

Artificial Classroom Lighting Effects on Secondary Schools Students Health in Nairobi County of Kenya

¹Calleb Magutu Oribo and, ²Peter Okemwa

1- Doctor of Philosophy Student, Department of Technology Education, P.O. BOX 1125 – 30100, University of Eldoret, Eldoret, Kenya.

2 – Professor, Department of Technology Education, P.O. BOX 1125 – 30100, University of Eldoret, Eldoret, Kenya.

Abstract:- Worldwide, there has been a challenge in having quality artificial classroom lighting. The purpose of this research was to evaluate artificial classroom lighting effects on public secondary school students' health in Nairobi County of Kenya. Twenty (20) secondary school principals, 100 teachers, 20 nurses and 409 public secondary school students were sampled for study. The study used three questionnaires which had been face and content validated to collect data. Reliability was determined using Cronbach's alpha of 0.822. The quantitative data was analyzed descriptively and presented in form of tables and a figure. The study found out that artificial classroom lighting in public secondary schools in Nairobi County of Kenya made students to suffer from eye itch, eye strain, visual impairment, headaches and other eye related sicknesses. The study recommended that artificial classroom installation should meet the required health standards.

Keywords:- Secondary School; Artificial Classroom Lighting; Health.

I. INTRODUCTION

Light directly influence every dimension of man's existence more especial human health. Light is a robust facilitator of visual routine and normalizes a multiplicity of bodily activities like sleep alertness, cognition and mood. Singh and Arora (2014) carried out a research on illuminance: its influence on learners' wellbeing in two public schools in Delhi-Nec and found out that natural lighting has a profound influence on the body. Besides the effects of illuminance, lighting of different color correlated temperatures ranging from 4000 K to 17000 K has a positive influence on children dental health, physical growth, school attendance, attentiveness and academic attainment. Harvard Health (2017) revealed that blue light greatly subdues melatonin emission, red light too subdues melatonin emission, however, it has a scanty circadian rhythm power swing. Kunz (2014) asserted that white illumination has more psychological influence as compared to a bright cool white light which subdues melatonin emission. Humanoid body's almost twenty-four-hour cycle is directed by hormonal rejoinders that are elicited by sunlight full-spectrum and light emitting diode lamps light, which is not the case with fluorescent lamps (Energy and Focus, 2015). Light has an extraordinary effect on human wellbeing than it is assumed. Luminous light of high correlated color

temperature of about 17000 K advances intellectual health, while inadequate artificial lighting lead to common health problems such as heart disorders, blood pressure and cardiovascular problems (Silvester and Konstantinou, 2010). Mott et al. (2012) reported that light is a robust facilitator of visual routine and normalizes a multiplicity of bodily activities like sleep, alertness, cognition and mood. They revealed that light is essential for cognition, enables secretion of vital hormones like cortisol and melatonin that are critical in a wellbeing rest-activity routines. Finally, they concluded that lights of diverse spectrums affect breathing rates, blood pressure, pulse rate, biorhythms, and brain activities.

II. STATEMENT OF THE PROBLEM

Despite the fact that technological advancements have greatly improved the quality of artificial lighting, most secondary schools' classrooms in Nairobi County of Kenya have insufficient artificial lighting that has caused students to suffer as they learn in the classrooms. Howard (2018) lamented that lighting facilities in education environment are much poorer than anticipated.

Conceptualizing the effect of the classroom design on students' wellbeing, attentiveness and academic achievement is vital because much of the learner's life is spent in the classroom (Singh and Arora, 2016). Since Schools play a pivotal role on the students' learning process, they should provide a good learning environment. Nevertheless, not much attention has been given to the study of the effects of artificial classroom lighting design on learners' well-being. Green schools offer safe, healthy, relaxed, and fruitful knowledge acquiring environs. Students' health is negatively affected when they learn in an uncomfortable environment due to poor lighting, heating, cooling and ventilation (Ibid, 2014).

III. RESEARCH OBJECTIVE

The objective of this research was to establish the effects of artificial classroom lighting on secondary students' health in Nairobi County of Kenya.

