

Indoor Lighting in Classroom Environment Influences on Students' Learning Performance

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Abstract

Students learning in educational institutions is associated with classroom environment which normally equipped with physical aspects consists of furniture, air-conditioning, fan, lamp, whiteboard, soft board and etc. The effectiveness and efficiency of learning process in the classroom may not be measured only through the students' ability and capability, whereas student's concentration and attention during the lesson also influenced by its physical classroom environment mainly related to indoor lighting. In this study, it's focused on how the students' learning performance affected by the indoor lighting in the classroom. The scope of this study is within the secondary school building around Selangor. The results showed the current practice in most of the classrooms at school building focused on the usage of artificial lighting compared to natural lighting. Even those aware of its benefit and teachers also agreed students' learning performance is influenced on quality lighting in a classroom either directly or indirectly through daily activities and tasks during a lesson at school. Students and teachers realized that lighting is important in order to improve the effectiveness of learning and to avoid from any health problem usually related to vision that could result headache.

Keywords: Classroom; Lighting; Performance; Students; School.



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1. Introduction

In a learning environment there are a lot of factors which affect students learning performance, where physical aspects also play the main role in an effectiveness of learning environment (Bozkurt, 2014). Otherwise, the well designed learning environments have directly affected students to more positively, energize and motivated. Sometimes, lighting in a learning environment such as classrooms may influence the quality of teaching and learning process. The designer or architect need to understand the relationship between lighting and the environment, in order to an improvement of interior designs in a classroom learning environment for better students' learning performance (Samani, 2012).

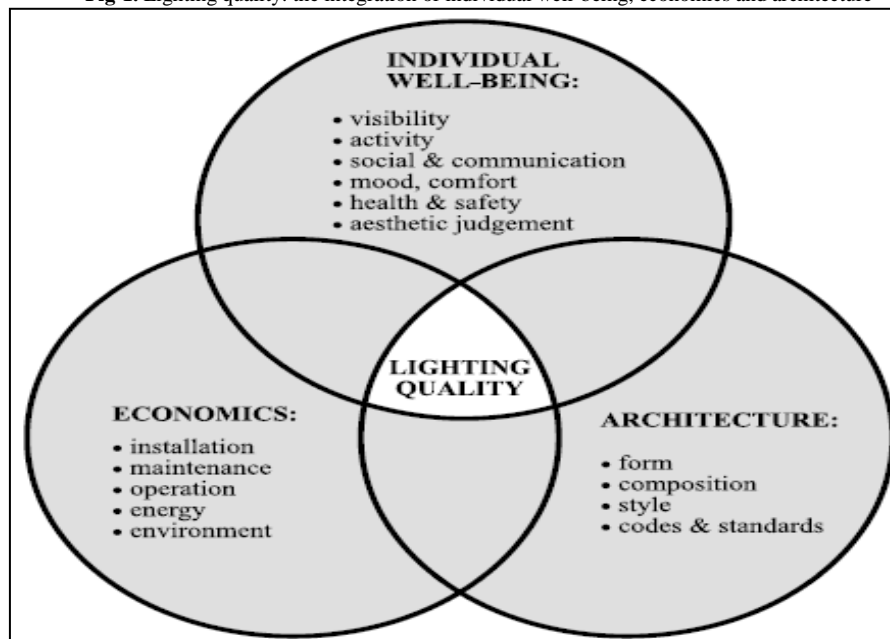
Indoor lighting that effect on student's performance specifically in a classroom learning environment in generally could be divided into two main types, which are natural and artificial lighting. Both of these lighting have their own advantages, where the usage of different types of lighting also based on the activity conducted in the classroom environment. Therefore, insufficient lighting especially for learning space at school building also can reduce a student's ability in learning due to the strain on students' eyes, leading to a decrease information and caused high stress levels (Lieberman, 1991). Natural lighting is synonym with daylighting, where a light is transmitted via sunlight then reflected on a surface before it's illuminating into an area or space. It's also the main physical aspects that should be consider in order to design high school building performance and energy efficiency of the classroom learning environment. Based on the daily basic activity in classrooms especially for Malaysian schools, all the lights will switched on throughout the day of schooling and only be switched off during break time and at the end of class session. However, daylight is a useful light source for most of the buildings especially in a learning environment such as classroom, where the quality of natural light is better compared to any electrical lighting. In Malaysia, level of luminous efficacy of daylighting is excellent and could achieve the required luminance needed during the day.

