



# Effects Of Daylighting on Users in Oyo State University Libraries

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## ABSTRACT

Daylighting, the strategic use of natural light in building design, is essential for creating sustainable and energy-efficient spaces. Its implementation must balance natural illumination, especially in academic buildings which requires good lighting system. In university libraries, where students and researchers spend a lot of time to gain knowledge, effective daylighting is paramount as it is importance for good sight and readability of books. Several research has been done on daylighting; however, little research has been carried out on the effect of daylighting in tropical savanna climates like Oyo State, which is characterized with high solar radiation, especially in libraries where good lighting is important. This study therefore fills that gap by accessing the effects of daylighting on users in libraries of Oyo state universities. Data for the study were collected using well-structured questionnaires. Twelve universities in Oyo State were considered for this study, out of which five university with purpose-built library were purposively selected. A total of 366 questionnaires were distributed. The results indicate that the majority of the respondent agrees that daylighting has an effect on visual comfort ( $TWV/n = 4.06$ ) and overall comfortability ( $TWV/n = 4.16$ ) while using the library. Respondents strongly associated daylighting with having an effect on library usage satisfaction ( $TWV/n = 4.27$ ) while a minority (24.3%) complained on the negative effects like glare and excessive heat. The study concludes that daylighting significantly enhances comfort and satisfaction in the university library while issues like glare and heat highlight the need for better control measures. The study recommends that library should improve daylight distribution, reduce glare with blinds or diffusers, while architectural upgrades like skylights can also be considered to increase natural light access.

**KEYWORDS:** Daylighting, Sustainability, Artificial light, Visual comfort, Energy efficiency.

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## I. Introduction

Daylighting is the strategic integration of natural light into a building design comprising of direct sunlight and diffused skylight. It is a critical element in creating sustainable, energy-efficient, and human-centric spaces. It reduces reliance on artificial lighting while fostering environments that support productivity and success (Rajendran & Charde, 2018). Daylighting is indispensable not only for human vision but improving mental health (Lee et al., 2022). Unlike artificial lighting, which has been linked to eye strain and fatigue, daylighting promotes alertness, reduces stress, and enhances mood which are vital in academic settings where concentration is paramount (Hamzah et al., 2018).

University libraries, as hubs of intellectual activity, benefit profoundly from well-designed daylighting. In university libraries, where students, lecturers, and researchers engage in prolonged periods of study, effective daylighting enhances visual comfort, cognitive performance, and overall well-being (Ma'bdeh & Al-Khatatbeh, 2019). A glare-free, evenly lit environment minimizes reliance on energy-intensive artificial systems and creates visually comfortable spaces that encourage prolonged study sessions (Tabadkani et al., 2021). However, its implementation requires balancing natural illumination with challenges such as glare, thermal discomfort, and climatic considerations (Wong, 2017) particularly in regions like Nigeria, where intense solar radiation demands meticulous design.

There is a strong correlation between students' academic outcomes and their satisfaction with the learning environment, with lighting conditions in library spaces being a critical contributing factor. Daylighting, plays a key role in regulating human biological rhythms. When light reaches the retina, it influences neural activity and controls hormonal cycles, particularly the secretion of melatonin, which promotes sleep. Melatonin levels are

naturally suppressed in the presence of light and rise in darkness. A study by Kime and Alibaba (2018) revealed that many library interiors are inadequately lit by natural light, leading to unusually high melatonin concentrations in students using these facilities. This hormonal imbalance can result in fatigue and decreased academic effectiveness.

Another study by Khanmohammadi, Masoudinejad, and Alirezaie (2016) indicate that artificial lighting has a limited impact on the body's internal clock when compared to natural daylight. Their research suggests that both the brightness and the spectrum of light that reaches the eyes significantly influence the circadian system. A variety of factors determine how much daylighting enters a building, including geographic coordinates, building shape and placement, surrounding vegetation, orientation, intended use, materials used in walls and façades, as well as window attributes such as size, position, type of glazing, and shading mechanisms. Large glazed windows risk excessive heat gain and glare, undermining user comfort. Solutions such as shading devices, light shelves, and strategic orientation can mitigate these issues while maximizing natural illumination (Kisteleghi et al., 2022). For instance, reflective surfaces and north-facing windows in the Northern Hemisphere can diffuse light evenly, reducing hotspots and glare.