IV. LITERATURE REVIEW

Lighting plays a pivotal role on human health. A study by McGowen (2007) in selected Texas high schools that assessed the influence of school amenities on students' behavior, academic attainment, school attendance, and teacher turnover rate revealed that students who were instructed in classrooms that were naturally lit had better health than their peers who learned in classrooms without sufficient natural lighting. The extent of the biological effects on light is substantial (Kunz, 2014). Thurber (2009) asserted that light is the utmost powerful go-between that interacts with biological systems. Caballero-Arce et al. (2012) investigated lighting space habitats in order to find out the significance of desirable illumination of the space habitats and ocular impacts of light on people's physical and psychological wellbeing. The study revealed that light influences physical and intellectual wellbeing of human beings. The study likewise showed that warm white light with color correlated temperatures of about 3000 K enhances relaxation and promotes wellbeing. The study also found out that prolonged exposure to artificial lighting modifies human biological functions which influence intellectual states. A theoretical assessment of the efficacy of state-of-the-art light emitting diode desk lamp advanced by a Germany company, Kunz (2014) revealed that Lucra light emitting diode desk lamp had capricious biological impact on the suppression of melatonin. An example of lighting biological effects is the suppression of cortisol and melatonin in people who get exposed to different lighting spectrums (Sleegers et al., 2012). A study conducted by Mirrahimi et al. (2012) in Malaysia that assessed the effect of day lighting on the students' overall wellbeing and performance revealed that day lighting is an efficient method of providing healthy learning environment in schools. The study likewise found out that inefficient classroom day lighting cause discomposure, which is detrimental to students' mental and physical health. The study finally revealed that classroom natural lighting enhances students' mental health.

Light greatly influence human health than it is presumed (KAN, 2015). The extent of the biological effects of light are substantial especially artificial light whose quality may either have a positive or a negative effect on an individual's health (Kunz, 2014). Research has indicated that both natural and artificial lighting affect people's health. Numerical revelation disclose that some current artificial classroom lighting makes students to suffer from a variety of sickness. An experiment conducted by Harvard Health (2017) that compared the effects of six and a half hours blue light exposure against green light exposure of compatible brightness revealed that undesirable artificial lighting cause some types of cancer, heart disease, obesity and diabetes. In agreement with Harvard Health, Thurbar (2009) reported that human health problems have been linked to human exposure to light that inhibit melatonin emission which is linked with the incidence of certain breast cancers. Samani and Samani (2012) revealed that light arriving in a human eye has non-visual biological effect on the body especially people's biological clock such as sleeping and waking periods. They

argued that insufficient lighting controls lead to many ailments such as eye strain, musculoskeletal damages, reduced attention time and abnormally high body temperature. They reported that amongst ecological aspects light has precisely prevailing effect on people's wellbeing. They reinforced that unsuitable lighting and insufficient lighting control cause eyestrain and headache. Headaches, eyestrain and fatigue are the most common complaints of unsuitable lighting. Creating glare less lighting in the classrooms is vital because there is an increased integration of information communication technology where computers are the key infrastructure.

Energy Focus (2015) reported that when fluorescent light bulb explodes, people around the vicinity get exposed to mercury fragments which are health hazard. It cautioned that mercury gas in fluorescent bulbs produce high frequency radiation which damage skin and eyes tissues causing vision inability and jeopardizes health.

Boyce and Wilkins (2017) revealed that insufficient lighting at a task area, intense variation in light distribution in the task area, shades, concealing reflectors, glare and twinkle are conditions likely to cause visual discomposure. They advised that the use of high-frequency regulator paraphernalia on luminous lamps reduce the prevalence of eye strain and headaches. Kappel and Alanoly (2018) asserted that artificial light that flickers induce headache, fatigue, blurred vision, eye strain and distraction. Hopper (2017) asserted that fluorescent lamps are known for producing twinkle effect that cause visual disturbances and headaches. He added on that twinkle effect has been associated with tiredness, eyestrain, and decline in visual performance. A study by Winterbottom and Wilkins (2009) conducted across eleven secondary schools and six local education authorities in ninety (90) classrooms in United Kingdom found out that eighty percent (80%) of the classrooms lit with 100 Hz luminous lighting caused headache and visual inability. They advised the use of colored overlays which reduce symptoms of visual stress and headaches.