Artificial lighting is necessarily need in order produce the safety and conducive classroom learning environment. In fact, artificial lighting source actually is starting from the fire combustion for cooking and safety

purposes. However, lighting techniques to adapt with the development of science and technology, where production of artificial lights has growth rapidly worldwide to support the demand of various types of lighting, light colors and human quality life. Besides, humans also created various high-tech designs lighting that able to produce various wavelength and light colors to meet their needs (Ismail and Impak, 2015). From the perspective of technical person, a classroom is a difficult space to support by only natural lighting throughout the day because of the depth of classroom and different activities or task must be performed (Norhati *et al.*, 2013). Therefore, artificial lighting is necessarily needed for any classroom learning environment to support the usage of natural lighting. To enhance energy efficiency in school building, it should be optimize usage of natural lighting and minimize usage of artificial lighting (Rácz, 2012).

There are three factors influence quality of lighting; individual well-being, economics and architecture. Therefore, if looking into individual well-being perspective, lighting may affect people's health, mood, wellbeing, comfort, activity, visibility and alertness (Samani, 2012).

Fig-1. Lighting quality: the integration of individual well-being, economics and architecture



1.1. Problem Statement

The first problem is based on the quality of learning environment. There are many physical aspects in the classroom learning environment, but for school building only consider on its building design and structure. However, people just ignore about the quality of building performance especially related to indoor environment mainly involves quality of lighting. Even while there have been intelligently and successful improvement in lighting technology, unfortunately the real situation is still lacking on awareness to support the energy efficiency in educational building. According to Samani (2012), lighting conditions in the majority of the workplaces are below the basic requirement of guidelines, then poor lighting (Lyons, 2001) and lack of maintenance to improve the lighting facilities take part as critical problems faced by various organizations and institution consists of learning environments. The issue also raised up when the students in a classroom not well control of windows and doors opening, thus negatively affected students' learning performance (Sulaiman, 2013).

The next problem comes out from the issues of building or space design. Once, designer decided to design a workplace it should be placed their self in different perspective role such as management, staffs, users and designer. This is important to understand their task and roles when using the space designed. In this context, for designing learning space designers should have same view to ensure all spaces adequate well design and facilitate (Soderdahl, 2011). However, designing learning environment such as classroom is more critical for school, college or university compared to workplace; this is due to learning environment and education are the pillar to develop civilized human being (Hensen and Lamberts, 2012).

Majority of people spend their time in the workplace or learning space. Thus, conducive classroom learning environment especially at school buildings encourage better performance of students and teachers. Besides, lighting is the other significant aspect needed which is to produce conducive classroom learning environment.

In this study, the researchers try to investigate how the indoor lighting quality in classroom environment influences on students' learning performance at school building. Good quality of lighting in learning space provided the large opportunity of conducive classroom environment, at the same time enhances students' overall performance (Leder *et al.*, 2015). Other than that, an appropriate lighting quality consists of installation and maintenance can increase the productivity of work (Iftikhar, 2015).

2. Methodology

The study was conducted based on mix mode which consists of qualitative and quantitative methods. The data of qualitative method is collected from the interview and observation. Qualitative data analysis for interview and observation used an approach of thematic analysis and visual observation to support the data from the interview output. Interviews focused on classroom environment learning space that required teachers perception on the most significant lighting used in the specific classrooms either natural or artificial lighting. Prior to the observation, researchers run a pilot study was conducted which almost a month. The observations were performed within minimum 8 hours from 8 am to 4 pm. Observation is available to identify the major types of artificial light source used in the current practice in the classrooms.

Otherwise, quantitative method is used experimental techniques for the data collection aided with a layout plan, a digital camera and observational sheet, thus the data is more on tabulation analysis that focused to the reading of lighting comfort level from the digital instrument. The experimental to measure lux of lighting in a classroom have been conducted accurately by using Digital Illuminance Meter (TES-1330A) in the selected classrooms.

The observation chosen study context located in the 20 classrooms in the ground floor to ensure the significant variables such as standard size of classroom and visible. The school building selection between the ranges 12 to 25 years established in Malaysia.

Table-1. Suggested Lighting Illumination

Indoor Spaces	Educational Building	Lux
Technical Drafting Room		750
Lecture Hall		500
Laboratory		500
Computer Lab		500
Music Room		300
Classroom		300
Tutorial Room		300
Assembly Hall		200

Source: Guidelines on Occupational of Safety and Health in Lighting at Workplaces (2018)

The table 1 shows level of lighting illumination for indoor educational building spaces that specifically available at school buildings. This lighting illumination is provided by Department of Occupational Safety and Health (DOSH) under scope of Act Safety and Health 1994 (Act 514), it based on the basic requirement of the building space. Good lighting either natural or artificial plays an important role in improving safety and health at the workplace or learning space (Issa, 2011). The most detail work normally needs higher level of illumination in order to provide comfortable and safe in doing work such as factory to produce micro products (Hewitt *et al.*, 2005). Otherwise, educational building consists of lighting illumination between 200 to 750 lux. However, lighting illumination of classrooms at school building stated with 300 lux and it should be spread over to all students in order to provide most comfortable due to maximize students achievement (Cheryan *et al.*, 2014).