Several research has been carried out on the daylighting in academic buildings as seen in a study carried out by Porrasn (2020). However, there is little research on the effects of daylighting in university libraries in a tropical savanna climate especially in Oyo state. Hence, there is a need to investigate how daylighting affects the users of library in order to create guidelines for architectural designs in this climatic typology

### **Conceptualization and Review of the Literature**

Daylighting is defined as the controlled admission of natural light, direct sunlight, and diffused-skylight into a building to reduce electric lighting and save energy (Rajendran & Charde, 2018). Daylighting is used by occupants or building users for the comfort of their lifetime living in the building. As humans, our visual comfort and psychology were adjusted to natural daylight and therefore it is needed as a basic alternative in the building during the day hours. Its dynamical change is stimulus for day and night cycle and it can control mood and health of occupants respectively. Minimum lighting requirements for visual performance described earlier refer to artificial lighting and daylighting as well. Improved lighting conditions for higher visual comfort and performance can be reached by integrating the design of day lighting without increase of energy use consumption and CO<sub>2</sub> emission of the built environment (Nasrollahi and Shokri, 2016). The view from the indoor to the outdoor is an important and significant requirement for natural day lighting design as well. The need for day lighting in the designs of buildings cannot be over emphasized. Although, artificial lighting is also augmented, it is not a replacement for daylight and not as sustainable. The emissions of fossil fuels into the atmosphere, the suitability etc. are some of the disadvantages of artificial lighting. (De Souza, Da Silva, Barbosa and De Oliveira, 2019).

### **Impact of Daylighting on Human Performance in Library Buildings**

Students' performance is considerably related with satisfaction with educational environment. One of the foremost important environmental factors in library building is lighting. Daylighting controls the body's biological time by touching the retina, impacting the neural structure organ and controlling hormone secretion. Endocrine (as sleep hormone) levels are reduced within the light and it is secreted in the dark. Kime and Alibaba (2018) has shown that there is not enough daylight in library buildings and that blood hormone levels of students in these libraries are most beyond those in areas with sensible lighting. This issue causes drowsiness among students and undermines their performance. On the other hand, Khanmohammadi, Masoudinejad and Alirezaie (2016) have demonstrated that hormone suppression values calculated for electrical light compared with natural light are low and so, this lighting system doesn't appear to supply enough information to the circadian system. During this research, the obtained results showed that not only the luminance but additionally light spectral power distribution of (the light the sunshine) received by eyes played a major role in circadian response and spectral characteristics of internal and external surfaces influenced light spectral power distribution.

Daylighting is the combination of sunlight, skylight and reflected light from the ground. Factors affecting the amount of daylighting in buildings include latitude and longitude, building form, building location, landscaping, building orientation, building usage, joinery construction materials of interior walls and exterior facades, window size and position as well as window components (such as glass ratio, glazing materials and shading devices). The amount of daylighting in interior spaces can be measured by calculating method of daylight illuminance of space (in Lux and Foot Candle units) and daylight factor (DF).

**Table 1: Proper Illuminance in Educational Spaces**

Standard maintained Illuminance (Lux)	Space Type
300	Class room
500	Library
500	Lecture hall
500	Black board
500	Art room

750	Technical drawing room
200	Entrance hall
100	Circulation area
150	Stairs
200	Student common room

Source: kime (2018)

## II. Materials and Methods

### Study Area

The study was carried out in Oyo State, Nigeria, an area of about 28,454 square kilometers and approximately between 7°50'N to 9°20'N and 3°00'E to 4°30'E. Temperatures range from 22°C during the rainy season to 35°C in hotter months, with Harmattan winds in December and January (Wahab and Ola, 2018). It is located in the southwestern part of the country sharing boundaries with Kwara State, Osun State, Ogun state and Republic of Benin. It has a population of approximately 7.8 million. The state (Figure 1) serves as a significant educational hub in Nigeria, renowned for its concentration of higher education. It is home to twelve (12) tertiary institutions which include both private, and public universities.

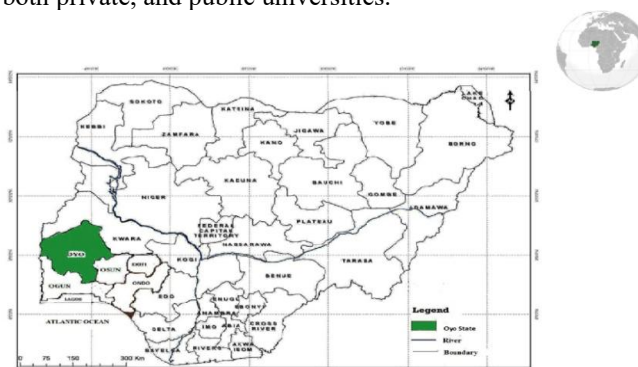


Figure 1: Oyo State within the Context of Nigeria

Source: Akanmu *et al* (2019)

This study utilized primary data collection. The primary data were obtained through multi-stage sampling technique. Firstly, Oyo state was stratified into regions: Ibadan, Oyo, Ogbomoso, Oke Ogun and Ibarapa. Twelve (12) Universities were identified in these regions except Oke ogun and Ibarapa region which had no university. In the next stage, five (5) universities with purpose-built libraries were selected purposively, and they include: University of Ibadan, Ladoke Akintola University of Technology, Ajayi Crowther University, Emmanuel Alayande University and Kola Dai University. Reconnaissance Survey showed that the total number of users of the libraries during peak hours is 4361 which served as the research population. However, Using Solving formula at 95% confidence level and a 0.05 margin of error, a sample size of 366 students was selected for questionnaire administration which is 8% of the research population.