A study conducted by Morrow and Kanakri (2018) that scrutinized experimental study on the impact of highly associated color temperature LED and luminous illumination on learners in their learning environment found out that flickering fluorescent have biological effect like common discomposure, sickness, headaches, eye-strain, diminished visual search speed and output. Terekova et al. (2018) reported that shortcomings in lighting cause visual discomfort (vision fatigue) which in return cause burning eyes, headaches and conjunctivitis. Mott et al. (2012) reported that insufficient fluorescent lighting cause visual performance impairment and headaches. Singh and Arora (2014) advised that a well-designed lighting environment can alleviate eye-strain and increase visual stability. McCreery and Hill (2019) reported that insufficient controls of lighting can yield undesirable outcomes such as eye strain, weariness, reduced attentiveness period and ultimately poor student academic performance. The intent of this study is to bridge the gap by providing information on

the effects of artificial classroom light on boarding secondary school students’ health especially in an African setting and particularly in Kenya.

V. METHODOLOGY

This study was carried out through a survey research design because the researcher was engrossed with providing quantitative and numeric descriptions of a target population. The study was conducted in twenty (20) public boarding secondary schools in Nairobi County of Kenya. The population for the study included twenty (20) secondary school principals, one hundred (100) teachers, twenty (20) nurses and four hundred and nine (409) public secondary school students. All twenty (20) principals, one hundred (100) teachers, twenty (20) nurses and four hundred and nine (409) students were sampled to participate in the study. Purposive, stratified and simple random sampling techniques were used to select the sample for the study. Three questionnaires were used to gather data for the study. The first questionnaire was for teachers, the second was for nurses and the third questionnaire was for the students. The questionnaires were both open and closed ended and used a four (4)-point Likert scale. A pilot study was conducted in Kiambu County of Kenya and the questionnaires were analyzed which gave satisfactory internal consistency reliable coefficient value of 0.8001. The researcher obtained a research permit from the National Council for Science and Technology and Innovation (NACOST). The researcher also sought for permission from the Ministry of

Education Science and Technology and the Nairobi County Government which allowed him to collect data in the selected schools. Finally, researcher administered questionnaires to teachers, nurses and students. The questionnaires were administered to one hundred (100) teachers, twenty (20) nurses and four hundred and nine (409) students. In this study the Statistical Package for Social Scientists computer software was used to analyze data using descriptive and inferential statistics.

VI. LIMITATION FOR THE STUDY

Researcher foresaw a challenge in accessing relevant data. Some public secondary schools especially in the military camps were over shielded by military officials who claimed that they did not trust any civilian individual because of security reasons. The researcher got permission from the secondary school principals so as to be allowed to access information.

The researcher also foresaw possibilities of being denied entry into the public secondary school compounds by school watchmen. The researcher obtained a letter of authorization to access information in the secondary schools from the regional coordinator of education, Nairobi region.

VII. RESULTS

The study showed the students’ views on how artificial classroom lighting affected their health.

Item	Responses							
	Disagree		Tend to disagree		Tend to Agree		Agree	
	f	%	f	%	f	%	f	%
Experience eye strain	104	25	33	8	272	67	0	0
Experience eyes itched	104	25	33	8	272	67	0	0
Visited hospital due to eye problems	94	23	33	8	272	67	10	2
Had visual impairment	261	64	43	10	12	3	93	23
Experienced headache	94	23	84	21	221	54	10	2
Eyes felt dry	104	25	254	62	51	13	0	0
Used spectacles to read	316	77	0	0	93	23	0	0
Complained of eye aches	0	0	80	40	60	30	60	30

Table 1:- Students’ views on how artificial classroom lighting affected their health

Many students 272 (67%) tended to agree, 104 (25%) disagreed and 33(8%) tended to disagree that that they experienced eye strain when they read using artificial classroom lighting. A study by Samani and Samani (2012) that was conducted to establish the impact of classroom lighting on learners’ leaning achievement in the instructional environment from an acquaintance understanding viewpoint found out that undesirable illumination is likely to cause multiple complications like eyestrain. He advised that well lit environment can relieve eye strain.

Many students 272 (67%) tended to agree, 104 (25%) disagreed and 33(8%) tended to disagree that their eyes itched when they read using artificial classroom lighting. Many respondents 272 (67%) tended to agree, 104 (25%) disagreed and 33(8%) tended to disagree that students

visited hospital for eye problems. Many respondents 261 (64%) disagreed, 43 (10%) tended to disagree, 12 (3%) tended to agree and 93 (23%) agreed that they had visual impairment.

