Evaluation of Visual Comfort for Drawing Rooms in Architectural Colleges (Case Study)

Dr. Mohamed Hassan Sayed Mostafa Elfalafly
Teacher of Architecture, October High Institute for Engineering and Technology- 6th of October City - Giza - Egypt

Abstract:

The drawing-rooms spaces are the main part of the success of the learning process in architectural colleges. Where lighting greatly affects the performance of the teaching process in the drawing halls. Thus, visual comfort plays an important role in improving educational performance in drawing halls. The research deals with an assessment of the effect of Daylight and Artificial lighting on the visual comfort of students in architectural drawing halls. This study was conducted in one of the educational drawing rooms in the Faculty of Architecture. The study phases were conducted using correlations between measures of current visual comfort and actual human perception. The data was collected by the simulation to analyze the quality of lighting and through questionnaires for the immediate realization of visual comfort. To discover the correlation of simulation analysis results with visual comfort assessment. The results indicate: When Daylight is used only inside the drawing-room (the study area). The results indicate: When using Daylight only inside the drawing-room (the study area). The average illumination intensity is 372 lx. When using Artificial lighting only, the average illumination intensity is 369 lx, while when using Daylight and Artificial lighting together, the average level of illumination intensity is 776 lx. As the appropriate value for the illumination intensity for drawing rooms is 1000 lx.
It appeared from the questionnaire to users of the drawing-room that the best lighting to achieve visual comfort is the use of natural lighting with artificial. Therefore, the drawing-room needs a set of treatments to achieve visual comfort. In general, the research aims to provide an adequate amount of lighting for users, and to achieve a uniform distribution of lighting within the space while avoiding glaring and darkness to achieve visual comfort.

Finally: These two evaluation approaches by simulation and questionnaire are useful for visualizing the appropriate lighting quality for drawing rooms to meet the needs of space users.

**keywords:**


1- **Introduction**

Education aims to improve the quality of life of human resources. The educational process can be hindered if the appropriate lighting is not available within the educational space. Visual comfort is the mainstay in the design of architectural drawing rooms (Castilla et al. 2018). Visual comfort is confirmed at all levels of education, from primary and secondary schools to university colleges in general (Bluyssen et al. 2018). Comfort in educational spaces has important effects on the educational process, as appropriate lighting can benefit health and productivity. (Leccese et al. 2020) Three main aspects are emphasized primarily (Thermal Comfort- Acoustic Comfort- Visual Comfort). (Wu, H et al. 2020). Where visual comfort depends mainly on lighting. (Yang, W et al. 2019).
The illumination intensity inside the drawing rooms is not less than 1000 lux as an average inside the space, which is a high amount of illumination when compared to other activities. It is twice the amount of lighting in reading rooms, three times the amount of lighting in classrooms, and five times the amount of lighting in residential buildings. It is also required that the amount of lighting should not be less than 6% of the total external lighting. (Egyptian code for lighting, 2008).

so does the need to achieve visual comfort. Lighting simulation has become a necessary tool in building design. Lighting simulation is used to show how a particular design prefers the use of Daylight, Artificial lighting, or both. (Diana, and Hans. 2017). Simulation-assisted lighting design processes require multiple simulation cycles, thus the task of comparing the alternatives is critical to finding the optimal solution. (Maaike et al. 2020). Lighting simulation tools help designers to analyze and evaluate different aspects of lighting quality in different spaces, providing an opportunity to improve lighting quality and thus visual comfort. (Anahita et al. 2019).

This study was performed to assess visual comfort in the Architectural Drawing Room, Faculty of Architecture, October 6 University. And that is by analyzing the visual comfort of users (students - faculty) through a questionnaire and simulation using the Relux Desktop program. This is done in three different cases (using Daylighting only - using Artificial lighting only - using both Daylighting and Artificial lighting), To discover the extent of the correlation between the results of the simulation analysis and the questionnaire to assess Visual comfort.
1-1 Literature review:

In the prior literature available, some examples of lighting analysis in academic classroom spaces have been found to name but not limited to. (Sathya, P. 2019), (Liang, Y et al. 2013), (Wang, R et al. 2017). Some of them focused on the analysis of lighting quality by simulation. On the other hand, many assessments about visual comfort and the effects of Daylight and Artificial lighting are based on surveys/interviews rather than measuring lighting levels for example (Ricciardi, P et al. 2018), (Castilla, N et al. 2018), (Bluyssen et al. 2018), (Barrett, P et al. 2015), (Yildiz, Y et al. 2019).

