

# LIGHTING AND PERFORMANCE: AN ANALYSIS ON LIGHTING EFFICIENCY OF ARCHITECTURE STUDIO

**Fazidah Hanim Husain<sup>1</sup>**

*Department of Architecture, Faculty of Architecture Planning and Surveying,  
Universiti Teknologi MARA (Perak), Malaysia*

<sup>1</sup>fazid896@perak.uitm.edu.my

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## **ABSTRACT**

*Lighting is one of the key elements in any space and building infrastructure. Good design for an area in the building requires sufficient light that contributes to the efficiency of the activities. The correct method allows natural light to transmit, reduce heat and glare in providing a conducive learning environment. Light plays a significant influence to the quality of space and contributes focus of the students in an architecture studio. Previous research has shown that the effect of light also controlled emotions, behavior, and mood of the students. The operations of artificial lighting that have been used most of the time in an architecture studio during day and night may create lavishness and inadequacy at the same time. Therefore, this paper focuses on the identifying the quality of light for the architecture studio in UiTM (Perak), to instill a creative learning environment. Several methodologies adopted in this study such as illuminance level measurement using lux meter (LM-8100), and a questionnaire survey in gauging the lighting comfort level from students' perspective. The study revealed that the illuminance level in the architecture studio is insufficient and not in the acceptable range stated in the Malaysian: Standards 1525:2007 and not evenly*

*distributed. The study also concluded that the current studio environment is not conducive and appears monotonous.*

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## 1.0 INTRODUCTION

Studio is a place where student spend most of the time of a day in order to complete a design project. Studio is the most important space in architecture education where student interacts, struggling on projects, sharing information and learning from peers (Ban, 2015). Studio learning involves task lighting which provide high illumination for a specific work such as drawing and detailing. A long hour's work need better task lighting to avoid physical discomfort such as fatigue and learning inefficiency (M.Winterbottom & M.Wilkins, 2009).

Council of Architectural Education Malaysia (CAEM) was formed under the supports Lembaga Arkitek Malaysia (LAM) to regulate all matters relating to architectural education (LAM, 2015). The CAEM mission is to ensure excellence in architecture education in accordance to the world standard. Under Policy and Procedure for Accreditation of Architectural Programmes, CAEM advises all architecture schools to have an allocation of 2.5 sqm work space per student in studio. Apart from the private work space, institutions shall also provide space & facilities for presentation & exhibition of student's works, laboratories, model making workshop, facilities for research, information and data exchange for new technologies to support effective

learning environment (LAM, 2015). In 2012 and 2014 respectively, architecture program in UiTM Cawangan Perak has successfully been accredited to be a recognized architecture school in Malaysia and the UK (RIBA,2015). However, on a lighting issue, this research is conducted to prove whether architecture studio in this university is sufficient and fulfil the illumination level for the drafting table as stated in the Illuminating Engineering Society (IES) & Malaysia Standard (MS)1525 which are 750 lux and 300-400lux respectively. Based on previous study, insufficient lighting setting in an architecture studio can affect student ability to perceive visual stimuli in a short term and vision impair in a long run (A.Che-Ani, N.Tawil & A.Musa, 2012).

## **2.0 LITERATURE REVIEW**

### **2.1 Mood and Performances**

As the students spend most of their time in the studio than a classroom, the lighting must be designed to fulfill not only the visual task activities but also to meet the other interpersonal and physiological needs as far as possible. This is in agreement with a pervious study that higher illuminance during daytime can led to a greater alertness (J.Phipps-Nelson, J.Redman, & D.Dijk, 2003). Although an individual's mood and performance can be increased in naturally lit environment (Z.Gou, S.Lau, & F.Qian, 2013), an optimal indoor environment with higher illuminance level, lighting uniformity, absent of glare and lighting ambience can contribute to high performance and motivate workers (J.Veitch & J.Geerts, 2005). Study done by Liberman (1994) also stated that light is one of main factor in maintaining health and poor lighting condition can influence a person's mood and energy. Lighting also has an important role in

revealing the form of an interior, especially in buildings of high architectural merit (Bean. R, 2004). The amount of light required for a particular task may vary from individual to individual, depending on upon their visual capacity. For the example, age or eyesight, it is possible to determine a lighting level that will meet the requirements of the most people.