Table 2: Universities with Purpose-built Libraries

S/N	University	Capacity of Library	Population of Library users (at peak hours)	Sample Size (8%)
1.	University of Ibadan, Ibadan	750	800	67
2.	Ladoke Akintola University of Technology	1500	1214	102
3.	Ajayi Crowther University, Oyo	1750	1000	84
4.	Emmanuel Alayande University, Oyo	1000	860	72
5.	Kola Dai University, Ibadan	500	487	41
Total		5500	4361	366

Source: Author's Field Survey, 2025

## III. Results and Discussion

### (i) Effects of Daylighting on Visual Comfort Across University Library in Oyo State.

The results from Table 3 evaluated the effects of daylighting on visual comfort across the selected university library which showed a positive consensus with the overall Total weighted value (TWV/n) of 4.03. Daylighting's effect on clear visibility scored a TWV of 1596 and a TWV/n of 4.36, showing that most respondents agree it contributes positively to visibility. Majority of the respondents also agrees that daylighting enhances the ability to read for extended periods without discomfort with a TWV of 1490 and a TWV/n of 4.07. The lowest

TWV (1340) and TWV/n (3.66) were recorded for the statement linking abundant daylighting to reduced eye fatigue, reflecting its critical role in minimizing visual strain, showing the need for improved daylighting distribution in the library. This result reinforces the importance of daylighting for long-term comfort in the library space.

**Table 3: Effects of Daylighting on Visual Comfort**

<i>Statement</i>	<i>Strongly Agree (5)</i>	<i>Agree (4)</i>	<i>Neutral (3)</i>	<i>Disagree (2)</i>	<i>Strongly Disagree (1)</i>	<i>Total Frequency (n)</i>	<i>TWV</i>	<i>TWV/n</i>
<b>Daylighting in the library affects clear visibility</b>	205	116	22	18	5	366	1596	4.36
<b>I experience less eye fatigue in areas with abundant daylighting,</b>	113	125	45	57	26	366	1340	3.66
<b>Daylighting affects my ability to read for long periods without discomfort</b>	144	156	24	32	10	366	1490	4.07
<i>Total</i>								4426/1098
	462	397	91	107	41	1098	4426	<b>4.03</b>

*Source: Author's Field Survey, 2025*

**(ii) Effect of Daylighting on Comfortability of the Library Users across Universities in Oyo State**

The results from Table 4 presented the respondent response to the level of agreement with the statement regarding how daylighting affects comfortability across the selected university library in Oyo State. It examines responses on how natural daylighting influences comfort in library spaces. For the first statement, "The presence of natural daylighting in the library makes me feel more comfortable and relaxed during my time here", the TWV is 1655, and the TWV/n is 4.52. This shows a relatively high level of agreement, showing that majority of respondents find natural daylighting relaxing, and strongly associate it with enhanced comfort in their library experience. The second statement, "I feel less fatigued and more comfortable when working or studying in areas with abundant natural daylighting," has a TWV of 1484 and a TWV/n of 4.05. Many respondents recognize the role of daylighting in reducing fatigue and improving comfort. For the third statement, "Daylighting contributes to creating a pleasant atmosphere in the library that makes me feel more comfortable staying for longer periods," the TWV is 1534, with a TWV/n of 4.19. This reveal that respondents agree with this statement, acknowledging that daylighting adds to the ambiance and encourages longer stays. The fourth statement, "I am more likely to choose seating areas with access to daylighting because they feel more comfortable and inviting, has a TWV/n of 3.75. This shows a moderate level of agreement, revealing that access to daylighting is not a major significant factor influencing respondents' choice of seating in the library.

For the fifth statement, "Natural light in the library improves quality and overall comfort during study sessions," the TWV is 1563, and the TWV/n is 4.27. This shows a strong level of agreement, with respondents recognizing the benefits of daylighting and endorsing it as a key factor in enhancing comfort during study sessions. The combined TWV of 7610 and average TWV/n of 4.16 across all statements highlight that respondents generally acknowledge the positive effects of daylighting on comfort, but their levels of agreement vary. The highest TWV/n value (4.52) for the effect of daylight on the respondent comfort show that the most impactful aspect of daylighting is making the users comfortable and relaxed. However, to enhance the overall experience, libraries should optimize daylighting design by increasing its uniformity, reducing glare, and ensuring a balance between natural and artificial lighting to cater to diverse user preferences

