PROSTOR

33 [2025] 2 [70]

A SCHOLARLY JOURNAL OF ARCHITECTURE AND URBAN PLANNING
ZNANSTVENI ČASOPIS ZA ARHITEKTURU I URBANIZAM

UNIVERSITY OF ZAGREB FACULTY OF ARCHITECTURE
SVEUČILIŠTE U ZAGREBU ARHITEKTONSKI FAKULTET

ISSN 1330-0652
https://doi.org/10.31522/p
CODEN PORREV
UDC 71/72
33 [2025] 2 [70]
183-332
7-12 [2025]

310-319 **Ayşe Nihan Avci**

Visual Comfort and Indoor Environmental Quality in a Workplace Setting

A Case Study in Ankara, Türkiye

Scientific Subject Review
https://doi.org/10.31522/p.33.2(70).11
UDC 72.012:159.931

Af

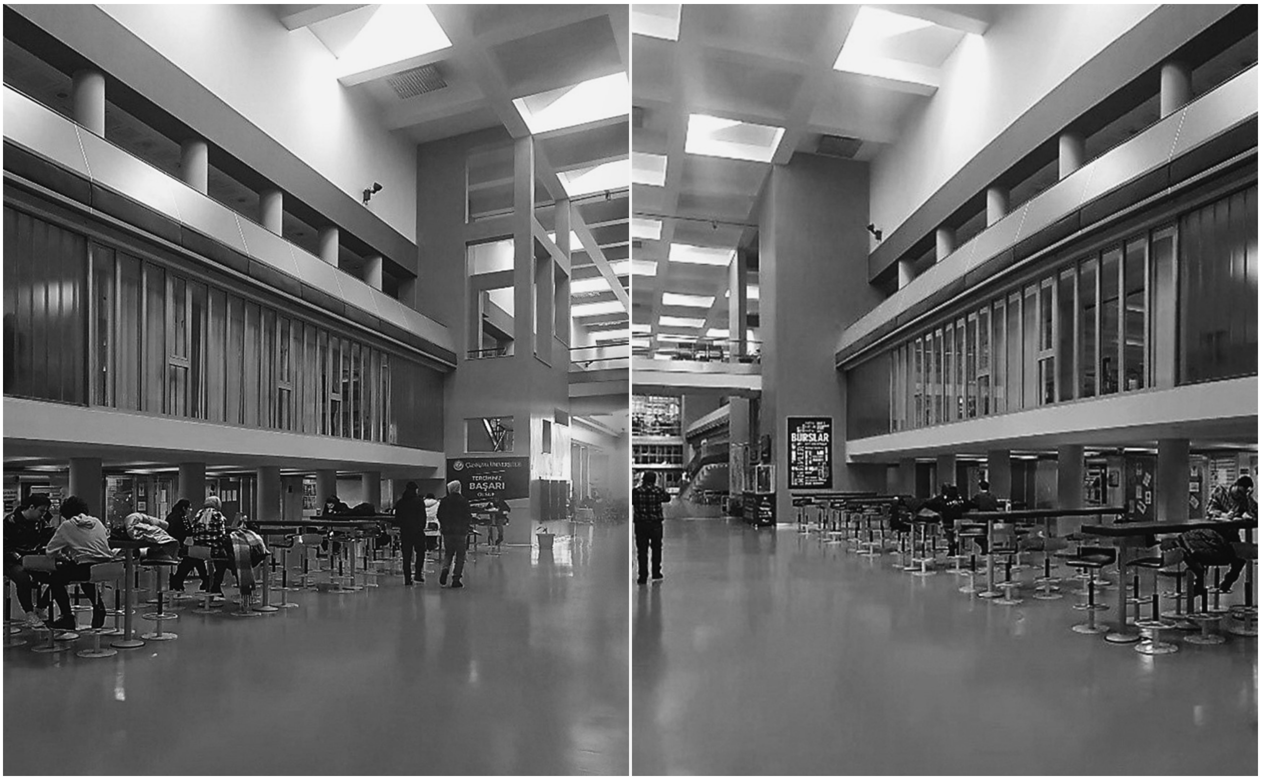

Fig. 1 Location of the experimental place within the building

Ayşe Nihan Avci

Çankaya University, Faculty of Architecture, Department of Interior Architecture, adresa, Türkiye
https://orcid.org/0000-0003-2340-0317

nihanavci@cankaya.edu.tr

Scientific Subject Review
https://doi.org/10.31522/p.33.2(70).11
UDC 72.012:159.931
Technical Sciences / Architecture and Urban Planning
2.01.01 – Architectural Design
Article Received / Revised / Accepted: 5. 9. 2025. / 27. 11. 2025. / 16. 12. 2025.