There is a lot of research in the field of visual comfort, to improve the visual comfort of users for example (Michael A et al. 2018). To improve the basic parameters of visual comfort. It has been used, for example, by (Vassiliades et al. 2018), (Jakubiec et al. 2015), (Kent et al. 2019). To assess or predict visual comfort. A wide variety of methods are applied in this field. The focus of the literature review is to identify the available tools that are used to assess visual comfort as well as the subjective evaluation of visual comfort using simulation tools. And in a study conducted by (Jakubiec et al. 2015). Simulations were used to predict the visual comfort of daytime users. The results showed that visual comfort can be predicted by simulation.

In Cyprus, buildings have been studied in different ways, using a field study using a questionnaire-based survey, as well as through simulations and on-site lighting measurements (Michael and Heracleous 2017). The results showed that the amount of daylight was sufficient throughout the year, but that excessive glare appropriately prevented the benefit of daylight. The study suggested different strategies based on room orientation to deal with a glare to improve visual comfort and improve the quality of day lighting.
2- **Study location:**

The study was conducted in one of the drawing rooms in the building of the Faculty of Engineering - Department of Architecture - October 6 University (O6U), as shown in figure (1). The drawing room is located on the third floor on the northeastern side of the building. Table (1) shows a description of the study room dimensions. The windows are located in the northwest direction, and there is one window behind the room in the northeast direction, as shown in figure (2). The room consists of 36 drawing tables.

![Figure No.(1): The layout of October 6 University shows the location of the Faculty of Engineering building. Source: Google Earth.](image)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>L (m)</th>
<th>W (m)</th>
<th>H (m)</th>
<th>Area (m²)</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room</td>
<td>20</td>
<td>8</td>
<td>3.5</td>
<td>160</td>
<td>560</td>
</tr>
</tbody>
</table>
Figure No. (2): shows the direction of the windows and used furniture.

3- **Methodology:**

The study was conducted during clear, overcast skies to cover minimum to maximum possible daylight with and without direct sunlight. The measurements were made at a height of one meter from the ground, where the operating level is relative to the drawing table. That is by simulating lighting in the drawing-room - making a questionnaire for users to measure the visual comfort in the drawing-room. And that in different lighting modes (Daylighting only - Artificial lighting only - Daylighting and Artificial lighting together).

3-1 **Carrying out the simulation**

The simulation did with (Relux Desktop 2020.1.1.0). For one day in January, when the sky is clear and overcast. Assess the level of illumination intensity located at the operating level. (the drawing table). The properties of the materials used are described. Table (2).

<table>
<thead>
<tr>
<th>Material</th>
<th>Reflectance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>White interior wall 70%</td>
</tr>
<tr>
<td>Floor</td>
<td>Generic floor 20%</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Generic ceiling 70%</td>
</tr>
<tr>
<td>Drawing Desk</td>
<td>Generic furniture 50%</td>
</tr>
<tr>
<td>Glazing</td>
<td>Glazing double pan 80%</td>
</tr>
</tbody>
</table>
3-2 questionnaire

A questionnaire was made for the users using an online questionnaire. It contained questions from different questionnaires (Hygge and Lofberg 1997), (Veitch et al. 2007), (Bluyssen et al. 2011).

User characteristics, and their reactions regarding visual comfort and satisfaction with the lit environment, were recorded. After introducing the survey and its purpose, questions were asked regarding drawing-room characteristics, satisfaction with the lit environment overall ("annual"), satisfaction with the lit environment, the response time ("instant"), user preferences, and behavior for light, as well as personal information.

The questionnaire was conducted by 50 users (35 students and 15 from the teaching and support staff). The participants were asked to rate the level of lighting quality. A 5-point Likert satisfaction scale (1 = very satisfactory to 5 = very unsatisfactory) was used for analysis.

4- Results:

The results are divided into two parts. The first section is the simulation results to evaluate the lit environment in terms of the level of illumination intensity. The second part is conducting a questionnaire to assess the visual comfort of users in the drawing-room.

4.1 Simulation results

The simulation results for the drawing-room were analyzed using Relux Desktop simulation software. The study space was evaluated in three cases (Day lighting only - Artificial lighting only - Day lighting and Artificial lighting together).
4-1-1 Day lighting analysis:

It was found that the average parameter of Day lighting is 6.3, the lowest parameter is 1.3, and the highest parameter is 26.9. Figure (3). The level of illumination intensity ranges between 80 to 1600 lx. The highest illumination intensity near the windows reaches 1590 lux, and the lowest level of illumination intensity is 80 lx at the southern part of the room far from the windows. While the average illumination intensity in the room is 372 lx. Figure (4).

Figure No. (3) shows the coefficient of Daylighting inside the drawing-room.