**Table 4: Effect of Daylighting on Comfortability across University Libraries**

Statement	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Total Frequency (n)	TWV	TWV/n
Natural daylighting in the library makes me feel more comfortable and relaxed during my time here	203	151	12	0	0	366	1655	4.52
I feel less fatigued and more comfortable when working or studying in areas with abundant natural daylighting	132	148	60	26	0	366	1484	4.05
Daylighting contributes to creating a pleasant atmosphere that makes me feel more comfortable staying for longer periods	115	206	45	0	0	366	1534	4.19
I am more likely to choose seating areas with access to daylighting because they feel comfortable and inviting	87	175	50	35	19	366	1374	3.75
Natural light in the library improves quality and overall comfort during study sessions	155	155	56	0	0	366	1563	4.27
<b>Total</b>	692	835	223	61	19	1830	7610	7610/1830 <b>4.16</b>

*Source: Author's Field Survey, 2024*

### (iii) Effect of Daylighting on Users Satisfaction of Libraries in Oyo State

The result of daylighting's effect on satisfaction of users in university libraries is shown in the Table 5 highlights its significant role in shaping the overall library experience. This provides insights into how daylighting influences the satisfaction of the users. The highest-rated aspect is clarity and ambiance, with a TWV/n of 4.31, indicating that users perceive daylighting as a key factor in creating a visually comfortable environment. A majority of respondents (328) rated this aspect as having a very high or high impact, with no responses indicating "No Impact." This confirms that daylighting significantly enhances visibility and spatial comfort, making it the most positively rated. For its effect on satisfaction with readability, the TWV/n of 4.22 suggests a slightly lower effect compared to clarity and ambiance. While 313 of respondents still rated daylighting as having a very high or high impact on reading materials like books, tablets, and computer screens, some users (15) reported low impact, indicating that issues such as glare or uneven lighting may sometimes hinder their satisfaction with readability. Despite this, the TWV/n remains well above 3.0, meaning that users generally find daylighting beneficial in supporting their reading activities.

The effect of daylighting with the overall satisfaction with the library use has a TWV/n of 4.26, which closely aligns with the total TWV/n of 4.27. A small percentage (19) rated the impact as low, reinforcing that daylighting, while beneficial, works best when integrated with other environmental considerations.

This connotes that the daylighting has the strongest effect on satisfaction with the clarity and ambiance of the library (TWV/n of 4.31), with the effect on the overall satisfaction (TWV/n of 4.26) follows closely, and its effect with satisfaction with readability (TWV/n of 4.22) has the lowest rating. However, in the absolute analysis, where TWV/n values are assessed on a scale of 5.0, all values remain well above 3.0, confirming that users are generally satisfied with daylighting's contribution to their library experience.

**Table 5: Effect of Daylighting on Users Satisfaction**

Statement	Very High Impact (5)	High Impact (4)	Moderate Impact (3)	Low Impact (2)	No impact (1)	Total Frequency (n)	TWV	TWV/n
How much impact does daylighting has with the clarity and ambiance of the library environment?	152	176	38	0	0	366	1578	4.31
What effect does daylighting have on satisfaction with the	150	163	38	15	0	366	1546	4.22

readability of materials such as books, tablets, and computer screens?								
What impact does daylighting have on the overall satisfaction with the library?	168	143	36	19	0	366	1558	4.26
<b>Total</b>	470	482	112	34	0	1098	4682	4.27

Source: Author's Field Survey, 2024

#### (iv) Effects of Excessive Daylighting (e.g., glare, overheating)

A number of 277 of the respondents (75.7%,) reported experiencing no negative effects while, 24.3% of respondents indicated experiencing negative effects, such as glare or excessive heat. This proportion, while relatively small, show a potential concern for nearly a quarter of the users, showing that certain spaces within the libraries may be inadequately shielded from excessive sun and glare. Addressing these concerns through improved shading, reflective materials, or ventilation systems will enhance user comfort and satisfaction. This reveal that while overall daylighting design is effective, targeted improvements in specific areas to create comfortable environment for all users. Enhancing shading mechanisms, optimizing window placement, or incorporating heat-reducing materials could help address.

### IV. Conclusion

The study reveals that daylighting positive effect on users' comfort, visibility, and overall satisfaction in the university library. Respondents strongly associate natural light with improved clarity, reduced fatigue, and a more pleasant study environment.

#### Recommendation

The study recommends that the university library prioritize the integration and optimization of natural daylight within its interior spaces through architectural strategies such as the incorporation of larger windows, skylights, or light wells, as well as the strategic placement of study areas to maximize exposure to daylight. Additionally, the use of light-diffusing materials or adjustable shading devices is advised to control glare while preserving the benefits of natural illumination. These measures are expected to enhance user comfort, improve visual clarity, reduce fatigue, and contribute positively to the overall satisfaction of library users, as evidenced by the findings of the study.

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