Many students 221 (54%) tended to agree, 10(2%) agreed, 94 (23%) disagreed and 84(21%) tended to disagree that they experienced headache when they read using classroom artificial lighting. This indicates that students in Nairobi Count experienced headache when they read using artificial classroom lighting. Inger et al. (2014) lamented that flickering lights have been shown to have detrimental effects on human such as headache and visual effects.

Many students 254 (62%) tended to disagree, 104(25%) disagreed, and 51 (13%) tended to agreed that

their eyes felt dry when they read using classroom artificial lighting. Many respondents 316 (77%) disagreed, 93(23%) tended to agree that they used spectacles when they read using classroom artificial lighting. Many respondents 80 (40%) tended to disagree, 60(30%) tended to agreed and another 60 (30%) agreed that the complained of eye aches when they read using classroom artificial lighting.

This analysis reveals that artificial classroom lighting in Nairobi County public secondary schools triggered eyes itch, caused headache and initiated eye strain. Mirriahim et

al. (2012) backs this finding by reporting that insufficient classroom lighting cause eye strain. They added on that insufficient classroom lighting is characterized by glare and flickering which cause headache and fatigue.

The following hypothesis was tested in the study;

H₀₁: There is no significant relationship between the effects of artificial classroom lighting and students’ health in Nairobi County of Kenya public secondary schools.

Item	Mean	SD	N
Visiting hospital due to eyes problems	2.4841	0.87187	409
Light color not being desirable for students’ eyes at night	2.4108	0.86743	409
Experiencing of eye strain	2.4108	0.86743	409
Students experience eyes itch	2.4108	0.86743	409
Experiencing headache	2.0244	0.73056	409
Eyes feeling dry	1.8704	0.60255	409
Classroom sections slightly darker than others	1.2543	0.43599	409
Light flickering	1.2005	0.40086	409
Light distribution uniformity	1.1491	0.35667	409

Table 2:- Rating of the top nine (9) effects of artificial classroom lighting on students’ health

As indicated in table 2 above, artificial classroom lighting factors relating to “hospital visit due to eye problems “(M=2.4841, SD = 0.87187) were the most prevalent artificial classroom lighting effects on students’ health.

The artificial classroom lighting factors relating to “lighting color not being desirable for the eyes” (M=2.4108, SD = 0.86743), “eye strain” (M=2.4108, SD = 0.86743), and “eye itch” (M=2.4108, SD = 0.86743) were more prevalent artificial classroom lighting effects on students’ health.

The artificial classroom lighting factors relating to “experiencing headache” (M=2.0244, SD = 0.73056) were the next prevalent artificial classroom lighting effects on students’ health.

The artificial classroom lighting factors relating to the “feel of a dry eye” (M=1.8704, SD = 0.60255) was the next prevalent artificial classroom lighting effects on students’ health.

The artificial classroom factors relating to “classroom sections slightly darker than others” (M=1.2543, SD = 0.43599) was the next prevalent artificial classroom lighting effects on students’ health.

The artificial classroom lighting factors relating to “lights sometimes flickering” (M=1.2005, SD = 0.40086) was the least prevalent artificial classroom lighting effects on students’ health.

To examine the effect of artificial classroom lighting on students’ health, the chi-square goodness-of-fit was applied to the scores obtained from the questionnaires. From the scores, the researcher tested whether artificial classroom lighting had an effect on student’s health. The research claim was that the artificial classroom lighting had an effect on students’ health that was observed against expected checklist. At $\alpha = 0.90$, degree of freedom of 4, the claim was tested and a critical value of 1.064 was determined.

At $\alpha = 0.90$, degree of freedom of 6, the claim was tested and a critical value of 2.204 was determined.

df	Item	Observed	Expected	O-E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
1	Experienced eye strain.	272	185	87	7569	40.91
2	Experienced eye itch.	272	185	87	7569	40.91
3	Visited hospital.	272	185	87	7569	40.91
4	Had visual impairment.	105	185	-80	6400	34.60
5	Experienced headache.	231	185	46	2116	11.44
6	Eye felt dry	51	185	-134	17956	97.06
7	Used spectacles.	93	185	-92	8464	45.75
Total		1,296				311.58

Table 3:- The Chi-Square source table of the results of the level of relationship between artificial classroom lighting and students’ health(Source: Author, 2020)

Decision: The decision rejected that claim since $311.58 > 2.204$. From the test results, there was enough evidence to reject that claim that there is no significant relationship between artificial classroom lighting and students' health. Therefore, there was a significant effect of artificial classroom lighting on students' health in Nairobi County public boarding secondary schools.

