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EXPLORATION OF ARTIFICIAL LIGHTING TOWARDS STUDENTS PERFORMANCE

Dr. ANANTHAN VALITHERM

UNIVERSITI TUNKU ABDUL RAHMAN

Abstract

The artificial lighting in the interior is the key elements shaping the visual environment and health aspects. The purpose of this study is to identify the influence of indoor lighting on students learning performance within learning environments from knowledge internalization perspective. This study is a comprehensive review of literatures base on the influence of indoor lighting on people's productivity and performance especially students learning performance. The result that comes from this study shows that it is essential to improve lighting in learning environments to enhance students learning performance and also motivate them to learn more. In this study the researcher utilized survey and measured the influence of lighting on students learning performance. This study found significant impact between lighting quality and students learning performance. This finding is also supported by references from experts.

Keywords: Lighting, Students, Illumination, Mood, Education

Introduction

Many elements have affected into environments, and the environments have directly affected people. Well-designed environments make people happy and energize and vice versa. These elements start with building structure and shape, and complete with color, light, outside viewing and furnish. Sometimes, the influence of light in the environment is much more than other elements.

The impact of lighting conditions on the emotions and performance of space users is gaining greater importance in our urban societies. While large resources are allocated for well-designed spaces with the right choices of lighting conditions, there is little scientific evidence that supports these choices. Although the literature on light is extensive, it does not present a uniform set of findings for a consistent perspective on the influence of interior lighting.

Reported effects of either illuminance or spectral composition on mood have been dismissed by some and viewed as problematic by others as a consequence of habituation effects or complex interactions with other variables. At an empirical level, the prevailing literature contains a mix of contradictory evidence of effects on mood from lighting. This paper attempts to structure and to provide a framework for some of these contradictions on the basis of recent experimental studies.

For the purpose of this paper, mood or affect is defined as the core feelings of a person's subjective state at any given moment and is not necessarily about anything. It can be distinguished from emotion, which may have identifiable causes and is more variable, less intense and less transient than mood.

Problem statement

Many people spend the majority of their time in the work or learning places. So, good environmental designing in school and universities is a kind of stimuli for students and even teachers to have better performance. Good lighting in learning places enhances users here (students) performance and enhance the overall performance. But anyhow many designers fail to follow this rule of creating better and suitable lighting design. As stated by (One workplace, 1999; Lyons, 2001) poor lighting and the lack of attention to improve the lighting facilities or using daylight are critical problems that many organizations and learning environments are faced with. This proves that lighting have majors issues in interior spaces for students and working adults.

Research Aim

The research aim is to highlight the needs of lighting design to meet the requirement of the user's vision form physical to psychological. Some people believe that lighting itself has no effect on their performance. Some researchers also argue lighting has no effect on people's mood or performance. But, in the other hand many people believe that lighting in environments has direct effect on their mood and it can change their performance as well. For instance, most of people have spent some of their time in buildings that may feel sick and uncomfortable, and they naturally desire to escape from that uncomfortable environment. That could refer to the poor designing or insufficient lighting quality. There is a kind of stress on people's body that can lead

to disease or slow breakdown of biological function. The important point is that the human body wishes to be healthy, and for having a very great physical and mental power it is necessary to have appropriate environment. Each cell in human body is separately able to sense and respond correctly to both positive and negative influences in environments (Rice, 2010). In fact, people have the skills in their bodies to know when a place is good or bad for them. However, sometimes the negative stresses that people experience are slighter and less noticeable or clear to them. As a result, Activation, arousal, and stress are three mental reactions that consider to lighting (Rice, 2010).

Unsuitable lighting can be the cause of many problems, such as eyestrain to other graves musculoskeletal injuries. Light arriving in human eyes has an essential non-visual biological effect on the human body, impacts human health, well-being and efficiency (One work place, 1999). Poor lighting has common exhibit on students or other people as well as: red or bloodshot eyes after reading, be uncomfortable and fidgeting during reading or close work activities, skipping words or lines while reading or writing (Johnson, 2011). Well-designed lighting environment can relieve eyes strain, speed up the recognition of things, and increase visual stability or durability.

