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Visual Comfort in Learning Environments: A Student Feedback Analysis

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Abstract

Students' academic performance and general well-being are greatly impacted by visual comfort in educational facilities because good lighting improves concentration and lessens discomfort. This study evaluates students' perceptions of lighting in MPB1.1 workshop classroom at Sultan Abdul Halim Mu'adzam Shah Polytechnic (POLIMAS), focusing on light perception, comfort, and acceptability. A total of 36 students from the Diploma in Building Services Engineering program participated by completing a survey questionnaire based on a 5-point Likert scale. Descriptive statistics were used to analyse the data and the results showed that respondents had generally favourable feedback about the lighting conditions with high ratings for brightness, colour accuracy, even distribution and minimal glare. The results highlighted the effectiveness of the lighting setup in supporting student comfort and productivity while identifying minor areas for improvement, such as glare management and enhanced uniformity. It emphasises how crucial well-designed lighting is to creating a positive learning environment and maintain high levels of visual comfort and usability.

Keywords **:** *Comfort perception; Lighting perception; Students' perceptions; Visual comfort*

I. INTRODUCTION

Visual comfort refers to the ease and relaxation experienced by our eyes and mind within a particular lighting environment [1]. It's not just about how bright or dim a space is, it's about how lighting makes us feel, and that can be different for everyone. Assessing visual comfort can be challenging as it depends on individual perceptions of their surroundings, which often differ based on personal preferences and needs [2]. In educational buildings, visual comfort is a critical aspect of classroom design, as it is closely tied to students' well-being and learning outcomes. Proper lighting can significantly reduce discomfort and enhance students' focus and productivity, creating an environment conducive to effective learning. Inadequate lighting in educational buildings can lead to visual discomfort, particularly during task-intensive activities. Research indicates that poor lighting design, characterized by improper brightness levels, glare, and uneven light distribution can disrupt students' visual comfort, causing eye strain and reducing concentration [3]. A study by [4] analyzed the lighting performance in a university architecture studio and found that appropriate lighting plays a vital role in achieving a satisfactory indoor environmental quality for students. Furthermore, [5] stress that bright and well-lit spaces are linked to enhanced positivity, energy, and motivation, while dim or overly harsh lighting can contribute to feelings of fatigue and gloominess. This emphasizes the significance of proper lighting in environments such as workplaces, schools, and homes to promote well-being and productivity.

II. LITERATURE REVIEW

Studies indicate that lighting design in classrooms has a profound and immediate impact on students' visual comfort, which influences their emotional and cognitive responses. [6] conducted a preliminary study to assess the emotional responses to different lighting conditions in university classrooms, highlights that well-designed lighting can evoke positive emotional responses, fostering a more conducive learning environment. The study underscored that emotional comfort is linked to visual comfort, emphasizing the need for lighting that complements natural light and avoids extremes that might cause eye strain or discomfort. This aligns with the broader understanding that lighting influences not only physical visibility but also psychological comfort, affecting students' attitudes and engagement levels.

Different learning activities demand varying levels and types of lighting to create optimal conditions for engagement and performance. Activities involving detailed visual tasks are better supported by higher light levels. Brighter and more

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focused lighting can improve accuracy and efficiency by reducing eye strain and enhancing focus. On the other hand, softer and more diffused lighting is more suitable for collaborative activities, such as group discussions or creative brainstorming sessions. This type of lighting helps to establish a calm and inviting atmosphere, encouraging open communication and fostering creativity among participants. By tailoring lighting to the specific requirements of different learning activities, educators can significantly influence students' ability to concentrate and perform effectively. Adjusting light intensity, color temperature, and distribution can help create environments that are not only conducive to specific tasks but also supportive of students' overall well-being and productivity. Such an approach recognizes the interplay between environmental factors and learning outcomes, as highlighted by [7].

A well-designed and comfortable classroom environment plays a pivotal role in motivating students to perform at their best and enhancing the teaching-learning process. The physical environment of the classroom, including factors such as lighting, ventilation, seating arrangements, and overall layout, significantly influences students' engagement, focus, and academic outcomes. Given that students spend a substantial portion of their time indoors in classrooms, it is essential to consider how the built environment affects not only their concentration and learning performance but also their physical and mental health. Elements like proper lighting can reduce eye strain, while good ventilation improves air quality, supporting better cognitive function. Ergonomic seating and spatial arrangements can minimize discomfort and distractions, allowing students to stay attentive for longer periods. Furthermore, a thoughtfully designed classroom can foster a positive atmosphere that enhances collaboration and reduces stress, thereby contributing to a more effective and enjoyable learning experience. As highlighted by [8], understanding the relationship between the classroom's built environment and its impact on students' well-being and academic performance is critical for creating spaces that support both learning and overall health.

