility, visual search and accuracy time and visual discomfort (fatigue). The goal in this study is to relate these categories under visual performance to illumination.

However it is important to note that illumination is not the only thing that affects visual performance. There are other variables that affect the visual performance of an individual apart from illumination. These include: light source, Character size, interline spacing and reading distance.

Light plays a significant role in creating a pleasant environment where students and teachers can interact and engage in the education process. Independent research has shown the benefits of good day lighting and of good artificial lighting to educational productivity in schools [14]. Proper lighting can enhance task performance, improve the appearance of an area, or have positive psychological effects on occupants.

Glare happens when one part of the visual scene is much brighter than the general brightness of the rest of the field of view [14]. A high source luminance, large source area, low background luminance and a position close to the line of sight all increase glare. Such glare can be of two types: disability glare and discomfort glare [14].

100 Hz modulation can adversely affect visual search performance even though subjects do not consciously experience it as flicker [14]. Establishing causative links between aspects of classroom environment and the factors mentioned is difficult, in part because of the practical and ethical difficulties in conducting controlled trials in classrooms [14].

Materials and Methodology

This study is a descriptive cross-sectional study of first year students in the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana for the 2020/2021 academic year.

The study rooms of selected campus halls were studied.

Inclusion Criteria: Students in first year located in the selected halls of the university were sampled for the study.

Exclusion Criteria: Students who are not in first year were excluded.

Sampling Technique: Random Sampling was used to select the Hall and its study room. Random sampling was used to select students from the selected hall in the university. Random sampling was used to select a hall room for the study.

Sampling Size: The sample size was 25 students randomly selected from the selected hall for the study.

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screen or print paper) under the various illumination levels

In addition, a rating scale with six items was administered to collect subjective rating. Accuracy was defined as the number of searched targets divided by the number of total targets. Subjective visual fatigue (visual discomfort) was determined by the total score of subjective rating of visual fatigue test which was administered to participants.

Statistical Package for Social Scientist (SPSS) software version 23.0 was used to analyse the data by way of Microsoft Excel in drawing graphs.

| | <i>Mean</i> | <i>Standard Deviation</i> | <i>Mean</i> | <i>Standard Deviation</i> | <i>Mean</i> | <i>Standard Deviation</i> | <i>Mean</i> | <i>Standard Deviation</i> |
|--|-------------|---------------------------|-------------|---------------------------|-------------|---------------------------|-------------|---------------------------|
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| Within Subjects Effect | | | | | | | | |
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Therefore the result for analysis of variance for the effect of illumination on accuracy with paper display was significant, $F(2, 48) = 4.244, p = 0.02$ [Figure 4]. These results suggest that the visual search time with paper was affected by the illumination levels. In fact visual search time with paper display decreased significantly with increasing illumination.

Visual Discomfort

The effect of illumination on visual discomfort was not significant

for the computer display [Table 5]. Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated, $\lambda^2(2) = 25.222, p < 0.05$.

Conclusion

The study found the effect of illumination on visual performance comparing reading on print paper and on the LCD screen of a laptop. Three parameters under visual performance were looked at: Legibility, Visual accuracy and search time and Visual discomfort.

These parameters were looked at under three illumination levels: Study room illumination, Hall room illumination and Sunlight Illumination (still in the study room but with only daylighting available). Average illuminance at desk level for the study room, hall room and sunlight illumination levels were 130 lux, 30 lux and 1440 lux respectively. From the results of the research the following conclusions were drawn:

All 25 participants passed the legibility testing at all illumination levels. Visual accuracy was affected by illumination especially on paper display. On paper display, visual accuracy increased with increasing illuminance levels being highest at 1440 lux illuminance. Concerning visual accuracy, participants performed better with paper display than with the LCD screen of a computer at all illumination levels particularly at 1440 lux (Sunlight Illumination).

Search time was also affected by illumination especially on paper display than on a computer LCD screen display. Generally on a paper display, search time decreased with increasing illumination. However participants were generally faster on the LCD screen of a computer than on a paper display in this study across the various illumination levels.

Participants were more comfortable reading from a paper across the various illumination levels. Participants experienced more visual discomfort with computer display especially at 130 lux and 1440 lux illuminance levels.

Thus we see a higher visual accuracy with paper display even at the lowest illuminance of 30 lux, a lower visual discomfort rating indicative of increased comfort with paper than on a computer screen even at the lowest illuminance of 30 lux and an increased visual search speed which decreased significantly with increasing illuminance. Visual performance generally increased with increasing illumination on paper display than on an LCD display.