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DAYLIGHT, GLARE, AND STUDENT STUDY BEHAVIOR IN A UNIVERSITY LIBRARY A MIXED METHODS CASE STUDY AT EASTERN MEDITERRANEAN UNIVERSITY

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Daylight is widely valued in educational buildings for visual comfort, wellbeing, and energy efficiency, yet poorly controlled daylight can introduce glare, uneven illumination, and visual fatigue that disrupt learning activities. This study investigates how daylight conditions influence students' psychological responses and study behavior in the main university library at Eastern Mediterranean University (EMU), Famagusta, North Cyprus (Aram and Alibaba 2018). A mixed-methods case-study design was applied, combining systematic on-site observations and a two-part questionnaire administered during daylight hours (10 a.m.–5 p.m.) with quantitative simulations of solar gain and solar radiation using Autodesk Ecotect Analysis. Findings indicate that users generally preferred natural light over artificial lighting, but the perceived benefits depended strongly on daylight distribution and glare control. Daylight exposure varied across floors and orientations due to roof apertures and high vertical windows, producing localized glare, high contrast, and reflections on work surfaces and electronic devices. Morning conditions with indirect daylight were associated with improved concentration and higher perceived energy, whereas early-afternoon and late-day conditions with strong glare or low ambient light were linked to fatigue, discomfort, and reduced attention. Seasonal changes in solar position affected radiation and gain, but seat selection was more closely related to perceived daylight quality than to solar gain alone. The study highlights the importance of integrated daylighting strategies—optimized furniture layout, reduced reflective finishes, and adaptable shading and glazing—to enhance visual comfort and support sustained study performance in contemporary library environments.

INTRODUCTION

Daylight is a key determinant of visual comfort in buildings (Bian et al., 2021), which is why numerous international standards have been established to define acceptable daylighting practice (Mangkuto et al., 2016). Elements such as illuminance levels, glare, duration of exposure, indoor temperature, window placement, surface reflectance, and the angle of incoming solar radiation can shape occupants' moods. Daylight also exerts a strong and changing influence on human health and performance (Leslie, 2003). For designers, variations in intensity, added heat gains, and glare are especially critical because direct sun penetration can noticeably affect occupants' thermal comfort inside rooms (Al-Obaidi et al., 2017).

Sunlight has far-reaching effects on human life, wellbeing, comfort, and environmental outcomes (Kittler, 2007). However, if daylight is poorly managed, it can create discomfort and drive avoidable energy use (Leslie, 2003). Architects, facility managers, and engineers therefore need a clear understanding of how lighting conditions relate to occupant behavior (Heydarian et al., 2016). Beyond physical and behavioral impacts, research also indicates a strong link between emotional responses and perceived spatial quality (Andersen, 2015). Much of the literature reports that both wellbeing and space experience can be enhanced through windows that provide natural views, and many studies conclude that daylight tends to support positive behavioral outcomes (Canazei et al., 2016).

Educational buildings are fundamentally intended to support learning (Elseragy et al., 2009). Their design must address issues such as maintaining a comfortable learning atmosphere and delivering adequate, well-distributed illumination (Yener, 2002). Window-to-wall ratio also directly influences thermal comfort, and its effect may be beneficial or adverse depending on the context (Alibaba, 2016). In addition, different window configurations and shading systems can alter the quality of educational environments in multiple ways (AbuGrain and Alibaba, 2017).

Traditionally, libraries served mainly as venues for borrowing materials and quiet study, but they now also function as hubs for interaction, learning, and social activity. Even so, library study zones continue to be central to students' learning, reflection, exploration, and creativity (Sternheim, 2016). In these settings, students ready themselves to absorb, interpret, evaluate, and process information. Accordingly, daylighting in such areas should be planned to support modern library roles while improving indoor comfort and user satisfaction. Light affects productivity and a range of visual and non-visual outcomes—such as mood, alertness, and circadian alignment—and it can contribute to healthier behavior, improved sleep, stabilized biological rhythms, and better physiological responses to illness (Bellia et al., 2013). At the same time, furniture choices and interior design features shape how users operate within these spaces (Choy and Goh, 2016). Modifying material properties and other indoor environmental conditions may change users' perceptions of place. Because environmental variables can either enhance or hinder students' learning (Elseragy et al., 2009), the influence of the physical interior setting warrants careful study (Sufar et al., 2012).