Visual Comfort and Indoor Environmental Quality in a Workplace Setting

A Case Study in Ankara, Türkiye

Çankaya University, Ankara, Türkiye
human-centric design
indoor environment
lighting
visual comfort
workplace

Workplaces are occasionally specified in locations where learning environments are placed together, and they are also found in common areas with various functions. Individuals need light, as it is a vital component of modern life that fosters a sense of comfort, health, and well-being. Lighting systems in interior architecture need to be designed according to the function of the space and individual needs. In cases where natural lighting is insufficient, comfortable, healthy, and prosperous places are designed with mixed-use lighting. Factors affecting indoor environmental quality, such as sound, color, and thermal comfort, should be designed together with lighting. This study aims to investigate the indoor environmental quality parameters of the specified workplace regarding visual comfort. Students voluntarily participated in the study. An experimental space on the first floor of the building, known as the "Common Building" of Çankaya University and serving as a connection point for the faculties, was chosen for the study. This type of research is crucial for ensuring that indoor environmental quality parameters are effectively utilized indoors to enhance human-centric interior design.

Introduction

Light enables individuals to experience their surroundings; therefore, lighting design is an important element of interior architecture. The way a space looks is determined by its lighting design, which alters as light is manipulated. People can gather visual information about their environment within seconds without tactile exploration. Their reaction to a space – whether sympathetic or antipathetic – is not only due to the sensation of light striking the retina, but also to other sensations that respond associatively during visual processing and significantly shape the form of the visual information. Space and users interact reciprocally. Lighting can impact occupant well-being, comfort, and productivity, and displeasure with lighting can increase operational costs if it leads to redesign or unexpected environmental intervention (Avcı, 2022: 24). Boyce (2018) suggests that lighting quality should be evaluated in terms of its impact on outcomes such as visual performance and behaviour, while Veitch and Newsham (1996) define lighting quality more broadly as lighting that supports visual performance, task and behavioural performance, social interactions, mood, health and safety, as well as aesthetic judgments. Both definitions include acknowledging the space's purpose (the functions or activities that occur in a specific context) and the user (the individuals who complete the duties and activities). According to Veitch and Newsham (1998: 98), individuals can meet all their behavioural needs with adequate lighting. This hypothesis has also the advantage of being quantitative, as it solely addresses the direct effects of bright settings on individuals (Alnajdawi, 2019: 214; Mahbob et al, 2011: 435). Veitch (2012: 255) classifies human needs for lighting quality into six categories: visibility, task performance, social behaviour, health and safety, comfort and mood, and judgments. Good lighting design starts with identifying and resolving visual functions and task-related difficulties. Good lighting may meet human needs in any context. According to Juslén and Tenner (2005: 846), high lighting quality improves performance, visual comfort, and interpersonal interactions. Visual performance improves when people can see the job at hand. Furthermore, by removing conspicuous discomfort, performance would improve due to increased concentration. Similarly, clearer visual contact among individuals enhances interpersonal interaction, resulting in more effective communication and collaboration.

Aside from specified locations such as libraries, workplaces have been changed into spaces where individuals work, socialize, and do other daily activities in educational buildings. Many people spend the majority of their time in workplaces or learning environments like universities, colleges, and schools. The physical environment has an impact on students' behaviour and achievement. Learning environments are essential places where most formal education takes place. Learning environment conditions are crucial to students' health, performance, and behaviour. Many researchers have found that indoor environmental quality parameters (IEQ) affect people's performance whether they are in work, home, or learning environments. This can be true for schools where it has been found that poor indoor environments may reduce students' performance (Fisk, 2000: 2; Mendell et al., 2002: 1435). The issues become more severe and complicated when dealing with students with special needs, those who have been diagnosed with mental health disorders, and who need special attention and treatment. Indoor environmental quality in buildings includes indoor air quality (IAQ), acoustics, thermal comfort, and lighting (Fielding, 2006: 3; Ricciardi and Buratti, 2018: 24; Zuhaib et al., 2018: 70). Lighting is crucial for indoor environmental quality in learning environments. Assessments of lighting quality are still subject to discussion in scientific studies.