## **2.2 Indoor Environmental Quality**

Previous experimental investigation on indoor environmental quality of the architecture studio in UKM by A.Che-Ani, N.Tawil & A.Musa, (2012) has shown the lighting setting is not within the range of Malaysian Standard MS1525:2007. This research is to study the lighting performance of the architecture studio in UiTM Cawangan Perak. It is necessary to investigate whether the lighting provided in the year three, architecture studios are within the scope Malaysian Standard (MS) 1525: 2007 “Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Building. Since each student in the studio is well equipped with a drawing and a working table, main activity happen in the studio will involved reading, writing and drawing. Based on the Malaysian Standard (MS) 1525: 2007 “Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Building (Figure 2.1), the nearest luminaire reference to architecture studio will be drawing office which the luminaire level is at the range of 300-400lux.

**ROOM ILLUMINATION LEVEL**

| GENERAL BUILDING AREAS  | IES STANDARDS ILLUMINATION LEVEL | MS 1525 RECOMMENDATION | PANDUAN TEKNIK JKR | NOTES |
|---|----------------------------------|------------------------|--------------------|-------|
| Fine bench and machine work<br>fine sanding, finishing        | 750                              |                        | 400                |       |
| <b>OFFICE</b>   |                                  |                        |                    |       |
| General office with mainly clerical<br>task and typing office | 500                              | 300-400                | 500                |       |
| Deep plan general offices                                     | 750                              | 300-400                | 300                |       |
| Business machine and typing                                   | 750                              | 300-400                | 300                |       |
| Filing room   | 300                              | 200                    | 300                |       |
| Conference rooms  | 750                              | 300-400                | 300                |       |
| <b>OFFICES AND SHOPS</b>                                      |                                  |                        |                    |       |
| Executive office  | 500                              | 300-400                | 300                |       |
| Computer rooms  | 500                              | 300-400                | 500                |       |
| Punch card rooms  | 750                              | 300-400                | 600                |       |
| Drawing offices drawing boards                                | 750                              | 300-400                | 600                |       |
| Reference table and general                                   | 500                              | 300-400                | 300                |       |
| Print room  | 300                              | 300-400                | 300                |       |

Figures 2.1 Comparison lux illuminance level of drawing office between IES Standards & Malaysian Standard (MS) 1525: 2007 "Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Building (source: <http://www.pioneerlighting.com/new/pdfs/IESLuxLevel.pdf>)

The experiment was conducted by collecting the illuminance level data at the third year (semester 5) architecture studio located at ground floor, Architecture department building. That particular studio was chosen because all the luminaires provided in the studio was well functioning to be compared to other architecture studios. The studio is 11.85 meter x 11.85

meter with 140.422sqm that accommodate approximately 30 students for that particular semester. The illuminance level reading is measured by using lux meter (LM-8100) at 9 specific locations as shown in figure 3.1 . The reading taken for eight hours for two consecutive days. Based on the reflective ceiling plan, there are 17 units of typical fluorescent with reflector with each unit contains two fluorescent lamps.