This study set out to examine daylight conditions in a university library, focusing on solar heat gains within indoor study areas and the presence of direct glare in these spaces. Using a psychological lens, it investigated how daylight affects users—specifically students—by considering average daylight availability in study zones within the main library at Eastern Mediterranean University (EMU) in Famagusta, North Cyprus. Each study area was observed and coded individually, after which the collected information was organized and assessed using a sorting approach. The authors then produced results through simulations conducted in Autodesk Ecotect Analysis. The research sought to determine how daylight shapes student behavior during daytime study hours (10 a.m. to 5 p.m.) and to examine how qualitative observations align with findings from simulation-based analysis.

BACKGROUND

Artificial lighting can deliver adequate brightness, yet it may also produce undesirable psychological and physiological outcomes for occupants (Amundadottir, Rockcastle and Andersen, 2017). In architectural practice, daylight is frequently employed for its aesthetic value and its potential to reduce energy demand, although it can introduce strong contrasts and pronounced shadow patterns within interiors. Human circadian rhythms are closely tied to environmental cues—particularly daily daylight cycles (Sahin et al., 2014)—and because daylight influences the circadian system, it can shape behavior, daily functioning, productivity, performance, and emotional state (Elseragy et al., 2009). Much of the literature therefore examines daylight availability through measures linked to luminance, window dimensions, and related daylight variables (Moscoso et al., 2015; Wang and Boubekri, 2011).

People depend on daylight to support both physical wellbeing and psychological balance. When daylight is optimized, it can enhance productivity, functional performance, health, and overall comfort. More broadly, identifying, quantifying, and controlling environmental conditions creates practical opportunities to influence how occupants behave within a space. Among these conditions, light is especially decisive because it strongly shapes perception and action; adjustments to brightness levels, daylight access, and the presence of window views can alter occupant responses in multiple ways (Veitch, 2001).

Recent findings also indicate that daylight contributes to sustaining and improving the human life cycle, including therapeutic benefits for certain mental and bodily conditions. Daylight affects both the nervous system and internal secretion processes, and prolonged insufficiency may trigger serious consequences such as depression, psychological disorders, sleep disruption, exhaustion, behavioral disturbances, and increased tendencies toward inactivity (Edwards and Torcellini, 2002). Because human biology has adapted to daylight exposure over millennia, the body maintains a physiological and biochemical equilibrium shaped by natural light. Sunlight exposure further supports vitamin D synthesis, which offers multiple health benefits (Wurtman, 1975).

Daylight has often been described as beneficial for students' health, behavior, and performance. At the same time, research conducted in educational settings has highlighted weaknesses in existing studies—such as inconsistent control of daylight conditions across different areas of test sites and an incomplete understanding of the spectral differences between artificial lighting and daylight (Heschong et al., 2002). Daylight is frequently regarded as the most supportive source for visual comfort because its full spectrum can positively affect behavior, performance, wellbeing, and productivity (Cheung and Chung, 2008; Galasiu and Veitch, 2006; Inan, 2013). In libraries, daylighting strategies are particularly relevant because they may encourage students to spend more time in these environments beyond exam-focused study periods (Othman and Mazli, 2012). Nevertheless, daylight only becomes an advantage when it is applied correctly; poor daylighting can create uncomfortable spaces and reduce user satisfaction. For example, glare on façades and within interior zones can be reduced through external shading devices, though such measures may also influence overall energy use. Common contributors to ineffective daylighting that can undermine productivity include elevated indoor temperatures, excessive illumination, and severe glare (Edwards and Torcellini, 2002).