It is well known that poor environmental quality severely influences individuals, particularly children, who, along with the sick and elderly, form a vulnerable population. Indoor environmental quality impacts building occupants' satisfaction, well-being, and productivity (Newsham et al., 2009: 142; Singh et al., 2010: 1665). School lighting must be regarded as a critical, essential, and dynamic component of the educational environment (Dunn et al., 1985: 865). Furthermore, various studies have emphasized the impact of school facilities and lighting on students' learning performance in the learning environment (Alnajdawi, 2019: 214; Samani and Samani, 2012: 129). According to Knez and Kers (2000), lighting in educational spaces directly affects students' memory, perceptual performance, and problem-solving abilities. To improve the performance of teachers and students, optimal lighting levels should be provided, together with appropriate natural and artificial light sources. Good lighting in these areas improves performance and encourages people to study more in educational facilities. Several factors should be considered while designing a workplace's lighting. According to Lyons (2001: 3), there is a direct relationship between the physical elements and characteristics of school buildings and educational outcomes. In educational facilities, natural lighting should be used to its full potential. Natural lighting promotes economic and visual comfort, as well as psychological health. Designs should be devised to ensure that as much daylight as possible enters the educational building. Large window surfaces and skylights should be used regularly in educational facility design. Gallery spaces promote visual comfort by extending visual communication across floors, allowing daylight, and improving overall perception and visibility. The artificial lighting system provides a visual condition in places where natural lighting is inadequate or unavailable. Lighting design should also consider the specific illuminance levels required for certain types of activity. Illuminance values established in the standard EN 12464-1 for workplaces in buildings must be maintained to meet visual comfort and performance requirements. The recommended illuminance requirements for educational areas are listed below: Learning environments 300 lx, technical drawing learning environments 750 lx, whiteboards 500 lx, meeting rooms 200 lx, labs 500 lx, conference rooms 500 lx, staircases 150 lx, circulation spaces 100 lx, and entry hall 200 lx. Based on all of this information, a workplace's lighting design should incorporate indoor artificial lighting and daylight to provide a comfortable lighting environment for the individuals. It should include contextual factors such as light requirements based on tasks and working hours, workplace location, orientation, height, occupant needs and preferences, and natural and artificial lighting availability.

Workplace lighting covers various working environments and tasks, from offices and small workshops to large manufacturing halls, to reading, sketching, writing, and computer applications. Millions of people spend a big portion of their days in an indoor built environment while working. Aside from its effect on visual performance, lighting significantly impacts the environment and the visual impression of the workspace. When properly planned, the entire working environment can be exciting for the individuals working there. Lighting is provided at their jobs to ensure they can complete their tasks efficiently, swiftly, and correctly.

Light has the most visible impact on humans. Vision, one of the most complicated senses, is the primary process through which people perceive their surroundings. The eye and brain interplay produce vision, allowing people to see their bright surroundings. Humans can only see when there is light; otherwise, they cannot. Visual comfort is the level of visual satisfaction the luminous environment provides due to reduced glare and disturbing luminance in the field of view (Gordon, 2015: 330). Available research results documents of the International Commission on Illumination (CIE) specify the following parameters as relevant to indoor visual comfort: glare, veiling reflections, illuminance levels, luminance ratios, and uniformities; colour rendering index (CRI), correlated colour temperature (CCT), flicker, space, and room appearance, surface brightness and colour, the appearance of light and luminaires (Iacomussi et al., 2015: 730).

Some strategies for assessing visual comfort have been tried. The unified glare rating (UGR) is used to assess visual comfort in lighting systems, considering the luminaires' positioning, the structure's proportions, the background reflection indices, and the user's position in an indoor environment (Rossi, 2019: 108). Wilkins and Boyce (2018: 100) discovered that legally enforceable minimum illuminance recommendations substantially exceed what is required to enable reasonable visibility in most countries. Values may differ between countries, depending on the conditions. Wang et al. (2015: 1436) evaluated visual fatigue under six distinct lighting settings, designing two illuminance levels (500 lx, 1000 lx) and three CCT levels (2700 K, 6500 K, and 10000 K). Their findings suggested that the two lighting levels (6500 K, 1000 lx, and 2700 K, 500 lx) caused the least visual fatigue.

The term 'spatial brightness' can be defined as the perceived brightness of humans when engaged in an environment or viewed from afar. The environment occupies a significant portion of the visual field (Islam et al., 2015: 55). One study found that the spatial power distribution (SPD) of a lighting source influences the perception of spatial brightness, with places illuminated by lighting sources with varying SPDs seeming differently bright at the same illuminance (Fotios, 2001: 170). SPD affects the visual comfort, task performance, energy efficiency, perception of space, health & well-being. The spatial brightness can be defined as dim or bright. Humans feel more at ease in a light indoor environment. Thus, spatial brightness for office lighting relationships is important for subjective indoor environment appraisal.

Avcı (2017: 55) investigated the impact of lighting conditions on visual comfort parameters such as distraction, clarity, fatigue, eye burning, focusing difficulty, and glare in an experimental room. Six lighting settings were tested (LED and OLED illuminance at 200, 500, and 800 lx). In terms of visual distraction, visual clarity, visual fatigue, burning eye, and focusing problems, OLED lighting results showed that the illuminance level of 500 lx was somewhat more comfortable than the other illuminance levels. According to Avcı and Akbay (2022: 137), OLED displays with a glare intensity of 200 lx are marginally more comfortable for work performance. These findings revealed that the visual comfort requirements differed depending on the lighting conditions and illuminance levels.