Definition of Lighting

Lighting is a fundamental feature of the designing building environment. Good lighting should be comfortable for all building users. With the modern technology designing a lighting system to meet all requirements of an environment is possible (Bright, 2009). Environment illumination is very important for determining the user's well-being and productivity. Illumination is a critical area that needs more attention from educators, administrators, designers and maintenance teams. Illumination is not only about electric light it also consist of direct natural light, indirect natural light, and indirect artificial light and reflected light, as well as the control of all light resources (Fielding, 2006; John & Timothy, 2005; Lieberman, 1990; One workplace, 1999).

Variable light applies a potential advantage in indoor office accommodations with respect to subjective or emotional mood (Hoffmann, Gufler, Griesmancher, Bartenbach, & Canazei, 2008). Controlled daylight and appropriate artificial illumination needs to be carefully addressed in schools as well because lighting is critical to the quality of students' performance (John & Timothy, 2005).

Types of Lighting

There are three main types of interior lightings, which is ambient light, also known as general lighting, task light, and accent light.

Ambient Light (General Lighting)

Ambient lighting provides an area with overall illumination. Also known as general lighting, it radiates a comfortable level of brightness without glare and allows you to see and walk about safely. In some spaces such as laundry rooms, the ambient lighting also serves as the primary source of task lighting. It can be accomplished with chandeliers, ceiling or wall-mounted fixtures, recessed or track lights and with lanterns mounted on the outside of the home. Having a central source of ambient light in all rooms is fundamental to a good lighting plan.

Task Light

Task lighting helps you perform specific tasks, such as reading, grooming, preparing and cooking food, doing homework, working on hobbies, playing games and balancing your checkbook. It can be provided by recessed and track lighting, pendant lighting and under the cabinet lighting, as well as by portable floor and desk lamps. Task lighting should be free of distracting glare and shadows and should be bright enough to prevent eye strain.

Accent Light

Accent lighting adds drama to a room by creating visual interest. As part of an interior design scheme, it is used to draw the eye to houseplants, paintings, sculptures and other prized possessions. It can also be used to highlight the texture of a brick or stone wall, window treatments or outdoor landscaping. To be effective, accent lighting requires as least three times as much light on the focal point as the general lighting surrounding it. Accent lighting is usually provided by recessed and track lighting or wall-mounted picture lights.

The Importance of Lighting

Learning places illuminating plays an especially critical role because of the direct relationship that good lighting and students performance have (Jago & Tanner, 1999). In fact, good lighting is very essential for any spaces that planned for formal media presentation and training, or intended to support teamwork or individual. People need enough and appropriate lighting system for reading or other visual tasks.

Functionality

One major role of lighting in the interior setting is functionality. Lighting needs to serve a purpose, or it simply wastes electricity. Chandeliers are not only used in large, open foyers, entryways and rooms because of their centrally themed placement but also because they provide excellent illumination for the room. Wall lights add length and size, visually, to an entryway hall, as well as light the way. Consider the style of lighting you want to ensure you get the best

directional or luminescent type for the setting. Look into task-specific lighting for desks and other work areas where functionality is more important than overall room illumination.

Directional Lighting

The lighting in a room either provides illumination for the entirety of the room, or it highlights very specific elements. Track lighting is the perfect example of positional lighting. Hung from the ceiling, the adjustable necks and lamps can be pointed at specific elements, such as a wall painting, the vase of flowers on an entryway table or the bar top or kitchen island. Consider mounting them on the walls, also. Special picture and mirror frames also have built-in lighting to highlight specific areas on a wall. Recessed lighting can be used in floors and ceilings to create vertical beams of light as opposed to an overall glow from central light fixtures hanging from a ceiling.

Sustainability

Sustainability is another important factor when considering the design of light in a space. Daylight is free and comes without electricity bills attached, and also has many benefits to occupants of an interior space. But daylight cannot be our only source of light, so how do we light up our spaces in an environmentally responsible way? There are many energy efficient lighting options out there to choose from. These are ever evolving and improving in a response to our more sustainably minded modern society. From fluorescent, to LED, to high pressure sodium; there is a suitable solution for every situation. We feel that it is very important that the functionality of the light source be considered first with the effective means of achieving this following. LED are very popular in today's market, but by no means are they the right solution to every lighting problem.