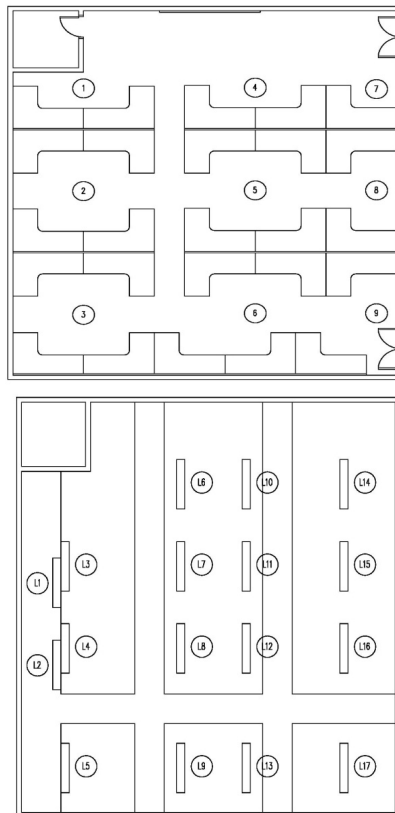


Figure 3.1 Floor plan (upper image) and reflected ceiling plan (below image) of the year three architecture studio in UiTM Cawangan Perak.

## 4.0 RESULTS AND DISCUSSIONS

### 4.1 Lighting Analysis

Table 4.1 show the tabulate result of the lighting analysis result and figure 4.2 shows the chart illuminance in lux against time on day one while figure 4.3 shows on day two. The data which is highlighted with yellow color is recorded as the lowest reading during both day and the data which is highlighted with red color is recorded the highest illuminance reading at point 1 which is 150. The lowest illuminance reading recorded is 110 lux on day one at time 1400. Meanwhile at point 8, the highest reading recorded is on day two which is 468 lux at 1600. The readings maintain in a range of 400+ lux on both days from 1400 until 1600, however decreases after 1700. Meanwhile, reading at point 6 which is highlighted in orange colour, maintain in the range of 300+ lux except for day one the reading is 217 at 2100. While the rest of the area, remain in general reading within the range 150 lux to 287 lux and the readings are below the recommended illuminance level set by Malaysian Standard as shown in figure 2.1.

From the findings (figure 4.1), point 1 show the lowest illuminance reading. Based on the floor plans (figure 3.1), point 1 is located far from the windows and received the least of natural lighting. Moreover, there are no luminaire provided at this area (figure 3.1). As a result, point 1 area give insufficient lighting to the workstations provided. Points 8 however experience the highest reading from 1400 to 1600 since it is located near the window. Point 8 workstation benefits both naturally and artificial lit environments but the reading decreases significantly from the 1700 onwards as a matter of decrease source of daylight. At point 6, the overall illuminance reading on both days achieved the appropriate range of illuminance level. The illuminance range is between

300 lux to 386 lux which has fulfill the requirement of ideal illuminance for studio space based on the Malaysian Standard in figure 2.1.

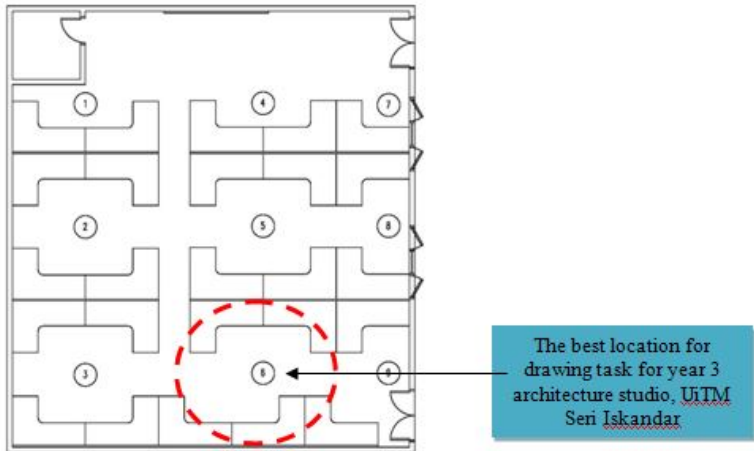


Figure 4.1 The best position in the studio (Point 6)