Methodology

Participants

The experiment was carried out with the participation of 46 voluntary students. The participant group for the study consisted of 26 females, 19 males, and 1 participant of this sex. They were undergraduate students from different departments and faculties at Çankaya University in Ankara, Türkiye. The participants from different departments use the selected workplace together. Their ages range from 20 to 39, with a mean age of 22.18. They were informed about the research and asked whether they would participate in the survey. All the participants who were given information about the study willingly agreed to answer the survey questions. They were from different departments: interior architecture, civil engineering, software engineering, computer engineering, electrics and electronics engineering, industrial engineering, translation and interpreting studies (English), psychology, public relations and advertising, and management information systems. 10 from the department of interior architecture, one from the department of civil engineering, one from the department of software engineering, 12 from the department of computer engineering, four from the department of electrics and electronics engineering, one from the department of electrics and industrial engineering, two from the department of translation and interpreting studies (English), 12 from the department of psychology, one from the department of public relations and advertising, and two from the department of management information systems. Most participants had no prior knowledge or experience in interior design, including interior design notions and an understanding of the effects of indoor environmental qualities in indoor environments. This increased awareness of the selected workplace regarding indoor environmental quality parameters.

Experimental Place

The experiment occurred in an 80 m² workplace at the Common Building, Çankaya University, Ankara, Türkiye. It was on the first floor. The workplace was in an atrium from which the two floors above it were visible and was located between two staircases. Six working tables (80×160×110 cm) were perpendicular to the cylindrical columns, with eight height-adjustable bar seats per working table. The second floor's exterior featured 34 frosted windows (17 on the left and 17 on the right) and 19 transparent windows. The third-floor facade featured composite panels and fabric coverings for the railing, and cylindrical columns were seen. The atrium benefited from natural lighting through eight triangular openings in the roof. Fig. 1 shows the location of the experimental place within the building.

The Natural Color System (NCS) was adopted as the colour standard, and the corresponding NCS notations were obtained using the NCS Colour Scan 2.0 colour measurement device. This device also defined coloured surfaces such as walls, floors, carpets, furniture, and textiles in the interiors. Table I presents the list of surfaces along with their NCS notations.

Experimental Instruments and Procedure

This study has undertaken a comprehensive experimental and theoretical investigation into indoor environmental quality (IEQ), particularly emphasizing visual comfort in a multi-functional university workplace setting. By integrating objective environmental measurements with user-based survey responses, the research provides insights into the interplay between lighting conditions and human comfort in shared indoor environments. This study was prepared with the approval of the Çankaya University Science and Engineering Sciences Scientific Research and Publication Ethics Committee dated 22. 01.2024 and numbered E-41645618-050-146205. Indoor environmental quality parameters, such as indoor air temperature, gases (CO_2), sound, etc., directly impact visual comfort. These indoor environmental quality parameters had to be controlled, otherwise differences in conditions had a negative impact on the participants' physical and psychological attitudes. The following lighting and measuring instruments were used throughout the experiment: i) indoor air temperature (Non-contact thermometer, 'Testo 174 T'); ii) sound level (Decibel meter, 'Testo 815'); iii) VOC levels (Detector, 'Toxi RAE Pro Pid'); and iv) Luminance Meter, 'Konica Minolta CL-70F'). These instruments collected information about the participants and the workplace during the procedure.

The experiment was carried out with the participation of 46 student volunteers and occurred in a workplace at the Common Building, Çankaya University, Ankara, Türkiye. The 'Lighting Conditions Survey' and 'Office Lighting Survey' evaluated general lighting conditions and indoor environmental quality parameters in the immediate surroundings. The questions in these tests were reduced to 10 questions and shaped in line with the scope of the study. Questions 1 and 5 aim to obtain demographic information, while questions 6 to 10 cover task lighting usage, evaluation of indoor environment quality parameters, assessment of general lighting conditions based on visual comfort criteria, and questions related to the daily purposes and usage duration of the selected work area. The questions seven and eight had a 5-point Likert scale. There were six tables in the experimental place and participants were required to sit at any of the six tables. There was no variation in environmental quality parameters across all desks in the work environment. After that, the lighting materials, devices, and measurements (CO_2 concentration, indoor air temperature, core body temperature, and sound), and questionnaires were explained. Data were collected from August 1 to August 15, 2024. Since outdoor weather conditions vary throughout the year; all results are limited to this period. Maximum daytime temperatures ranged from approximately 31-35 °C. Illuminance levels measured on 16 points of 8 table surfaces varied between 320-580 lx. Participants progressed through all stages at their own speed, with session durations averaging around 10 minutes and varying between 5 and 15 minutes.

Table I The surfaces, along with their NCS notations

Surface	Material	NCS Notation	Color
Floor	Epoxy	S 5005-G80Y	
Wall	Paint	S 6005-Y80R	
Cylinder Column	Paint	S 2002-B	
Stair Well	Paint	S 1070-Y10R	
Working Table	Laminated MDF	S 8000-N	
Bar Chair (Sitting)	Artificial Leather	S 3030-Y40R	
Bar Chair (Skeleton)	Plywood	S 9000-N	

They left the workplace after completing the process.