The impact of Lighting towards Human Activity

The visual environment affects a learner's skills to observe visual stimuli and affects his or her mental manner, and then, performance. The fact is if students have motivation in their school's interior environment, they would be more academically successful (Fielding, 2006; Pulay, 2010). The positive effect of lighting on students' learning performance occurs if it is designed correctly. According to Pulay (2010) cited in Benya (2001) explained "A well-lit classroom includes glare control, balanced brightness, higher reflectance ratings, and accent on the focal wall." Students must read many different surfaces, like papers or they should look on computer monitors. So they often have to shift their gaze from "heads up" to "heads down," therefore appropriate high-quality illumination is very critical and important (Pulay, 2010).

Visual Performance

When people can see the task clear definitely they work and perform that better. Visual performance does not have clear deification and importance in all tasks. Some tasks do not need much light in order to be performed well visually.

Visual Comfort

By remove or decline discomfort glaring the performance will increase because concentration will enhance.

Interpersonal relationship

When people can see each other better they can have better communication and more cooperation.

Productivity and concentration

Places where our brains need to be stimulated the most such as schools and office buildings are always brightly lit. The most prevalent source of light in these locations is often fluorescent, due to cost and energy efficiency. However spending excessive time solely in harsh artificial light can cause you to start to feel nervous and uneasy. Occasionally libraries tend to use "warmer" bulbs to try to build a more comfortable reading environment. To optimize a creative space, try dimming your lights a little, then adjust your lights to make them brighter when you need to focus.

Decision making

Studies suggest that emotions are experienced more intensely under bright lights. So, fictional detectives interrogating suspects under bright, harsh lighting, to get to the truth, may have really been on to something. So if you are buying emotional products, such as flowers or an engagement ring, check to see if the store has their light as bright as possible. Contrary wise, dimming the lights reduce emotionality in everyday decisions.

Research Method

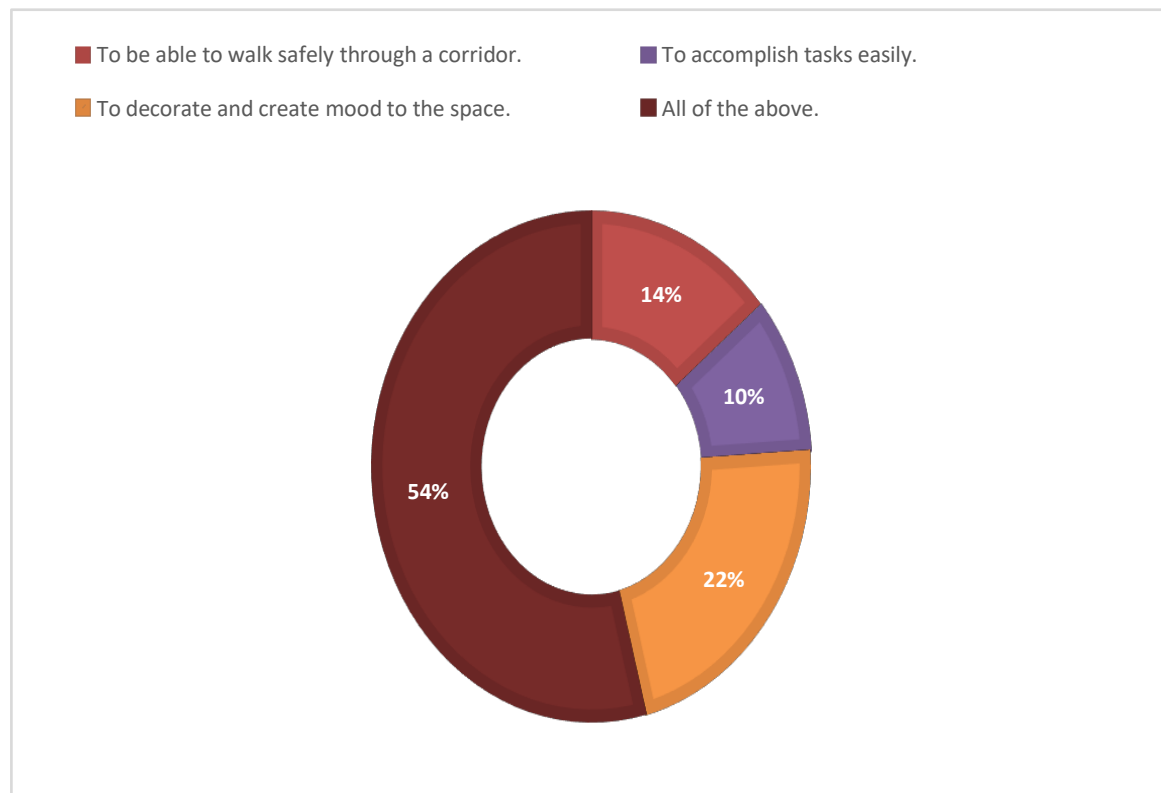
Data is collected using sources from journals, such as (Samani 2012), (Knez 1995), and (McCloughan 1998) after finding out what are the targeted criteria for this study. For better understanding of the topic, literature study was carried out in the above about the background, the aim and objectives of the research. Data is collected and recorded through survey using the convenience sampling and snowball sampling. Convenience sampling (also known as availability sampling) is a specific type of non-probability sampling method that relies on data collection from population members who are conveniently available to participate in study.

