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A review paper of: the impact of daylight on students‟ learning performance

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ABSTRACT: The purpose of this study is to identify the impact of daylight on students‘ learning performance within learning environments. Since, learning plays an important role in people‘s life; having suitable and appropriate learning place seems very important an essential. It can motivate people to learn more and better. Learning environment includes all schools, universities or other places even libraries where people study there. Well designed learning palaces make students happy and energize and vice versa. In general, lighting in an environment is one of the necessary and important elements which have direct impact on people‘s performance. Apart from all indoor (artificial) light profits, natural light itself has more benefits on peoples‘ health and wellbeing. Having apt windows in classrooms are very important for having appropriate daylight, and also outside viewing. This connection with outside can provide significant physical and physiological benefits for users especially students. In this study the researchers try to identify the importance of daylight in learning places and discover the influence of that on students‘ learning performance. The result that comes from this study indicates that applying daylight in learning environment is very essential, but students feel and understand that while they involved with that. This paper is a review paper which came for a master thesis. Researchers review that to find support for the hypothesis that applying daylight in classrooms affects and enhances students‘ learning performance.

Keywords: students‘ learning performance, learning environments, Lighting quality, daylight;

INTRODUCTION

Good lighting quality plays an important role in psychological and biological process of human begins. From literatures we know that students‘ performances enhance by good visual environment (Pulay, 2010; Wu & Ng, 2003). Recent studies indicate that using or applying daylight in schools may considerably enhance students‘ test scores. Teachers and students spend the majority of their time in schools and good lighting is very critical for their health. So, researchers suggest that applying daylight in such places support better health and physical development for them (Plympton, Conway, & Epstein, 2000). For instance, in a study that came from an elementary school in Sweden; researchers deliberate health, behaviour, and cortisol (a stress hormone) level over the course of a year in four classrooms with altering daylight level. ‒The results indicate that work in classrooms without daylight may upset the basic hormone pattern, and this in turn may influence the children‘s ability to concentrate or cooperate, and also eventually have an impact on annual body growth and absenteeism.‖ (Küller & Lindsten, 1992) Apart from the affect of lighting on people‘s health, energy using by electric lighting is one of the important energy costs for schools. In this study, researchers have focused on the influence of daylight on students‘ learning performance and the importance of applying it on learning environments.

However, in a tropical country like Malaysia covering windows to keep out heat, but it make classrooms dark and force students to use electric lighting sources. Schools Designers should consider about this problem. Maybe they should think of different space configurations from non-daylight classrooms that may change many factors of classroom‘s standard lighting design. But, they must have knowledge to know how daylight is important and they cannot just simply skip that. The 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 (Lyons, 2001).When students have a classroom that have not well control of windows and lighting students' performance is negatively affected (Johnson, 2011).

The purpose of this study is to consider how learning places like schools, universities and colleges must be designed to supply a better condition for learners. In this study, researchers try to show how lighting quality is critical and how it affects students' learning performance. In fact to answer the problem designers and experts should consider about the basic environmental design and the knowledge for applying an appropriate light. Today, the role of light and the quality of that in schools and classrooms is noticeable. Providing an appropriate lighting quality with the combination of daylight and artificial light in classrooms will motivate s tudents for learning more and it will improve their performance. Lighting is one of the most serious physical characteristics of the classroom. The importance of an appropriate visual environment for learning tasks deserves careful attention (Johnson, 2011).

1. BACKGROUND OF THE STUDY

Lighting, heating and acoustics are three important physical environmental elements that should consider in a environment. Sometimes the importance of light in some places like educational place and workplace is more critical than other elements. Learning place illuminating plays a critical role because of the direct relationship that good lighting and students' performance have (Jago & Tanner, 1999). Few years ago, before use of electricity became extensive, schools and other learning environment depended completely on uncontrolled natural daylight as the only lighting source. Lighting design moved away from natural light while electricity appears, and classrooms counted on electric lighting sources as their primarily source of light. On that time the numbers of windows in classrooms area were reduced, and classrooms environments became disconnected from the outside environment and psychologically asphyxiate and stifling (John & Timothy, 2005).