Limitations

Despite the methodological rigor employed in this study, several limitations should be acknowledged. First, the sample size was relatively small (N = 46) and consisted solely of undergraduate students from a single university. Although the participants represented a variety of academic departments, the sample may not fully reflect the broader population of workplace users, thereby limiting the generalizability of the findings to other age groups, professional contexts, or cultural settings. Second, the study was conducted within a single workplace environment located in the Common Building at Çankaya University. The architectural characteristics, interior layout, colour scheme, and lighting configuration of this specific space may differ substantially from other university or office environments. As a result, the conclusions drawn from this particular setting may not fully extend to workplaces with different spatial or environmental characteristics. Third, although objective measurements were taken for several indoor environmental quality parameters (CO_2 concentration, air temperature, sound level, VOCs, and luminance), the study relied on self-reported survey responses to assess participants' perceptions of lighting quality and visual comfort. Self-reported data are inherently subject to biases such as social desirability, recall limitations, and individual differences in perceptual sensitivity. Fourth, the experiment employed a cross-sectional design in which participants completed the surveys in a single session lasting 5-15 minutes. This design does not allow for the assessment of changes in visual comfort perception over time or under varying lighting scenarios. Participants were also

Tables II and III Applied test results for gender groups (Independent Samples t-Test)

Table II Lighting Conditions Survey (Sample Groups)

Independent Samples t-Test

Parameter	t	df	*p*
Natural Lighting	.998	43	.324
	.954	31.924	.347
Noise Level	-.146	43	.885
	-.142	34.786	.888
Odor	-1.061	43	.295
	-1.053	37.771	.299
Ventilation	-1.276	43	.209
	-1.317	42.392	.195
Air Temperature	-3.115	43	.003
	-3.138	39.944	**.003**
General Environment	-2.524	43	**.015**
	-2.479	36.237	**.018**

Table III Office Lighting Survey (Gender Groups)

Independent Samples t-Test

Visual Comfort Criterion	t	df	*p*
Visual Distraction	-.910	43	.368
	-.915	39.764	.366
Visual Clarity	.198	43	.844
	.190	32.548	.850
Visual Fatigue	-.771	43	.445
	-.769	38.530	.447
Eye Burning	.764	43	.449
	.771	40.116	.445
Focusing Problem	.355	43	.725
	.363	41.834	.718
Glare	.394	43	.695
	.394	38.922	.695

allowed to choose any of the six available tables, which, although consistent in IEQ conditions, may introduce minimal, uncontrolled micro-variations in perceived comfort. Finally, most participants had limited prior knowledge of interior design concepts and indoor environmental quality parameters. While this may reduce expectation bias, it may also constrain their ability to articulate nuanced evaluations of lighting conditions, potentially affecting the depth of perceptual data. Future research could address these limitations by incorporating larger and more diverse samples, examining multiple workplace environments with varying architectural and lighting characteristics, conducting longitudinal or seasonal comparisons, and integrating additional objective visual performance measures to complement subjective evaluations.

Results and Discussion

IBM SPSS Statistics 23.0 software was used to assess data normality. Mean and standard deviation statistics were used to make observations about the distribution of the items. Normality can be determined to some extent by calculating skewness and kurtosis values. The skewness and kurtosis values (between -1.5 and +1.5) of the questionnaires generated by the scale scores were deemed adequate for a normal distribution. The analysis was conducted using parametric approaches. An independent samples t-test was used to evaluate the sample groups using the Lighting Conditions Survey and Office Lighting Survey based on the experimental place's indoor environmental quality parameters. Bivariate Correlation Analysis was applied to investigate the relationship between the natural lighting conditions and visual comfort criteria, natural lighting, and the relationship between indoor environmental quality parameters. When conducting this test, visual comfort criteria were evaluated based on the lighting conditions in the experimental place. It was also found that 42 participants used their right hand and 4 used their left hand; 27 participants wore glasses or contact lenses; and 22 used task lighting to do daily activities in their home. It was also determined that 16 participants used the experimental place for less than 30 minutes per week, 18 used it for 1-2 hours per week, and 12 used it for more than 2 hours per week.

Accordingly, the differences between genders and the indoor quality parameters of the part of the Lighting Conditions Survey were analysed within the scope of the study. The results of an independent samples t-test indicated statistically significant differences between the groups for indoor air temperature ($t(43) = -3.115$, $p = 0.003$) and general environment features ($t(43) = -2.524$, $p = 0.015$). According to the mean values, female participants found the experimental place more satisfying than males for these parameters. Table II presents the statistical results. The differences between genders and the visual comfort criteria were also analysed using the same test. The results indicated that there were no statistically significant differences between the sample groups and the visual comfort criteria. The lack of difference between genders was interpreted as the participants having the same age range. It was also said that the experimental place provided visual comfort conditions for the students, and the lighting conditions were sufficient. Table III presents the statistical results.