Facebook polls or questions can be mentioned as a popular example for convenience sampling. While Snowball sampling (also known as chain-referral sampling) is a non- probability (non-random) sampling method used when characteristics to be possessed by samples are rare and difficult to find. This sampling method involves primary data sources nominating another potential primary data sources to be used in the research. In other words, snowball sampling method is based on referrals from initial subjects to generate additional subjects. Therefore, when applying this sampling method members of the sample group are recruited via chain referral.

There will be a list of 10 questions in the questionnaire. Data will be collected from only high school students. Due to the big amount of students, the survey will only focus on 40 students. Researcher did the survey through Survey Monkey, which is a website that conduct free surveys. Researcher sent the questionnaire out to 6 high school students. The targeted age is age 15 years old to 17 years old. Researcher track down the number of responses every day to make sure have met the requirement. After completing the collection of questionnaires of 51 respondents, data will be recorded in Microsoft Excel and frequency analysis will be conducted.

Analysis

Base on your personal judgment, what is the importance of interior lighting?



There are 54 percent of students, which is the highest voting among all answers that chose the last answer, which is all of the above, which mean most of them agree with all the answers given above.

To walk safely through a dark corridor, the most important thing is to have some artificial light in that area to give them a clearer visual to walk safely without running into something or another person. Although there are some windows along the corridor and might be enough brightness during day time, but there are no natural light during the night, so that is the use of artificial light, is to back up when there is no natural lighting.