Figure 1 shows the observed graph is very much below the expected. The gap between the two graphs shows how the results of the Chi-squares test for goodness-of-fit-test is not a good fit.

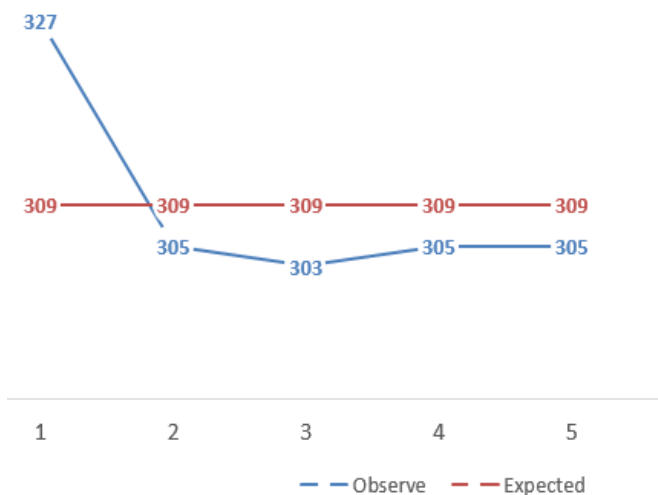


Fig1:- Results of the Goodness-of-fit for artificial classroom lighting effect on students' health.

NOT GOOD FIT

From this analysis we find that insufficient artificial classroom lighting in Nairobi County of Kenya affected the student's health negatively because it made them strain when they read, their eyes itch, experience headache and some students developed visual impairment which forced them to put on spectacles to be able to read. This indicated that student who read using insufficient classroom artificial lighting suffered from lighting related health problems.

VIII. DISCUSSIONS

The study assessed the impact of artificial classroom lighting on secondary school students' health. In the collection of data, the study used principals who were secondary school administrators, teachers who instructed the secondary school students, nurses who were in charge of secondary school students' health and the students who learning using artificial classroom lighting. In the analysis the results established that artificial classroom lighting in Nairobi County of Kenya public secondary schools made students to suffer from eye itch, eye strain, visual impairment, headaches and other eye related sicknesses. This is in tandem with Samani and Samani (2012), Inger et al. (2014), Mirrahim et al. (2018), Kappel and Alanoly (2018) and Morrow and Sanakri (2018) who unanimously agree that inadequate artificial classroom cause a number of light related ailments.

The results exposed that there was a positive significant effect of artificial classroom lighting on students' health in Nairobi County public boarding secondary schools. This is in agreement with Inger et al. (2014) who indicated that there is a significant effect of artificial classroom lighting on students' health.

IX. CONCLUSION

This study concluded that artificial classroom lighting in Nairobi County of Kenya public secondary schools was not good for students' health because it made them to experience eye itch, eye strain, develop visual impairment, have headaches and suffer from other eye related sicknesses.

RECOMMENDATIONS

The study recommends the following;

1. The government and Ministry of Health to ensure artificial classroom lighting installed in secondary schools provide an illumination that ranges between 240 lux and 500 lux since it deters lighting characteristic which cause lighting health related problems.
2. The government to enforce the installation of pendant luminaires in secondary school classrooms since they distribute light in the classroom uniformly which create a good learning space and prevent the learners from undesirable lighting sources which cause light related sicknesses.