Table 4.1 Illuminance in lux against time (Day 1&amp;2)

| Time | Location | Illuminations |            | Time | Illuminations |            | Time | Illuminations |            | Time | Illuminations |            |
|------|----------|---------------|------------|------|---------------|------------|------|---------------|------------|------|---------------|------------|
|      |          | Day 1         | Day 2      |      | Day 1         | Day 2      |      | Day 1         | Day 2      |      | Day 1         | Day 2      |
| 1400 | Point 1  | <b>110</b>    | 129        | 1600 | 131           | 139        | 1800 | 138           | <b>150</b> | 2000 | 130           | 133        |
|      | Point 2  | 313           | 305        |      | 245           | 252        |      | 230           | 240        |      | 241           | 248        |
|      | Point 3  | 245           | 250        |      | 216           | 227        |      | 236           | 237        |      | 215           | 217        |
|      | Point 4  | 253           | 266        |      | 217           | 237        |      | 235           | 235        |      | 219           | 238        |
|      | Point 5  | 315           | 326        |      | 287           | 297        |      | 274           | 283        |      | 268           | 270        |
|      | Point 6  | <b>395</b>    | <b>386</b> |      | <b>315</b>    | <b>313</b> |      | <b>336</b>    | <b>340</b> |      | <b>300</b>    | <b>353</b> |
|      | Point 7  | 240           | 257        |      | 229           | 239        |      | 179           | 180        |      | 150           | 150        |
|      | Point 8  | <b>421</b>    | <b>423</b> |      | <b>453</b>    | <b>468</b> |      | <b>274</b>    | <b>290</b> |      | <b>165</b>    | <b>169</b> |
|      | Point 9  | 253           | 260        |      | 238           | 257        |      | 250           | 253        |      | 240           | 257        |
| 1500 | Point 1  | 129           | 132        | 1700 | 129           | 129        | 1900 | 146           | <b>150</b> | 2100 | 129           | 120        |
|      | Point 2  | 251           | 250        |      | 272           | 281        |      | 243           | 240        |      | 232           | 226        |
|      | Point 3  | 233           | 255        |      | 220           | 227        |      | 228           | 233        |      | 210           | 236        |
|      | Point 4  | 245           | 252        |      | 237           | 238        |      | 220           | 223        |      | 220           | 223        |
|      | Point 5  | 273           | 295        |      | 283           | 289        |      | 270           | 276        |      | 257           | 257        |
|      | Point 6  | 344           | 344        |      | 347           | 359        |      | 300           | <b>300</b> |      | 217           | <b>334</b> |
|      | Point 7  | 213           | 224        |      | 209           | 215        |      | 158           | 158        |      | 148           | 148        |
|      | Point 8  | 400           | <b>400</b> |      | 302           | <b>380</b> |      | 187           | 190        |      | 160           | 177        |
|      | Point 9  | 263           | 267        |      | 230           | 246        |      | 250           | 252        |      | 236           | 251        |

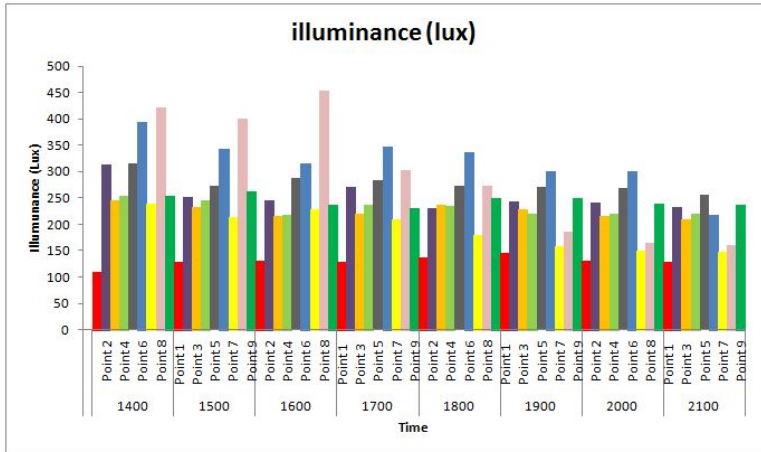


Figure 4.2 Illuminance in lux against time (Day 1)