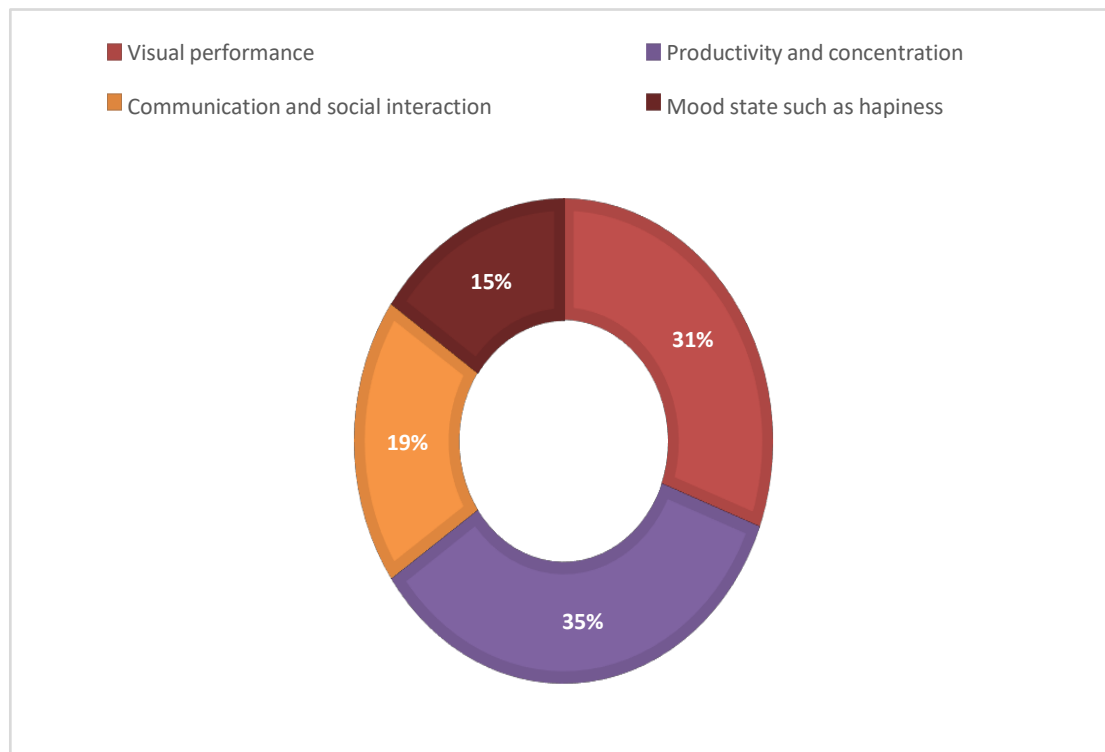
Artificial light not only distribute brightness, but also creates mood to the space. There are also several coolers of LED lighting in current market that is usually used in interior design by an interior designer to add different mood into the space, doesn't matter it is a school, residential, or commercial. Colored LED lighting usually creates mood without users to notice the color of lighting in the space. They just feel comfortable hanging out in the space. With simpler explanation, bringing in white light and warm light into the discussion. Supermarket like Tesco, Giant, Cold Storage and etc. usually use bright white light to brighten up the supermarket because it is important to retain the color of fresh products such as vegetables, fruits, meat, fish etc. as customers evaluate the freshness of the food by looking at the color and first impressions. Whereby places that use warm light like high end restaurants and etc. because sitting under warm lighting is much more comfortable than white lighting because white light would be too bright and might feel uncomfortable.

People are drawn to light (Taylor & Sucov, 1974). A second aspect handles on a more product-based level, which in turn also influences people's behavior light can draw attention to products (LaGuisa & Perney, 1974); Under bright lighting conditions products are more often examined and touched than under dim lighting conditions (Areni & Kim, 1994; Summers & Hebert, 2001); lighting influences the attractiveness of products in a store (Magnum, 1998). So, products under high light levels were found to be more appealing than products under lower light levels with the same spectral distribution.

The only way to accomplish tasks easily is to have appropriate lighting in an appropriate space. Like having an under cabinet lighting, table lamp, or floor lamp in desired space while doing certain tasks like reading, cooking, doing homework and etc. By installing these unimportant lighting like how people looks at them to help to reduce eyes tiredness while doing tasks. It will be tiring if to be forced to work under a dim lighting.

Most of the respondents choose all of the answers is because they are fully aware of the use of artificial lighting and what they need and do not need.

How the lighting in your classroom discomforts you?