Bivariate Correlation Analysis was applied to investigate the relationship between the natural lighting conditions, spending time in the experimental place, and visual comfort criteria. The positive correlations were identified between specific questions and the visual comfort criteria. When the correlations between visual comfort criteria were examined, visual distraction had positive correlations with visual fatigue ($r = 0.304^{*}$, $p = 0.040$), eye burning ($r = 0.524^{**}$, $p = 0.000$), focusing problem ($r = 0.572^{**}$, $p = 0.000$), and glare ($r = 0.410^{**}$, $p = 0.005$). The criterion of visual fatigue had correlations between eye burning ($r = 0.400^{**}$, $p = 0.006$) and focusing problem ($r = 0.292^{*}$, $p = 0.049$). There was also a positive correlation between eye burning and focusing problem criteria ($r = 0.387^{**}$, $p = 0.008$). When the visual comfort criteria were analysed with one another, no correlation was observed between focusing and the other comfort criteria. Aside from this finding, the interrelations among the remaining criteria suggest that the lighting conditions in the experimental setting were assessed using a holistic approach. However, the relationship between spending time in the experimental place and visual comfort criteria was investigated. Statistical data revealed a moderate correlation between spending time and visual distraction (r = 0.582**, p = 0.000). This relationship is considered significant. A correlation between spending time, focusing problem (r = 0.369*, p = 0.012), and glare (r = 0.328*, p = 0.026) was also found. As the duration of time spent in an environment increases, attention tends to become more distracted, highlighting the importance of interior design in maintaining visual comfort and sustained focus. Consequently, achieving a visually balanced environment that avoids monotony and overstimulation is essential, particularly in working, studying, or waiting environments. Table IV presents these statistical results. The relationship between indoor environmental quality parameters were also investigated with the bivariate correlation analysis. Results indicated that there was a correlation between the general environment and natural lighting conditions of the experimental place (r = 0.292*, p = 0.049), and temperature (r = 0.305*, p = 0.039). Table V shows these statistical results.

Table IV Applied test results for Visual Comfort Criteria and Spending Time (Bivariate Correlation Analysis)

Bivariate Correlation Analysis – Visual Comfort Criteria / Spending Time

		Visual Distraction	Visual Clarity	Visual Fatigue	Eye Burning	Focusing Problem	Glare	Spending Time
Visual Distraction	Pearson r	1	.275	.304*	.524**	.572**	.410**	.582**
	p		.065	.040	.000	.000	.005	.000
	n	46	46	46	46	46	46	46
Visual Clarity	Pearson r	.275	1	.128	.180	.211	.191	.085
	p	.065		.395	.232	.159	.203	.574
	n	46	46	46	46	46	46	46
Visual Fatigue	Pearson r	.304*	.128	1	.400**	.292*	-.112	.089
	p	.040	.395		.006	.049	.460	.557
	n	46	46	46	46	46	46	46
Eye Burning	Pearson r	.524**	.180	.400**	1	.387**	.232	.279
	p	.000	.232	.006		.008	.121	.060
	n	46	46	46	46	46	46	46
Focusing Problem	Pearson r	.572**	.211	.292*	.387**	1	.203	.369*
	p	.000	.159	.049	.008		.177	.012
	n	46	46	46	46	46	46	46
Glare	Pearson r	.410**	.191	-.112	.232	.203	1	.328*
	p	.005	.203	.460	.121	.177		.026
	n	46	46	46	46	46	46	46
Spending Time	Pearson r	.582**	.085	.089	.279	.369*	.328*	1
	p	.000	.574	.557	.060	.012	.026	
	n	46	46	46	46	46	46	46

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

Table V Applied test results for Indoor Environmental Quality Parameters (Bivariate Correlation Analysis)

Bivariate Correlation Analysis – Indoor Environmental Quality Parameters

		Natural Lighting	Noise Level	Odor	Ventilation	Temperature	General Environment
Natural Lighting	Pearson r	1	.178	-.006	-.044	.147	.292*
	p		.236	.969	.770	.331	.049
	n	46	46	46	46	46	46
Noise Level	Pearson r	.178	1	.109	-.064	.163	.163
	p	.236		.472	.674	.279	.279
	n	46	46	46	46	46	46
Odour	Pearson r	-.006	.109	1	.592**	.271	.258
	p	.969	.472		.000	.069	.083
	n	46	46	46	46	46	46
Ventilation	Pearson r	-.044	-.064	.592**	1	.308*	-.096
	p	.770	.674	.000		.037	.524
	n	46	46	46	46	46	46
Temperature	Pearson r	.147	.163	.271	.308*	1	.305*
	p	.331	.279	.069	.037		.039
	n	46	46	46	46	46	46
General Environment	Pearson r	.292*	.163	.258	-.096	.305*	1
	p	.049	.279	.083	.524	.039	
	n	46	46	46	46	46	46

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

Visual comfort is one of the critical factors in overall satisfaction with the indoor environment in workplaces. This study aimed to evaluate the effectiveness of various factors for investigating the overall visual comfort at the Common Building, Çankaya University, Ankara, Türkiye. Findings from the independent samples t-test revealed statistically significant gender-based differences in the perception of indoor air temperature and general environmental features, with female participants rating the environment more positively. However, no significant differences were found between genders concerning visual comfort criteria, suggesting that shared characteristics among participants – such as age and academic context – may have homogenized perceptions of lighting quality. These findings also support the conclusion that the experimental workplace successfully met general visual comfort standards for both male and female users. Further, bivariate correlation analysis highlighted meaningful relationships between various dimensions of visual discomfort. Notably, visual distraction was significantly correlated with visual fatigue, eye burning, focusing problems, and glare, indicating that these interconnected symptoms can emerge and impact user performance even in generally well-lit environments.