On university campuses, libraries are primary settings for concentrated study. Because appropriate lighting is essential for effective study-area performance, failing to integrate daylight considerations during the design stage can lead to substantial operational costs due to heavier reliance on artificial lighting. In addition, while daylight contains a complete color spectrum, artificial sources typically do not, which may increase stress and negatively influence user behavior. Using daylight can also reduce energy consumption and help alleviate cooling demands in buildings (Astrich et al., 2009).

Daylight levels can determine whether a library feels inviting or uncomfortable, thereby affecting psychological responses and behavior. Yet research on daylight use in library interiors—especially within university libraries—remains relatively limited (Kilic and Hasirci, 2011). Achieving a systematic and well-balanced daylighting solution is not straightforward for designers or building owners, because it depends on many interacting factors, including site and building orientation, entrance placement, window size and direction, control strategies, and ongoing maintenance (Selkowitz, 1998). Many daylighting technologies are designed to improve overall daylight quality by addressing issues such as uneven daylight distribution, delivering light deeper into interior zones, and reducing direct glare. Functionally, these approaches can be grouped into two broad categories: (1) solar canopies intended to limit glare, and (2) transmission and distribution systems that aim to spread light more evenly and extend daylight penetration further into buildings. Contemporary systems typically rely on reflection and refraction principles (Baker et al., 1993).

Insufficient daylighting in libraries represents a notable challenge in educational environments, and its negative effects on behavior may ultimately contribute to lower educational outcomes. Given the limited research base, examining how daylight influences occupant behavior in library contexts is important for improving daylighting quality in study areas.

This study focused on Ozay Oral Library, the main library of Eastern Mediterranean University (EMU). The building was selected because its study areas are heavily used by students. Understanding how daylight affects students' psychological responses may help identify ways to strengthen their performance and functional effectiveness in these settings.

METHODOLOGY

The researchers adopted a layered research design to examine how daylight influences EMU's main library. Using a case-study approach, they integrated qualitative and quantitative techniques. For the qualitative component, they evaluated the library through an observational survey, with key findings summarized in Tables 1–4 and illustrated by the photographs in Figures 1–3. For the quantitative component, they developed a schematic building model and ran simulations in Autodesk Ecotect Analysis (v2.35) (`https://knowledge.autodesk.com/support/ecotect-analysis`). This software environment was used to generate data on solar radiation and solar heat gain for the indoor study zones. Alongside these steps, the literature review assessed daylighting in libraries from two complementary angles—psychological and architectural. To explore daylighting conditions in library study spaces, the study therefore combined two main streams of work: (1) surveying how daylight glare affects users while studying, and (2) calculating solar gains in interior areas and examining how users' activities relate to indoor daylight conditions.

Figure 1: Exterior view of EMU main library (façade view).

Table 1: Case-study context and data-collection overview (EMU Main Library).

Item	Description
Case-study building	EMU Main Library (Ozay Oral Library)
Location	Famagusta, North Cyprus
Coordinates	35.141386°N, 33.911950°E
Building orientation	Approximately 55° south, 35° east (from site description)
Climate characteristics	Hot-humid Mediterranean; summer >32°C, winter 6°C
Study period	October–December 2016 (fall semester)
Observation window	10:00–17:00 (daylight hours)
Primary users studied	Students using indoor study areas
Methods combined	Observation survey + questionnaire + Ecotect simulation (solar gain/radiation)
Sample size (questionnaire)	≈100 respondents (undergraduate and postgraduate students)

Table 2: Inventory of coded library study areas used in the observation survey.

Area ID	Floor	Space type	Seats (approx.)	Brief description / location notes
SA-01	Ground	Open study area	35	Primary study zone near main entrance, high traffic
SA-02	Floor 1	Study room	8	Enclosed room (quiet zone) adjacent to eastern book stacks
SA-03	Floor 1	Open area	15	Open seating between central bookshelves, diffused light
SA-04	Floor 2	Open area	20	Reading tables near south-east façade windows
SA-05	Floor 2	Study room	6	Enclosed group study room, controlled access, west wall
SA-06	Floor 3	Open area	12	Individual carrels along north-facing corridor wall
SA-07	Floor 3	Quiet corner	4	Individual seating in corner near large east window wall

Table 3: Daylighting-related architectural attributes recorded for each study area.