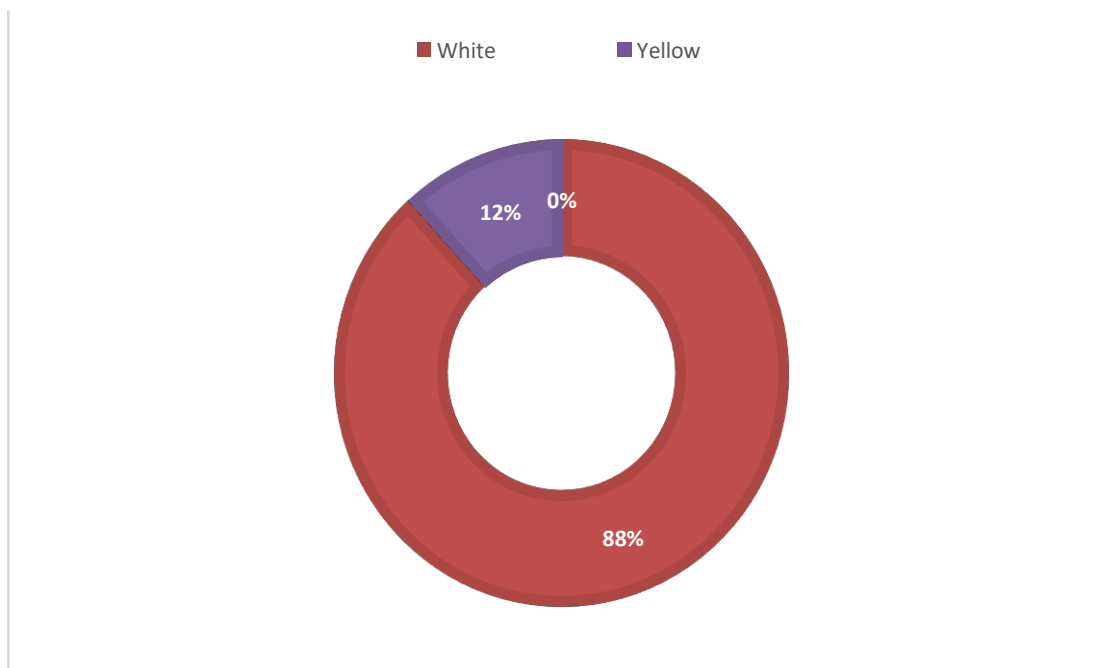
Lighting is so important that even it can affect a person's productivity and concentration level from high to low, which is why most of the students chose this answer besides others. So, according to science and experts, what color temperature lighting is most beneficial in a work setting? It turns out cooler light makes workers more productive [External link](#). A number of studies have found sunlight can have a multitude of benefits on our health. Exposure to natural light is especially beneficial to workers [External link](#) cooped up in an office all day. Natural light from both the morning and evening has been found to decrease depression and improve mood, energy, alertness and productivity. [External link](#) .As a result of these findings, Feldman and Keatinge prefer to bring down drywall and "use an extensive amount of glass" in the offices they design. With this strategy, light is able to travel and disperse throughout the office space (MBA@UNC Staff 2015).

While the second highest vote is visual performance, PJC Slegers et.al, performed an experiment in schools under experimental and control conditions using students as subjects, in order to study the impact of indoor lighting on children's concentration. Their goal was to confirm or scout previous studies in elementary schools which proved that it is not only brighter light (500lx) that had more positive effects than standard lighting (300lx), on

the reading and mathematics solving but also different CCTs (4000K and 17000K). Their main concern on their experiment was the effect of dynamic lighting on students performance and concentration. Dynamic light is a scheme where different lighting settings are provided in specific luminance and CCTs over time to alert or relax the human rhythms. The dynamic lighting scheme consisted of four types of lighting. Energy setting, a 650lx on desk surface with a 12000K (cold-blue, white lighting), Focus setting with a 1000lx at 6500K bright white light, calm setting with a 300lx at 2900K white light with warm red color tone. Fourth and final setting is a standard setting of 300lx at the desk surface and 4000K of CCT with a standard white light. The teacher of the classroom had the ability to choose a setting using a 5 button control unit. A number of 98 students were tested, while students with learning disabilities were excluded.

The reason why communication and social interaction and „mood state such as happiness is the least chosen answer is because they do not discomfort them this way.

What color of light do you prefer for study purpose?



The type of lighting source is a factor in students' performance. Sources that lighting emits x-rays, radiation, and radio wave is used in classrooms like fluorescent. These emissions reduce productivity, hyperactivity and so on (Sojoudi & Jaafar, 2012). Lighting color is another factor in students' performance. Colors impress upon employees in industry as psychologically. In many cases carefully choice of colors have increased production five to ten percent and can reverse depressing and monotonous atmosphere and promoting positive feelings about the school and lessons (Papadatos, 1973) and unsatisfactory lighting have negative impacts on student

performance (Yang, Becerik- Gerber, & Mino, 2013). A study shows that every color has a wavelength that affects brain differently. Colors can impress your character and state of mind at the moment. For example, red can trigger more aggressiveness or engagement and positive emotions in different states of mind (Tokcan, 2009).

Most of the respondents like white lighting more than yellow lighting because white lighting is brighter and is more suitable for study and doing all kinds of activities.