The correlation coefficients between seven visual comfort criteria are not zero. The relationships are significant, which indicates a substantial direct effect of them on the student's visual comfort. These findings align with previous studies (Kwong, 2020: 8; Noda et al., 2020: 8; Abboushi et al., 2021: 332). IEQ has been discovered to both promote and hinder user's comfort, performance, and contentment with their physical environments, and hence can help achieve environmental and economic goals for sustainable building. The building's contributions to the biological basis of user comfort, health, and well-being are appropriate indoor environmental factors such as light, air, temperature, sound, visible and physical space, and users' ability to personally manage these (Choi et al., 2014: 2).

Conclusion

This research carried out a broad experimental and theoretical analysis of indoor environmental quality (IEQ), focusing particularly on visual comfort within a multifunctional university workplace. Through the combination of objective environmental data and user survey feedback, the study sheds light on how lighting conditions interact with human comfort in shared indoor built environment. This study contributes to the literature by empirically validating a multidimensional IEQ framework in a higher-education context, demonstrating that perceived environmental quality mediates the relationship between physical design inputs and learning-related satisfaction outcomes. Nonetheless, future research employing objective performance indicators (e.g., cognitive tests, academic achievement, physiological measures) and longitudinal experimental designs would strengthen causal inference and further advance evidence-based sustainable learning-environment design. However, the application of such studies to large and different groups is of great importance for other studies that may appear in the literature. In addition, this study reinforces the critical role of well-balanced lighting design in enhancing occupant comfort and productivity. It also underscores the importance of concurrently evaluating multiple indoor environmental quality parameters rather than in isolation when designing human-centric indoor environments. This research's empirical evidence and user feedback may inform future lighting strategies in educational and professional settings, particularly in multi-use or transitional zones. Expanding this study to include diverse user profiles, time-of-day variations, and dynamic lighting systems could offer deeper insights into optimizing visual comfort across varied interior contexts.

Bibliography and sources

1. Abboushi, B., Elzeyadi, I., Van Den Wymelenberg, K., Taylor, R., Sereno, M. and Jacobsen, G. (2021) 'Assessing the visual comfort, visual interest of sunlight patterns, and view quality under different window conditions in an open-plan office'. *Leukos*, 17(4), pp. 321-337. https://doi.org/10.1080/15502724.2020.1785309
2. Alnajdawi, A.M. (2019) 'Exploring Jordanian children's perceptions of the characteristics of an ideal school and learning environment'. *Journal of Social Studies Education Research*, 10(4), pp. 201-225.
3. Avci, A.N. (2017) *Effects of illuminance levels of solid state lighting sources on visual comfort*. Master's thesis. Çankaya University, Graduate School of Applied Sciences.
4. Avci, A.N. (2022) *Circadian lighting design: Effects of OLED lighting conditions on visual comfort and well-being in an indoor office environment*. Ph.D. dissertation, Çankaya University, Graduate School of Applied Sciences.
5. Avci, A.N. and Akbay, S. (2022) 'Visual comfort assessment of OLED lighting in an indoor office environment'. *GRID – Architecture Planning and Design Journal*, 5(2), pp. 129-143. https://doi.org/10.37246/grid.993713
6. Brainard, G.C., Hanifin, J.P., Greeson, J.M., Byrne, B., Glickman, G., Gerner, E. and Rollag, M.D. (2001) 'Action spectrum for melatonin regulation in humans: evidence for a novel circadian photoreceptor', *Journal of Neuroscience*, 21(16), pp. 6405-6412. https://doi.org/10.1523/JNEUROSCI.21-16-06405.2001
7. Choi, S., Guerin, D.A., Kim, H.Y., Brigham, J.K. & Bauer, T. (2014) 'Indoor environmental quality of classrooms and student outcomes: a path analysis approach'. *Journal of Learning Spaces*, 2(2), 2013-2014.
8. Dunn, R., Krimsky, J.S., Murray, J.B. and Quinn, P.J. (1985) 'Light up their lives: A review of research on the effects of lighting on children's achievement and behavior'. *The Reading Teacher*, 38(9), pp. 863-869. https://www.jstor.org/stable/20198961
9. Fielding, R. (2006) 'Learning, lighting, and color: Lighting design for schools and universities in the 21st century'. *DesignShare (NJ1)*, pp. 1-7.
10. Fisk, W.J. (2000) 'Estimates of potential nationwide productivity and health benefits from better indoor environments: an update'. *Indoor air quality handbook*, pp. 1-38.
11. Fotios, S.A. (2001) 'Lamp colour properties and apparent brightness: a review'. *Lighting Research & Technology*, 33(3), pp. 163-178. https://doi.org/10.1177/136578280103300306
12. Gordon, G. (2015) *Interior lighting for designers*. Hoboken, NJ: John Wiley & Sons.