Effective lighting is a critical component of the learning environment, as it enhances the visibility of whiteboards and other educational materials. By providing sufficient illumination, good lighting reduces eye strain and fatigue, enabling students to focus better and engage more effectively with their studies [9]. Proper lighting levels not only support clarity and comfort but also play a pivotal role in academic performance. Research highlights that adequate lighting can significantly boost reading comprehension and speed, allowing students to process information more efficiently [10].

In contrast, inadequate or poor-quality lighting can negatively impact students' ability to concentrate and learn. Insufficient lighting often forces students to squint, which can cause discomfort, headaches, and even long-term vision issues. These physical challenges can lead to reduced focus, lower retention of information, and decreased academic productivity [11]. Optimizing classroom lighting is therefore essential for fostering an environment conducive to effective learning. Educators and school administrators must prioritize the installation and maintenance of appropriate lighting systems, considering factors such as brightness, color temperature, and even light distribution, to ensure students' comfort and academic success.

III. RESEARCH METHODOLOGY

A. Research Design

This research aims to evaluate students' perceptions of lighting in workshop classrooms, focusing on aspects such as light perception, comfort perception, and overall acceptability. The study specifically targets students in their third and fifth semesters from the Diploma in Building Services Engineering (DPB) program at Sultan Abdul Halim Mu'adzam Shah Polytechnic (POLIMAS), who have hands-on experience in workshop classrooms, specifically in MPB1.1. A total of 36 respondents participated, representing both the third and fifth semesters. This selection was made to ensure a diverse representation of perspectives, as students at different stages of their education may have varying experiences and expectations regarding their learning environments. By concentrating on these specific groups and settings, the study aims to capture detailed insights into lighting needs and preferences in specialized learning spaces.

B. Data Collection

Data were collected through a survey questionnaire that comprised six statements related to lighting perception, six statements related to comfort and one item on acceptability. The questionnaire used a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) to gauge students' levels of agreement with each statement. The perception questions were adapted from [12], utilizing light descriptors to explore participants' perceptions. The second section focused on comfort, addressing aspects such as color, light levels, distribution, glare, and an overall evaluation of the visual environment. Additionally, a final question assessed the acceptability of the visual environment.

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C. Data Analysis

The collected data were analyzed using descriptive statistics to determine the mean and the standard deviation for each statement. This analysis provided insights into the overall trends in students' perceptions of lighting in workshop classrooms.

D. Limitations

The sample size of 36 respondents, while providing initial insights, may limit the generalizability of the findings. Future studies could benefit from a larger sample size to capture a broader range of experiences. This study focuses solely on students' perceptions and does not include objective measurements of lighting conditions, which could provide additional context to the findings. Additionally, the sample was restricted due to the absence of student intake for semesters two and four, and first-semester students have not yet used the workshop classroom, further narrowing the representation of perspectives. Expanding the sample to include a more diverse set of student experiences and integrating objective lighting measurements could enhance the depth and applicability of future research in this area.

IV. RESULT AND DISCUSSION

Table 1 presents the analysis of mean and standard deviation for each lighting perception item.

Table 1 Lighting Perception Analysis

No.	Item	Mean	Standard Deviation
1.	The color of the lighting in the room is warm.	3.167	1.342
2.	The color of the surfaces seems natural, without distortion.	4.000	1.014
3.	The room seems bright.	4.222	0.989
4.	The light is distributed evenly in the room.	4.278	0.882
5.	There is imperceptible glare in the room caused by the lamps.	2.694	1.390
6.	Overall, the visual appearance of the room is very pleasant.	4.139	0.931

The mean score of 3.167 suggests that students have a mixed perception regarding the warmth of the room's lighting, with some finding it acceptably warm and others possibly feeling it lacks warmth. The high standard deviation of 1.342 indicates considerable variability in students' opinions on this aspect, suggesting that while some students may find the lighting temperature suitable, others may feel it deviates from their preference, perhaps due to the intensity or hue of the light.

With a mean score of 4.000, students generally agree that the lighting allows for a natural appearance of surfaces without color distortion. This high rating reflects satisfaction with the light's quality in maintaining the true colors of surfaces, which is essential for a visually comfortable environment. The standard deviation of 1.014 shows moderate variability, suggesting that while most students perceive the colors accurately, a few might see slight inconsistencies, perhaps due to differences in light intensity or their seating position.