Conclusion

Having a source of good lighting is critical in the classroom for many obvious reasons. Students need to be able to see the teacher and each other, and to read the chalk board, white board, or projection screen as necessary. Based on the analysis of 51 questionnaires from 3 different high schools in Penang, majority of them have provided students proper lighting in their classrooms for a healthier long hour to hang out at school and clearer visual to read and doing other activities. Illuminance refers to the average light level in an area. Low illuminance has been linked to slower reading, reduced concentration, poor posture and long term weakened vision. An excessive variation of illuminance can also be an issue – this has been shown to actually reduce visual performance, causing discomfort and hyperactivity. A level of uniformity needs to be achieved to avoid excessive contrast and distraction (Innova 2014). As most of the students spent almost half of their day in the classroom, lighting makes an important role to provide brightness. This also leads to the fact that lighting in the classroom is one of the main key of the students' health and poor eyesight as they will need to read what the teacher write on the white board or a projection screen from a distance.

Lighting color is another factor in students' performance. As in question 8 above, researcher had found evidence from Mr. Kopuri. He said that as for the desired Color for reading, the 4000–5000K neutral white is more appropriate. Since eyes vary with age, it makes sense that as your eyes get older, you will need more light to read by. Dr. Eleanor Faye, the ophthalmological director of the Lighthouse for the Blind Low Vision Service, says: "The eye's need for more light to read by increases 1 percent a year.

When you're 10, you can read by 40 watts or hardly any light. By the time you're 60, you need around 100 watts." As brightness is measured in lumens, the following will help you choose a bulb with the wattage (or equivalent wattage) that you need.

- 40 watts: Look for at least 450 lumens
- 60 watts: Look for at least 800 lumens
- 75 watts: Look for at least 1,100 lumens

- 100 watts: Look for at least 1,600 lumens

If the light isn't comfortable, they will show signs of fatigue, like burning, redness, brow-ache, headache, or squinting.

"The problem with lighting today is that lights are so specific," says Paul Marantz, a lighting consultant at Jules Fisher & Paul Marantz Inc. in Manhattan. "The glowing light that Grandma's silk-shaded floor and table lamps provided made good reading light. But this kind of lamp is no longer in fashion." The doctors warn that too much light or glare is just as bad as too little light. "When light glares from highly reflective surfaces, it's fatiguing and especially disturbing for older people with cataracts and retina problems," Dr. Faye says. Shaded lamps cut the glare and focus and modulate the light.

In choosing bulbs for a reading lamp, "the old three-way, 50-100-150- watt soft-glow bulb is the most comfortable and useful," Mr. Cline says. "Not only are people used to its warmth, but the different levels of brightness accommodate a change in ambience and a family's assorted needs." One reason Mr. Cline prefers the flexibility of the three-way bulb to a single 100- watt bulb controlled by a dimmer switch lies in its construction. A 50-100-150 bulb is designed with two filaments, one of 50 watts and one of 100 watts, which can be used singly or in combination, giving a more consistent bright light at all times. A single-filament bulb controlled by a dimmer switch darkens to a yellowish light as the wattage is diminished. While there are small halogen incandescent bulbs available now, for reading they must be used in a lamp with a large shade and equipped with a dimmer or high-low switch. "If you use a tiny light bulb in a tiny shade, it produces a small pool of light and a crisp shadow, neither of which are good for reading," Mr. Cline says (LOUIE 1986).

Base on the all results lighting has a very powerful and essential role on students learning performance on learning places. According to all evidence lighting and the way of applying that in learning places is depend on the subject of study. Lighting control to avoid discomfort and glare in all different types of lighting is very important. Also students feel and act well in a place with a good lighting quality. The best lighting quality comes from the combination of daylight or natural light and artificial light (Erwine & Heschong, 2002).

References

University of Twente, The Netherlands. "Lighting affects students' performance positively: findings." *RUNNING HEAD: Lighting affects students' performance*, n.d.

A. Johnson, & P. Toffanin. "Self-chosen Colored Light Induces Relaxation." n.d.

Ana Teresa Luís Negrão, *THE IMPACT OF ARTIFICIAL LIGHT IN ARCHITECTURAL SPACES*, 2013

Anita. n.d., *How light affects your health*, 2011

Anjali Joseph, Ph.D. "The Impact of Light on Outcomes in Healthcare Settings." no. 2 (2006).