–Up through the 1950s and into the early 60s almost all school buildings in the United States were daylight‖. (Heschong, et al., 2002) they constructed and designed schools in a way that they have sufficient interior daylight for normal daytime visual tasks. Though, by the mid-1960s while engineers asked to provide air conditioning in classrooms some changes appeared in building structures. Those were large expanses of glass and high ceilings. engineers suggested that the smaller windows could enhance the quality of the energy while air-conditioning was used in schools (Wu & Ng, 2003). On that time –Educational theorists argued that a more flexible arrangement of open classrooms, grouped in large open plan buildings, would encourage team-teaching and creative learning. Construction economists argued that schools could be built more inexpensively on smaller sites if the classrooms could be grouped together in modules, without constraints on solar orientation.‖ (Heschong, et al., 2002) So, more and more, schools were built with no or very little daylight supplied to the classrooms. –In 1974, Belinda Collins of the National Bureau of Standards and Technology (NIST) conducted a major literature review of available research on windows, and concluded there was no conclusive evidence that windows were a necessary component of classrooms.‖ (Heschong, et al., 2002)

Having daylight in educational places is very important and beneficial, but a daylight source in classrooms is not practical possible. According to Benya as cited by Higgins, et al., (2005)‖lighting to be effective, daylight must be supplemented by automatically controlled electric lighting that dims response to daylight levels.‖(p.20) It shows that good lighting in educational environments is achievable by combination of both direct and indirect lighting.

2. THE IMPORTANCE OF DAYLIGHT

"Near 5,000 new schools designed and constructed to encounter the needs of students in kindergarten through grade 12 schools between 2000 and 2007 in the United State. National efforts are ongoing to support and encourage the use of daylighting, energy efficiency, and renewable energy technologies in schools' designing, which can considerably enhance the performance of learning environment.‖ (Plympton, et al., 2000) Today applying daylight in educational design is the most important task. There are two important reasons for extensive use of daylight in classrooms. First one is saving energy from turning off the electric lights in classrooms in day time. This provides two benefits as well first is decreasing the electricity use by the lights and second is also can

reduce the cooling loads generated by internal heat in the classrooms. The second and even the stronger reason is daylight in classrooms may improve students‘ health and academic performance (Erwine & Heschong, 2002; Heschong, et al., 2002; Plympton, et al., 2000).

The classroom is the most important area of a school in all levels; from kinder garden till universities. It is where teachers and students spend most of their time and where the learning process takes place. Classrooms‘ lighting is very critical area that experts and architected should focus on it. The light positions on classrooms are very important for e.g. it must focus on the front of the classroom and over the student‘s desks (Berry, 2002). Many factors affected students learning, which contain interior classroom design elements, noise level, scheduling and many other similar issues. Some of these factors cannot be controlled such as scheduling, finances, time and day and etc, but the classroom‘s environmental design can be developed to improve students‘ learning performance (Pulay, 2010). The efficient lighting of schools has been related to high performance test scores time and again.

Daylighting is a natural solar energy strategy at the facility levels that applying from windows and skylights to decrease building electrical lighting. Apart from considering the health effects of daylight on people who associated with it the economic side of using that is significant too. Lighting needs to be carefully addressed in any construction because controlled daylight and also appropriate artificial illumination are critical to the quality of students‘ performance.

2.1 Definition of Daylight, Sunlight and Skylight

This is obvious that light has an important position in all people‘s life. Sunlight is the main source and provider of light, warmth, and energy, not only maintains all life on Earth, but to maintains the Earth itself. Expect the energy that sun provides for all living creatures, it also is the source of much of knowledge that people will capture (Liberman, 1990). Because most learning occurs by seeing with eyes and people can see because of the sunlight. Daylight is more competent at providing light than most electric light sources.

Compared with electric light using daylight reduces heat in building. Thus, high reflectivity in a building can reduce not only the building‘s electric light using, but also its use of cooling energy. In addition visual comfort increases in a term of using daylight, because daylight is the natural light source that most closely matches the human visual reaction and response (Hagenlocher, 2009). In the importance of daylight many researches show that daylight should always be the first choice for illuminating any space during day time. It is valuable because of its zero energy expenditure, variability, directionality, power and colour (Halliday, 2008; Lyons, 2001). However electric lightning doesn‘t have any of these elements. Natural light has a deep influence on people‘s body and mind.

Sunlight directly comes from the sun after it has been diffused by the atmosphere. It is nice and welcome in some buildings and spaces because it provides interest and enjoyment, and because it is a resource of energy. However it can cause problem in some spaces as well. In offices, and sometimes schools, it is a main reason of dissatisfaction, and frequently leads to disability glare, overheating and discomfort. Skylight comes from the sky, which excludes direct sunlight. It is the accepted account for daylight (Halliday, 2008).

2.2 Benefits of Daylight on Students

By using natural light the demand of electric lighting system will decrease. Having appropriates windows in classrooms are very important for having suitable daylight and also outside viewing. This connection with outside can provide important physical and physiological benefits for users. However, controlling glare and extreme light levels from daylight is significant aspect (Erwine & Heschong, 2002; Oneworkpalce, 1999).