REFERENCES

- [1]. Boyce, B. and Wilkins, A. J. (2017) Visual discomfort indoors. *Highlighting Research Technology*, 50, 98 – 114.
- [2]. Caballero-Arce, C., Vigil-de Insausti, A. and Benuoch-Marco, J. (2012) Lighting of space habitates: Influence of colour temperature on a crew's physical and mental health. *42nd International Conference of Environmental Systems 15 -19 July 2012, San diego, California*.
- [3]. Energy Focus (2015) LED Lighting sets the new standard in schools improving health, safety and performance in classrooms with a simple switch. [Online] Available: <http://www.energyfocusinc.com/> (July 14, 2016).
- [4]. Harvard Health (2017) Blue light has a dark side. *Harvard Health*, 1 – 2.
- [5]. Hopper, D. (2017) *The Impact of Fluorescent Lighting in Children: An Overview*. Amason. Australia. Dabbie Hopper Publishers.
- [6]. Howard, J. (2018) How just the right lighting may improve learning in classrooms. [Online] Available: [http://www.lightage.lighting/wp/wp-content/uploads/South%20Korean%20Research .pdf](http://www.lightage.lighting/wp/wp-content/uploads/South%20Korean%20Research.pdf) (January 10, 2018).
- [7]. Singh, P. and Arora, R. (2016). Classroom Illuminance: Its impact on Students' Health Exposure & Concentration Performance. *Research Gate, International Ergonomics Conference HWWE December 2016, At Guwahati, India, 1 – 5*.

- [8]. Inger, R, Bennie, J., Davies, T. W. and Gaston, J. K. (2014). Potential biological effects of flickering light. *Open Access Journal*, 9 (15) pmc 4038456, 1- 7.
- [9]. Kappel, A. L. and Alanoly, Y. (2018) Fighting flicker: The effect of flicker in the classroom. *Energy Focus*, April 24, 2018, 1 - 34.
- [10]. Kunz, D. (2014) Biological effects of LUCTRA LED desk lamp.[Online] Available: https://www.luctra.eu/fileadmin/luctra/media/documents/INTELLUX_Final_Report.pdf(January 10, 2018).
- [11]. McGowen, R. S. (2007) *The impact of school facilities on student achievement, attendance, behaviour, completion rate in selected Texas high schools*. A Dissertation Submitted in Partial Fulfilment of the Requirements for the Award of a Degree of Doctor of Philosophy to the Office of the Graduate Studies, Texas A & M University.
- [12]. McCreery, J. and Hill, T. (2019) *Illuminating the Classroom Environment*. [Online] Available:http://www.lightingassociates.org/i/a/2127806/f/tech_sheets/illuminating_the_classroom_environment.pdf (April 26, 2019).
- [13]. Mirrahimi, S., Ibrahim, L. M. and Surat, M. (2012) Effects of day lighting on student health and performance. *MDPI*, 1-15.
- [14]. Morrow, B. L. and Kanakri, S. (2018) The impact of fluorescent and LED lighting on students attitude and behavior in classroom. *Advances in Pediatric Research*, 5 (15). DOI: 10.24105, 1-12.
- [15]. Mott, M. S., Robinson, D. H. Walden, A., Burnette, J. & Rutherford, A. S. (2012) *Illuminating the Effects of Dynamic Lighting on Student Learning*. SAGE, DOI: 10.1177/2158244012445585, 1- 9.
- [16]. Samani, S. A. and Samani, S. A. (2012) The Impact of Indoor Lighting on Students' Learning Performance in Learning Environments: A knowledge internalization perspective. *International Journal of Business and Social Science* 3 (24),127-136.
- [17]. Silvester, J. and Konstantinou (2010) Lighting, well-being and performance at work. *Philps*, 1-36.
- [18]. Singh, P. and Arora, R. (2016) Classroom illuminance: Its impact on students' health exposure and concentration performance. *Research Gate*. International Economic Conference. HWWE, December 2016, At Guwahati, India, 1- 5.
- [19]. Slegers, P., Moolenaar, N., Galetzka, M. and Van der Zandenc, B. (2012). *Lighting and Student Concentration*. University of Twente, Twente, The Netherlands. Netherlands, 1-39
- [20]. Terekova, I., Lukacova, D. and Banesz, G. (2018) Quality assessment of university classroom lighting: A case study. *TEM Journal*, 7 (4), 829 – 836, ISSN 2217 -8309, Doi: 10.18421/TEM 7, 1 – 21.
- [21]. Thurber, J. (2009) Artificial light in the environment. *The Royal Commission of Environment Pollution*,1-39.
- [22]. Winterbottom, M. and Wilkins, A. (2009) Lighting and discomfort in the classroom. *Journal of Environmental Psychology*, 29, 63 – 75.