B.M.T Shamsul, C.C. Sia, Y.G Ng, K. Karmegan*. "Effects of Light's Colour Temperatures on Visual Comfort Level, Task Performances, and Alertness among Students." *American Journal of Public Health Research* 1, No. 7 (2013): 159-165.

Bellizzi, J. A., Crowley, A. E., and Hasty, R. W. (1983). The effects of color in store design. *Journal of Retailing*, 59(1), 5-8.

BRE, Building Technology Group. "Lighting effects on human health and wellbeing." n.d.

Elaine Louie, *EXPERT ADVICE ON SELECTING A GOOD READING LAMP*, 1986

Fatih Bozkurt, Hüseyin Coskun, Hakan Aydogan. "EFFECTIVENESS OF CLASSROOM LIGHTING COLORS TOWARD STUDENTS' ATTENTION." *JOURNAL OF EDUCATIONAL AND INSTRUCTIONAL STUDIES* 4, no. 2 (May 2014).

Fielding, R. (2006). *Learning, Lighting and Color: Lighting design for schools and universities in the 21st century*. 1-7.

Hannah, Ryan. *The Effect of Classroom Environment on Student*, 2013.

Katelijn Quartier, Jan Vanrie, Koenraad Van Cleempoel. "As real as it gets: What role does lighting have on consumer's perception of atmosphere, emotions and behaviour?" *Journal of Environmental Psychology* 39 (September 2014): 32-39.

Knez, Igor. *effects of indoor lighting on mood and cognition* , 1995: 39 - 51.

Knez, I., & Kers, C. (2000). Effects of indoor lighting, gender, and age on mood and cognitive performance. *Environment and Behavior*, 32(6), 817.

MBA@UNC Staff . "How Lighting Affects the Productivity of Your Workers." 2015.

McCloughan, C L B. the impact of lighting on mood , 1998: 81 - 88.

Michael S. Mott, Daniel H. Robinson, Ashley Walden, Jodie Burnette & Angela S. Rutherford. "Illuminating the Effects of Dynamic Lighting on Student Learning." n.d.

N.G.Katsikas¹, S.A. Dedegkika², C.S.Psomopoulos¹, K.D.Mardikis¹, G.Ch.Ioannidis¹. "Indoor illumination in tertiary sector and human health. A review." n.d.

Naik, Anita. "How light affects your health." 2011.

Negrão, Ana Teresa Luís. "THE IMPACT OF ARTIFICIAL LIGHT IN ARCHITECTURAL SPACES." May 2013.

PJC Slegers PhDa, NM Moolenaar PhDa, M Galetzka PhDb, A Pruyn PhDb, BE Sarroukh PhDc and B van der Zande PhDc. "Lighting affects students" concentration." *Lighting Res. Technol.*, 2013: 159-175.

Pulay, A. S. (2010). Awareness of Daylighting on Student Learning in an Educational Facility. University of Nebraska - Lincoln, Lincoln.

Rosella Tomassoni, Giuseppe Galetta, Eugenia Treglia. "Psychology of Light: How Light Influences." 2015.

Sabra, A. I. (1981). *Theories of Light: From Descartes to Newton*. Cambridge: Cambridge University Press.

Samani, Sanaz Ahmadpoor. "International Journal of Business and Social Science vol.3 no. 24." The Impact of Indoor Lighting on Students" Learning Performance in Learning Environments: A knowledge internalization perspective, 2012: 127 - 136.

Sheffield Hallam University Research Archive. "Retail design: lighting as an atmospheric tool, creating experiences which influence consumers" mood and behaviour in commercial spaces." 2008.

Torcellini, L. Edwards and P. "A Literature Review of the Effects of Natural Light on Building Occupants." 2002.

TURLEJ, Zbigniew. "ELEMENTS OF THE DAILY." 2011.

Winterbottom, M., & Wilkins, A. (2009). Lighting and discomfort in the classroom. *Journal of Environmental Psychology*, 29(1), 63-75.

Zeki, S. (1999). *Inner Vision: An Exploration of Art and the Brain*. Oxford and New York: Oxford University Press.