National efforts are ongoing to support and encourage the use of daylighting, energy efficiency, and renewable energy technologies in schools‘ designing, which can considerably enhance the performance of learning environment. For example evidence shows that ―In daylight classrooms math scores improve by 20% and verbal scores by 22%.‖(Fielding, 2006)

Today the most important task in educational design has been a demand for addition of daylight into the design of classrooms. There are two important reasons for extensive use of daylight in classrooms. First one is saving energy from turning off the electric lights in classrooms in day time. This provides two benefits as well first is decreasing the electricity use by the lights and second i s it also can reduce the cooling loads generated by internal heat in the classrooms. The second, and even more vigorous, reason that has appears for inclusion of daylight in classrooms is improving students' academic performance (Ander, 2003; Plympton, et al., 2000).

Also, recent studies show that using daylight in schools may considerably enhance students' test scores and promote better health and physical growth. ―In one school district, students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% faster on reading tests when compared to students in the least daylight classrooms.‖ (Plympton, et al., 2000) Students improved their learning substantially in well-designed classrooms which had adjustable skylight that diffused daylight through the room and reduced glare faster than students were in more traditional classrooms (Lyons, 2001).

Daylight also affects on human behavior. Researchers mention that ―For the schools study, these can generally be summarized as improved vision, improved morale, and improved health.‖ (Heschong, et al., 2002: p.109) Some of the important effects of daylight as mentioned by Heschong, et al., 2002 are:

―• Improved vision due to:
• Higher illumination levels under daylight
• Better color rendition under daylight
• Improved spectral content of daylight (scotopic enhancement)
• Improved three-dimensional modeling with high lights and shadows
• Reduction of flicker effects from electric lighting
• Improved student and/or teacher morale or performance due to:
• Mental stimulation from varying lighting conditions
• Calming effect of a connection with the natural world (weather, time of day)
• Greater mental alertness due to circadian biochemical responses to daylight (neurotransmitter levels)
• Better memory retention due to one or more of the above processes
• Improved longer term health due to circadian biochemical responses to daylight.‖ (p.109)

Daylight levels should be plenty enough to decrease the number of initial fixtures in classrooms and allow electric light to be turned off during the day, even on cloudy days. Daylight classrooms have some different structure from non-daylight classrooms that will change the factor of standard lighting design in classrooms. For instance, ceilings are likely to be considerably higher in use of daylight. Windows should be placed in particular place and meet the standard that depends on weather of countries. For instance, in the Austin Independent School District: all windows place at eye-level use a ¼-inch green-tinted infrared-absorbing glass, which is very operative in Austina's climate. Therefore, the lighting designer is faced with a new set of challenges like: saving energy, supply flexibility of use over time and space, minimizing glare, low cost and low maintenance system, complementing daylight—along with the standard educational needs for standardized vertical surface illumination (Erwine & Heschong, 2002; John & Timothy, 2005; Plympton, et al., 2000).

Controlled daylight and appropriate artificial illumination needs to be carefully addressed in educational places (John & Timothy, 2005). Using windows as a part of buildings design and as resources for lighting are very important. In a part of lighting, daylight has an especial place and catches too many focuses. Many studies have even shown access to natural light and fresh air systems can increase health, comfort, and productivity (Gregg & Ander, 2008).

3. LIGHTING CONTROL RECOMMENDATION

In a term of controlling daylight windows and the location of them have very critical role. The main roles of windows are providing daylight, views, ventilation, a sound barrier and glare protection. ―Windows provide a link to outside which occupants

appreciate, but orientation needs to be considered in relation to solar penetration at all times of day and year.‖(Halliday, 2008) These are some of recommendations about the locations of windows that Halliday (2008) mentioned in his book:

- Low-altitude morning and evening sun is usually linked with glare. In design for this kind of light it should be considered that shading come from east and west direction. In some situations for adjustment it will be necessary to exclude the low-altitude sun, but beneficial daylight at other times of the day will available.
- North-facing windows are located in a situation that have the least vulnerable to glare problem. They can provide useful lighting quality, other than they can be a source of local cooling, leading to heat loss.
- South-facing windows are tending to create a broad range of problems, except providing the adequate and well-controlled shade.

According to Halliday (2008) and Kats (2008) buildings should consider a situation for using daylight as much as possible because it provides amenity and visual value. Though high level of daylight alone do not transfer the required energy. Good l ighting control is always necessary. In the morning on dull days and at night electric ligting will usually needed. When daylight is sufficient appropriate control is needed to reduce the use of electrict lighting.