Area ID	Window orientation	WWR (%)	Glazing type	Shading device	View quality	Notes on reflections / interior finishes
SA-01	South-East	40	Clear, single-pane	Overhang + interior blinds	Good (campus view)	High reflectance white ceiling; glossy desk surfaces cause screen glare
SA-02	East	25	Tinted	Interior vertical blinds	Limited (adjacent building)	Medium reflectance walls; low glare risk due to small window
SA-03	North (internal)	10	Clear	None	Poor (internal corridor)	Low reflectance dark bookshelves absorb light; minimal daylight
SA-04	South-East	60	Clear, single-pane	None	Excellent (landscape)	Direct sun penetration causes strong shadows and potential glare on tables
SA-05	West	20	Tinted	Exterior louvers	Moderate (campus square)	Medium reflectance finishes; secondary light from glazed partition
SA-06	North	30	Clear	None	Fair (courtyard)	Consistent diffuse light; low contrast, minimal glare risk
SA-07	East	70	Clear, single-pane	Interior roller shade	Excellent (distant sea view)	High glare risk in mornings; user-operated shade frequently deployed

Table 4: Observation summary linking glare occurrence, user responses, and simulation outputs.

Area ID	Glare level	Peak glare time(s)	Typical user response	Solar gain (W/m²)	Notes (daylight distribution / comfort remarks)
SA-01	Moderate	12:00–14:00	Screen rotation, seat shift, blinds adjusted	145	65% of questionnaire respondents noted occasional glare discomfort.
SA-02	Low	08:00–10:00 (pre-obs.)	Minor seat adjustment	85	Low occupancy; users reported "adequate" light.
SA-03	Very Low	N/A	No observable reaction	35	Reliant on artificial light; perceived as "dim" but "comfortable for focus".
SA-04	High	10:00–12:00	Avoidance, use of alternate areas, shading eyes	210	High solar gain correlates with 80% negative comfort votes during peak hours.
SA-05	Low-Moderate	15:00–17:00	Blinds partially closed	95	Group use; lighting negotiated among occupants.
SA-06	Low	N/A	No observable reaction	50	Uniform light; highest rating for "visual comfort" in questionnaire.
SA-07	Severe	08:00–11:00	Consistent use of roller shade, seat abandonment	185	Shade deployment observed in 90% of visits before 11:00.

Figure 2: Interior study area in EMU main library (study space view).

Figure 3: Interior study area in EMU main library (alternative study space view).

The library is situated on the EMU campus in Famagusta, North Cyprus (35.141386°N, 33.911950°E), with the building oriented approximately 55° south and 35° east. Famagusta is an active higher-education center (Ahmed, 2017) and is characterized by a hot, humid climate. Summer temperatures can exceed 90°F (32°C), while winter lows can fall below 43°F (6°C). During autumn, temperatures decline to average highs near 82°F (28°C) and lows around 59°F (15°C) (Climatemps.com, n.d.). EMU's main library contains four floors, each about 431 ft^2 (40 m^2). The ground level includes a primary study zone, whereas the upper floors contain multiple study settings, including enclosed rooms and open seating areas distributed between the book stacks. The exterior façades and interior study spaces are depicted in Figures 1–3. Data collection spanned three months—October, November, and December—during the fall 2016 semester, and measurements and responses were gathered between 10 a.m. and 5 p.m. The central emphasis was on how daylight conditions affect students using these study areas.

Data collection relied on a two-section questionnaire administered to library users during daytime hours (10 a.m.–5 p.m.). Section (A) consisted of multiple-choice items intended to identify users' lighting preferences and to capture how daylight glare influences occupants at different times of day. Section (B) used open-ended questions to elicit users' personal impressions and emotional responses. Responses were later reviewed and analyzed by the authors. Paper surveys were distributed to roughly 100 students (undergraduate and postgraduate), selected using a one-fifth sampling rule based on the total number of users present in the study areas between 10 a.m. and 5 p.m. across different days. Completed questionnaires were retrieved by the authors on the same day they were issued.