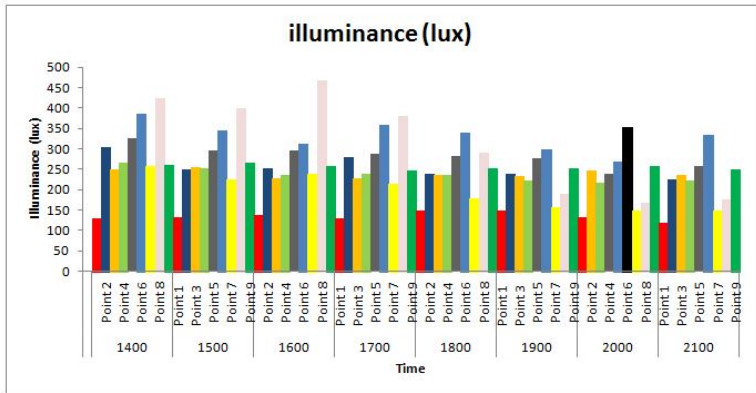


Figure 4.3 Illuminance in lux against time (Day 2)

## 4.2 Questionnaire Survey

Questionnaire was distributed to measure the level of studio occupancy, conducive and visual comfort. The three parameters were used to identify student perspective on studio environment quality. These three criteria evaluate student's response whether current studio environment can instills critical thinking in order to produce better design project. Figure 4.4 shows the percentage results of the respondents on agree and disagree of the three main criteria. For studio occupancy, most of the third year architecture student feel more comfortable to do their design drawings and assignments at home or hostel rather in the studio. Most of them find the studio is not very conducive and cozy to work with due to the internal layout and security purposes. Meanwhile, majority of the student feel the lighting level in the studio is acceptable and convenient.

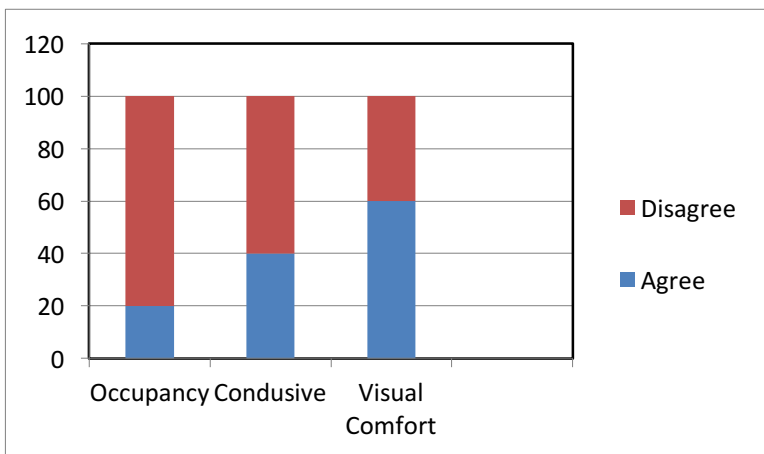


Figure 4.4 Questionnaire scores chart for third year architecture students showing the agree & disagree percentage from the students perspective based on the three parameters.

## 5.0 CONCLUSION

There is evidence that lighting is important in student's learning. From the research has shown that illuminance level in the architecture studio is insufficient and not in the range level as according to Malaysian:Standards 1525:2007. The finding shows that the lighting is not well-distributed to the whole studio. Most of the workstations in the studio are actually received insufficient amount of light which is not suitable for drafting task. According to the student's response the current studio environment is not conducive and appears monotonous. Poor lighting may contribute to their lost of interest in working in the studio. The suitable lighting arrangement shall also be considered in designing future and upgrading current architecture studio. According to lumen method calculation, design of a uniform general lighting scheme in a space can determine the number of luminaires needed to realize the illuminance (lux) required in the room (P.Trengenze & D.Loe, 2004). This method can be applied only in square or rectangular rooms with a regular array of luminaires such as the current study of the architecture studio. With this method we can avoid lavishness and inadequacy in lighting design in the future.

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