3. Results and Discussion

Literature review had shown that comfort level of the classroom was including the element of lighting either natural or artificial sources. According to mentioned that natural and artificial lighting comfort level in the classroom suggested is 300 lux (refer table 1). Based on the outcome from visual observation,

natural lighting is generally depends on the opening of a classroom, which usually consists of windows (louver) opening on the left and right of wall (refer figure 2). Additionally, there are two (2) units of doors (timber) in the classroom that contributed to the opening of classroom to allow direct daylighting. However, there are two (2) types of artificial lighting source commonly used for the classroom involved in the case study which are fluorescent and Limited-emitting diode (LED).

Fig-2. Classroom Layout Plan (case study)



Table-2. Major artificial lighting source in the classrooms

Item	Types of Artificial Lighting Source	Units (Classroom $\Sigma=20$)
1.	Fluorescent	16
2.	Light-emitting diode (LED)	4

The combination of both lighting sources which are natural or artificial lighting could contribute to the illuminance or value of lux in a classroom. Refer to table 2 there are two major artificial lighting sources that installed in the classrooms at school building in Malaysia, there are fluorescent and light-emitting diode (LED). Based on the observation through 20 classrooms, it clearly illustrates the amount of classrooms installed with fluorescent (16 out of 20) is higher than LED (4 out of 20). Refer to the teachers in the selected schools; they briefly explained that the cost of fluorescent lighting is cheaper and is technically easy to maintain. In fact, LED lighting the cost is higher but its lack of maintenance, more efficient and save energy, in terms of electricity bill (Borille *et al.*, 2013).

Table-3. Accuracy of Lighting Illumination in Classroom at School Building

Suggestion Classroom by DOSH (Lux)	Illuminance Level of	Average Illuminance Level of Lighting in Classroom (Lux)
Natural Lighting	300	Natural Lighting
Artificial Lighting		Artificial Lighting
		226

* Standard classroom size = Height (H) x Length (L) x Width (W) = 3.60m x 9.23m x 7.31m = 242.89m

* Standard installation of artificial lighting = 9 fluorescent light cover, 18 units fluorescent bulb

Table 3 illustrates the results of experiments that have been done in 20 selected classrooms by considering the standard classroom size and standard installation of artificial lighting. Thus this experiment conducted in order to look forward to classroom accuracy of its lighting illumination consists of both natural and artificial lighting in SI Units of illuminance, lux. According to stated that suggested lighting illumination for classroom is 300 lux, however from the experimental conducted the average of illuminance level for classroom measured is 226 lux. Therefore, findings clearly explained that both types of lighting are equally important in order to fulfil the suitability of illuminance level or light level in classroom as a learning environment. According to Sulaiman (2013), the physical environment of learning space should be healthier and comfort mainly lighting level, whereas its ability to provide conducive classroom and improve the students motivation during learning process.

The lack of lighting comfort level in the classroom has been supported through interviews with students. Thus, four (4) out of five (5) students stated that they prefer the artificial lighting. This indicates that the amount of natural lighting is limited as discussed above paragraph.

Table-4. Interview on relationship between quality of lighting and students' learning performance in the classrooms

Teachers feedback from the Interview (n = 5)	Impact on Students' Learning Performance			
	YES		NO	
	%	n	%	n
Good quality lighting in classroom	100	5	0	0
Poor quality of lighting in classroom	80	4	20	1

Refer to table 4, there are 100% teachers mentioned yes for good quality lighting and 80% teachers mentioned yes for poor quality in classroom may give an impact to students' learning performance. Thus, shown feedback from interview session with teachers at school building clarify both of good (Yes=100%) and poor (Yes=80%) quality of lighting in classrooms will give an impact on students' learning performance.

According to Samani (2012) lighting is a fundamental feature of designing a space, the condition of lighting can influence the activity and productivity of working or learning, in addition critical indoor lighting in any environment may have direct impacts to the transition and creation of knowledge. In fact, poor quality of lighting also encourage on health problem once stay in a workplace or learning space like classroom throughout the day.

4. Conclusion

Overall, the study found that quality of lighting either natural or artificial lighting may influence the students' learning performance in the classroom at school building, it consists of students' achievement, attendance, motivation, skills, concentration and focus during the learning process conducted throughout the day. Otherwise, teachers also take the responsibility to improve the student awareness about significant of natural lighting in our future, besides control the usage of artificial lighting in the classroom. Based on all results and discussion it shows lighting has a very powerful and essential role in energy efficiency and students' learning performance specifically in classrooms at school building. Providing an appropriate quality of lighting in a classroom with the combination of natural lighting or artificial lighting will motivate students to more appreciate and learn about lighting. Therefore, accurate and suitable visual environment for classroom learning environment deserves more careful attention.

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