4. CONCLUSION

There are many researchers which argued the benefit of daylight and comparing that with electric light sources. To illumination environment daylight is more efficient than most electric light sources; also less heat is produces form daylight in compare with electric light (Erwine & Heschong, 2002; Heschong, et al., 2002; Plympton, et al., 2000).

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 (Hoffmann, et.al., 2008; John & Timothy, 2005). Erwine & Heschong (2002) worked on a special schools design beased on the lighting quality. They expalined the importance of lighting in leraning places and the influnce of that on students as well. They argued that; sometimes the need for low costs and simplicity of operation and maitenance are important in educatioal design. ‖A smart lighting designer can take advantage of new technologise and lighting design analysis tools to integrate all of those needs into a efficient, flexible and economical system.‖ Thereofre, accaroding to all resaerches and studies in this area except the importance of lighting quality in educational places and the influence of that on students other areas like costs, simplicity of operation and maitenance are remarkable in lighting design.

There is some fundamental roles for construction daylight classrooms that designer should consider. Daylight classrooms should have different space configurations from non-daylight classrooms that will change the parameters of standard classroom lighting design (Erwine & Heschong, 2002). For instance, Ceilings are higher than classrooms which have artificial lights. The design and places of windows should be related to the building situation. Lighting designers are faced with a new term of challenges. They should think of all needs form visual task situation created by visual display devices, saving energy, low cost, flexibility of lighting system, maintenance system, minimizing glare and so on. And in the term of daylight system they should consider about complementing daylight base on standard educational needs (Erwine & Heschong, 2002; Halliday, 2008; Winterbottom & Wilkins, 2009). The benefits of illumination by using of daylight and the impact of that on students learning performance beside on too many researches are clear. However the glare and discomfort are two possible disadvantages for the all types of lighting that should be consider in building design.

To prove the Effect of daylighting on learning performance Abadzi (2006) explained: ―Daylight in schools is related to better students‘ performance (possibly because of effect on circadian rhythms and the pineal gland). Students in U.S. classrooms with well-designed, adjustable skylights that diffused daylight throughout rooms and reduced glare improved their learning substantially faster than students in more traditional classrooms. There may also be non-visual effects of lighting on students, including improved dental health, physical growth, mental development, academic achievement, and attendance. When schools have no electricity

> lighting is much harder to control. In tropical countries, metal windows cover to keep out heat make classrooms dark. (Abadzi, 2006, p.99)

Physical area in designing is very important and lighting is one of the most important features in physical area in all environments especially in educational and working environments (Juslén & Tenner, 2005; Knez & Kers, 2000).

Veitch (2010) have indicated six categories of human requirements addressed by lighting. These are visibility, task performance, communication and social behaviour, health and safety, mood and comfort, aesthetic, and judgments. Good quality of lighting can support human needs; form contributes to conditions in all environments (Veitch, 2010). According to Juslen and Tenner (2005) since changing light is achievable certainly productivity and increase performance via the following mechanism is possible:

1) Visual performance: When people can see the task clear definitely they work and perform better. Visual performance doesn‘t have clear deification and importance in all tasks. Some tasks do not need much light in order to be performed well visually.
2) Visual comfort: By remove or decline discomfort glaring the performance will increase because concentration will enhance.
3) Interpersonal relationship: when people can see each other better they can have better communication and more cooperation.

Consequently, increasing the lighting quality will enhance well-being and motivation among people they will have better performance (Juslen & Tenner, 2005; Hoffmann, Gufler, Griesmancher, Bartenbach, & Canazei, 2008).

5. THE IMPORTANCE OF THE STUDY

There is a fact that people work better in places which they feel comfortable there (Oneworkplace, 1999). Companies can increase job satisfaction by providing a good working environment, and this truly worked in educational places as well. Basic physical environment like light, noise, colour, temperature have impact on students‘ learning in learning places. Today, the role of l ight and the quality of that in schools and classrooms is noticeable. Providing an appropriate lighting quality with the combination of daylight and artificial light in classrooms will motivate students for learning more and it will improve their performance. Lighting is one of the most serious physical characteristics of the classroom. The importance of an appropriate visual environment for learning tasks deserves careful attention (Jago & Tanner, 1999; Johnson, 2011).

According to documented data daylight in schools is connected to better students‘ performance (possibly because of effect on circadian rhythms and the pineal gland) (Abadzi, 2006). Beside the importance of daylight on students learning performance some non-visual appeared during using daylight. Improved dental health, physical growth, mental development, academic achievement, and attendance are some of the non-visual effects of daylight on people or students.

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