Figure No. (4) shows the illumination intensity for Daylighting inside the drawing-room.
4-1-1 Analysis of Artificial lighting:

It was found that the average illumination intensity is 369 lx. While the highest light intensity is 484 lx and the lowest intensity is 185 lx. Twenty-five fluorescent lighting units with a capacity of 40 watts were used for each lighting unit, as it is in reality, where it is distributed regularly, as in Figure (5).

![Diagram of Artificial lighting](image)

Figure No. (5) shows the illumination intensity for Artificial lighting inside the drawing-room.

4-1-1 Analysis of Daylighting and Artificial lighting together:

It was found that the highest level of illumination intensity was 2010 LAX in the areas near the windows on the north side of the hall. The brightness of 292 lx was lowest in the southern area of the room far from the windows. As the average illumination intensity is 776 lx, which is relatively acceptable as in Figure (6).
Figure No. (6) shows the illumination intensity for Daylighting and Artificial lighting together inside the drawing-room.

By comparing the results in the three measurement cases (Daylighting only - Artificial lighting only - Daylighting and Artificial lighting together). We find that the level of illumination intensity is not suitable for practicing the activity Since the appropriate value for the illumination intensity is 1000 lux for practicing the activity of drawing (Egyptian code for lighting, 2008). The average illumination intensity when using Daylighting is only 372 lx, and this is not enough. And glare occurs near the windows, which hinders the practice of drawing activity. When using Artificial lighting only, the average illumination intensity is 369 lx. When using Daylighting and Artificial lighting together, the average illumination intensity is 776 lx, which is relatively acceptable. There is a glare area that impedes the practice of activity. Therefore, the drawing-room needs processors to reduce the glow resulting from Daylighting near the windows. In addition to adding appropriate lighting units to achieve the illumination intensity required to practice the activity correctly. Figure (7).
Figure (7): shows the comparison between the illumination intensity inside the drawing-room in the three cases (Day lighting only - Artificial lighting only - Day lighting and Artificial lighting together).

4-2 Questionnaire results

The questionnaire was shown for the drawing-room 80% of 50 participants feel visual comfort when using daylighting with artificial lighting. 20% of the participants feel uncomfortable due to the glare due to their proximity to the windows. As for relying on daylighting only, 68% felt comfortable. 10% do not feel comfortable because of the glare, 22% do not feel comfortable because of their distance from the windows and the low illumination intensity. As for the current use of artificial lighting only, 40% of the participants felt visual comfort to some extent, while 60% of the participants did not feel comfortable, as shown in Figure (8).
Lighting units must add or changed to achieve the illumination intensity required to practice the activity in the drawing-room.

*Figure (8) Participants' perception of visual comfort in the drawing room*
5- Discussion:

Exploring the relationship between user evaluation and simulation evaluation is critical, as it seeks to integrate simulation with human cognition. Often in practice the performance evaluation and questionnaire are used to assess visual comfort. Accordingly, data from personal questionnaires and simulation data were compared.

The results show that although the preference for lighting and visual comfort varies greatly between individuals, there was a positive correlation between the overall lighting quality perceived by the users and the amount of light falling on the work area. There were high correlations for some variables, for example, lighting quality, artificial lighting, and glare. The results show that although the preference for lighting and visual comfort varies greatly between individuals, there was a positive correlation between the overall lighting quality perceived by the users and the amount of light falling on the work area. There were high correlations for some variables, for example, lighting quality, artificial lighting, and glare. Through the three evaluation cases (Daylighting only - artificial lighting only - Daylighting and artificial lighting together). The results indicate that treatments must be made to reduce the glare resulting from daylighting and to replace the current lamps with others that rely on LED technology to achieve visual comfort inside the drawing-room.

Currently, visualization techniques in most lighting simulation software are ideal to simplify the understanding of the designed lighting conditions. Reference should be made to the lighting simulation program ReluxDesktop. That was used in this study.
6- **Conclusion:**

In this study, the application was to assess visual comfort by conducting a case study of a drawing-room in the building of the Faculty of Architecture to analyze the quality of lighting and assess visual comfort from subjective and objective points of view. The study indicated the use of a systematic approach such as questionnaire, data collection, evaluation of human responses, and its integration with simulation-based evaluation using Relux Desktop software. There is a strong link between simulation evaluation and human perception, which helps designers achieve visual comfort for users. Detailed input of light sources, potential users, and their behavior or intended use of spaces is critical.

The visualization techniques provided by lighting simulation software are explored to support simulation-assisted lighting design and analysis processes. Where the visualization and analysis techniques provided by the lighting simulation software: ReluxDesktop to identify the techniques commonly used in the field of lighting design and analyze the results of the simulation.

7- **References:**


6- Egyptian Code No. (308) for lighting works, National Center for Housing and Building Research, Ministry of Housing, Utilities and Urban Communities, Arab Republic of Egypt, (2008).