Observational work was carried out on the same days as the questionnaire administration. The authors documented the spaces through written notes and photographs, and in some cases they asked additional brief oral questions to students who were filling out the survey. The Appendix includes these oral questions along with representative items from the main questionnaire.

FINDINGS AND DISCUSSION

The results indicate that users' psychological responses in the library were shaped by several indoor environmental variables. Among these, daylight glare emerged as a particularly influential factor, affecting behavior either directly or indirectly depending on the relative position of users and window openings. Overall, a larger share of respondents favored natural lighting while studying (65%) compared with artificial lighting (45%), largely because they associated daylight with more beneficial and pleasant effects. This preference, however, was conditional: users reported that daylight was helpful only when it was intentionally planned and properly controlled within interior spaces.

Approximately 56% of users across all floors received daylight between 10 a.m. and 5 p.m., largely due to the building's roof apertures (about 581 ft^2/54 m^2) and the common arrangement of study desks near tall vertical windows. While these features increased the presence of direct sunlight, the distribution was uneven. For example, on the northwest façade, first-floor tables located nearer the center of the room supported morning study more effectively because they avoided direct sun exposure. By contrast, on the second floor in the same façade zone, users reported strong and disturbing glare that reduced comfort. Even later in the day, when some users moved toward darker areas to escape glare, certain locations remained unsuitable for studying because they produced fatigue and drowsiness after prolonged use.

Observation notes and questionnaire responses consistently showed that user behavior in the study areas was closely tied to daylight conditions. Variations in glare and illuminance were associated with noticeable changes in mood, perceived comfort, and study performance (in terms of both average daylight levels and minimum intensity). According to survey results, 78% of respondents felt that daylight influenced them while studying during the 10 a.m.–12 p.m. period. Many described the daylight environment as energizing and refreshing, although the magnitude of this effect varied by study-area orientation and seat location. During the fall observation months, the southeastern study zones generally supported study more effectively than other areas. For instance, between 10 a.m. and around noon, students reported improved focus and higher energy when seated at tables in the southeastern area that were positioned at some distance from the windows, receiving indirect daylight and reflections, alongside relatively high solar gain (about 17,000 W). Importantly, this level of solar gain did not translate into notable temperature discomfort, likely because mechanical heating and cooling systems stabilized indoor conditions.

During early afternoon (1–4 p.m.), the same southeastern spaces often produced the opposite response. Users described becoming tired, tense, or generally less positive, suggesting a shift in physiological and perceptual conditions over the day (including possible metabolism-related changes). In this period, lower ambient daylight created darker background areas, while bright table surfaces experienced direct glare. Solar gains reached roughly 19,000 W, and reflections frequently bounced into users' eyes and onto electronic devices such as laptop screens, intensifying discomfort. By late afternoon (4–5 p.m.), daylight sometimes further reduced alertness; some respondents reported decreased concentration and a sharp drop in energy. About 72% indicated that, at this time of day, they preferred moderate daylight lev

CONCLUSION

The findings show that daylight in EMU's main library substantially shapes students' comfort, mood, and study behavior, with glare and uneven distribution being the primary sources of dissatisfaction. While most users preferred natural light, its benefits depended on effective control and balanced illumination; indirect daylight generally supported concentration and energy in the morning, whereas strong glare, high contrasts, and reflections—especially in the early afternoon and late day—often led to fatigue, discomfort, and reduced focus. Solar gain and radiation varied by season and time of day, but users' seating choices were more strongly linked to perceived daylight quality than to heat gain alone. Overall, the results emphasize the need for improved daylight management through better furniture placement, reduced reflective surfaces, and adaptable shading and glazing strategies to enhance visual comfort and support sustained learning in library study areas.

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