A high mean score of 4.222 shows that students perceive the room as sufficiently bright, which is ideal for visibility and focus in an educational setting. The low standard deviation of 0.989 indicates that most students consistently agree on the room's brightness, with little variability in perception. This consensus highlights that the lighting is suitably adjusted for brightness across the room, contributing positively to the students' learning environment.

This item received one of the highest ratings, with a mean of 4.278, indicating that students perceive the lighting distribution as uniform throughout the room. Even distribution reduces shadows and ensures all areas are equally illuminated, which is beneficial in maintaining visual comfort. The relatively low standard deviation of 0.882 shows strong agreement among students, suggesting that most find the lighting to be well-balanced and consistent, enhancing the overall quality of the environment.

This item has a lower mean score of 2.694, indicating that students may notice some glare from the lighting, which can be distracting and uncomfortable. The high standard deviation of 1.390 reflects a wide range of responses, showing that glare is a concern for some students more than others, possibly due to seating position or the type of light fixtures. This variability suggests that glare management may be an area for improvement to enhance the room's overall visual comfort.

The mean score of 4.139 demonstrates a positive perception of the room's visual appeal under

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the current lighting conditions, suggesting that most students find the room visually comfortable and pleasant. The low standard deviation of 0.931 indicates consensus among students, with only minor differences in opinion. This high satisfaction level with the overall ambiance suggests that the lighting setup contributes positively to a comfortable and aesthetically pleasing environment.

The analysis of student perceptions on lighting quality reveals a generally positive response, particularly in brightness, even distribution, and natural color rendering. Students have expressed satisfaction with the brightness levels, noting that the lighting is sufficient for tasks such as reading, writing, and using electronic devices without causing strain on the eyes. Additionally, the even distribution of light throughout the room ensures there are no dark spots or overly illuminated areas, which contributes to a comfortable and balanced environment. This uniform lighting helps to reduce distractions caused by glare or shadows, enhancing focus and productivity. Furthermore, the natural color rendering of the lighting has been well-regarded, as it accurately reflects colors within the space, creating a warm and inviting atmosphere. This aspect not only improves the aesthetic appeal of the room but also supports activities that require accurate color perception. Overall, the positive feedback underscores the effectiveness of the room's lighting design in meeting the students' needs.

Table 2 displays the analysis of mean and standard deviation for each comfort perception item.

Table 2 Comfort Perception Analysis

No.	Item	Mean	Standard Deviation
1.	The color of the lighting in the room is very comfortable.	4.278	0.882
2.	The appearance of the surfaces' colors is very comfortable.	4.222	0.866
3.	The amount of light in the room is very comfortable.	4.222	0.866
4.	The light distribution in the room is very comfortable.	4.250	0.967
5.	The lamp do not cause glare.	4.083	0.906
6.	Overall, the visual environment of the room is very comfortable.	4.194	0.856

The high mean score of 4.278 suggests that students find the color of the lighting to be very comfortable, indicating that the chosen color temperature aligns well with their preferences for a visually pleasant environment. The relatively low standard deviation of 0.882 shows that students generally agree on this comfort level, with little variability in responses, reflecting a successful choice in the color tone used.

A mean of 4.222 indicates that students perceive the color rendering of surfaces as comfortable, meaning that the lighting allows surfaces to appear naturally, without color distortion. This score suggests satisfaction with the accuracy of color representation under the room's lighting. The low standard deviation of 0.866 suggests strong consensus among students, indicating minimal variation in their comfort levels regarding this aspect.

Similar to color rendering, the amount of light in the room also scored highly, with a mean of 4.222. This score reflects that students generally feel comfortable with the brightness level, finding it neither too intense nor too dim. The low standard deviation of 0.866 suggests that most students are aligned in their comfort with the room's brightness, indicating that the lighting is well-adjusted for the activities in this space.

With a mean score of 4.250, students perceive the light distribution to be comfortable, indicating that it is spread evenly across the room. Proper light distribution prevents shadows and bright spots, which can cause discomfort and distraction. The slightly higher standard deviation of 0.967 indicates a little more variation in comfort levels, suggesting that while most students feel satisfied, some may perceive minor inconsistencies in distribution.

The mean score of 4.083 indicates that students generally find glare from the lamps to be minimal or non-existent, which is essential for visual comfort and focus. The standard deviation of 0.906 shows moderate agreement among students on this point, with some variability in experiences of glare, potentially influenced by seating positions relative to the light sources.

The high mean score of 4.194 reflects a positive overall perception of the visual environment, with students generally finding it comfortable and conducive to focus and engagement. The low standard deviation of 0.856

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suggests strong agreement across responses, indicating that the room's lighting conditions create a consistently comfortable experience for students.

The analysis of student comfort perceptions regarding the room's lighting reveals a strong positive response, with high comfort ratings across all assessed aspects: color, brightness, distribution, and glare. Students find the lighting environment comfortable overall, with minimal variability in responses, suggesting that the setup is well-aligned with their needs. However, there are slight indications for improvement in light distribution and glare, which can further enhance visual comfort and reduce potential strain. Such adjustments could make the lighting even more supportive for extended focus and general well-being.

To optimize the comfort of the room's lighting, several targeted adjustments are suggested. Enhancing the consistency of light distribution can address minor variations in comfort, as uniform lighting reduces shadows and creates a balanced visual field [13]. This could be achieved by repositioning fixtures or adding supplemental lighting in underlit areas. Minimizing glare further would be beneficial, as glare disrupts visual comfort and can cause eye strain.

The analysis of the mean and standard deviation for the acceptability item, as shown in Table 3, provides valuable insights into students' perceptions of the current visual environment. The mean score of 4.306, which is relatively high on a typical five-point Likert scale, indicates that students largely find the visual environment satisfactory. This high mean suggests that key aspects of the environment, such as lighting levels, color schemes, and spatial arrangement, align well with the students' needs and expectations, thereby promoting a positive and conducive setting for their activities. The standard deviation, measured at 0.889, is relatively low, signifying a tight clustering of responses around the mean. This implies a strong level of agreement among the students regarding the adequacy of the visual environment. In other words, the students' assessments are consistent, with few outliers or extreme differences in opinion.

Table 3 Acceptability Analysis

No.	Item	Mean	Standard Deviation
1.	At this moment, the visual environment is acceptable.	4.306	0.889

This overall positive perception suggests that the lighting configuration and general room setup have successfully achieved a balance between aesthetic appeal and functionality. Good lighting is critical for tasks such as reading, writing, and prolonged focus, while a well-organized room layout enhances comfort and ease of movement. These factors, when combined, likely contribute to the high acceptability rating and consensus among students. Moreover, the findings point to the effectiveness of the current design in meeting both practical and psychological needs. A visually acceptable environment not only supports physical activities but also fosters a sense of well-being, which can positively influence students' productivity and satisfaction. This data reinforces the importance of maintaining and potentially refining such environmental features to ensure sustained or improved user experience.

While the current visual environment is generally perceived as acceptable, there remains room for improvement to further optimize comfort and sustain high standards over time. Enhancements such as ensuring uniform light distribution and addressing potential issues with glare could significantly contribute to a more comfortable and functional environment. These adjustments are particularly important as they help to minimize eye strain and improve overall visibility throughout the room [13], ensuring a more balanced and conducive visual experience for all users. Moreover, by fostering a positive learning atmosphere through thoughtful lighting design, educators can play a pivotal role in supporting students' focus and engagement throughout the school day. Research by [14] highlights the importance of well-designed lighting in maintaining students' attention and productivity. Proper lighting not only reduces distractions caused by poor visibility or discomfort but also creates an inviting and motivating environment that encourages active participation and sustained concentration.

Integrating these strategies into the current visual environment can enhance not only the physical comfort of students but also their cognitive and emotional well-being. Over time, this comprehensive approach to lighting and room design can help maintain a high level of satisfaction and promote an environment that fully supports educational objectives.

V. CONCLUSION

The results indicate that the current lighting setup in the room is well-received by students, with high ratings across all aspects of comfort, including color, brightness, even light distribution, and minimal glare. The strong consensus and low variability in responses reflect that the lighting environment effectively supports student comfort, contributing to a positive and visually pleasant atmosphere. Students generally find the lighting

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color and brightness levels appropriate, the light distribution balanced, and the glare manageable, which are all crucial elements for maintaining focus and reducing eye strain. The positive rating of the overall visual environment as "acceptable" further confirms that the lighting conditions align well with students' needs.

These findings suggest that the room's lighting setup is successfully optimized for comfort, creating a conducive learning environment. Minor adjustments to ensure consistent uniformity and continued monitoring can maintain and enhance this positive experience, keeping the environment adaptive to any evolving student preferences.

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