13. Higgins, S., Hall, E., Wall, K., Woolner, P. and McCaughey, C. (2005) *The impact of school environments: A literature review*. Design Council, University of Newcastle, UK.
14. Iacomussi, P., Radis, M., Rossi, G. and Rossi, L. (2015) 'Visual comfort with LED lighting'. *Energy Procedia*, 78, pp. 729-734. https://doi.org/10.1016/j.egypro.2015.11.082
15. Innes, M. (2012) *Lighting for interior design*. London: Laurence King Publishing.
16. Islam, M.S., Dangol, R., Hyvärinen, M., Bhusal, P., Puolakka, M. and Halonen, L. (2015) 'User acceptance studies for LED office lighting: Lamp spectrum, spatial brightness, and illuminance'. *Lighting Research & Technology*, 47(1), pp. 54-79. https://doi.org/10.1177/1477153513514425
17. Juslén, H. and Tenner, A. (2005) 'Mechanisms involved in enhancing human performance by changing the lighting in the industrial workplace'. *International Journal of Industrial Ergonomics*, 35(9), pp. 843-855. https://doi.org/10.1016/j.ergon.2005.03.002
18. Kaye, S.M. (1988) *Variations in the luminous and sonic environment: Proofreading and visual search effects; Mood states and frustration tolerance aftereffects*. New York, NY: Lighting Research Institute.
19. Knez, I. and Kers, C. (2000) 'Effects of office lighting on mood and cognitive performance and a gender effect in work-related judgment'. *Environment and Behavior*, 30(4), pp. 553-567. https://doi.org/10.1177/001391659803000408
20. Kwong, Q.J. (2020) 'Light level, visual comfort and lighting energy savings potential in a green-certified high-rise building'. *Journal of Building Engineering*, 29, 101198. https://doi.org/10.1016/j.jobe.2020.101198
21. Lyons, J.B. (2001) *Do school facilities really impact a child's education?* IssueTrak: A CEFPI brief on educational facility issues.
22. Mahbob, N.S., Kamaruzzaman, S.N., Salleh, N. and Sulaiman, R. (2011) 'A correlation studies of indoor environmental quality (IEQ) towards productive workplace'. *2nd International Conference on Environmental Science and Technology*, 6, pp. 434-438.
23. Mendell, M.J., Fisk, W.J., Kreiss, K., Levin, H., Alexander, D., Cain, W.S., Girman, J.R., Hines, C.J., Jensen, P.A., Milton, D.K., Rexroat, L.P. and Wallingford, K.M. (2002) 'Improving the health of workers in indoor environments: Priority research needs for a national occupational research agenda', *American Journal of Public Health*, 92, pp. 1430-1440. https://doi.org/10.2105/AJPH.92.9.1430
24. Newsham, G., Brand, J., Donnelly, C., Veitch, J., Aries, M. and Charles, K. (2009) 'Linking indoor environment conditions to job satisfaction: a field study'. *Building Research and Information*, 37(2), pp. 129-147. https://doi.org/10.1080/09613210802710298
25. Noda, L., Lima, A.V., Souza, J.F., Leder, S. and Quirino, L.M. (2020) 'Thermal and visual comfort of schoolchildren in air-conditioned classrooms in hot and humid climates'. *Building and Environment*, 182. https://doi.org/10.1016/j.buildenv.2020.107156
26. Ricciardi, P. and Buratti, C. (2018) 'Environmental quality of university classrooms: Subjective and objective evaluation of the thermal, acoustic, and lighting comfort conditions'. *Building and Environment*, 127, pp. 23-36. https://doi.org/10.1016/j.buildenv.2017.10.030
27. Rossi, M. (2019) *Circadian lighting design in the LED era*. Cham, Switzerland: Springer International Publishing, pp. 57-100. https://doi.org/10.1007/978-3-030-11087-1
28. Samani, S.A. and Samani, S.A. (2012) 'The impact of indoor lighting on students' learning performance in learning environments: A knowledge internalization perspective'. *International Journal of Business and Social Science*, 3(24), pp. 127-136.
29. Singh, A., Syal, M., Grady, S.C. and Korkmaz, S. (2010) 'Effects of green buildings on employee health and productivity'. *American journal of public health*, 100(9), pp. 1665-1668. https://doi.org/10.2105/AJPH.2009.180687
30. Veitch, J.A. and Newsham, G.R. (1996) *Determinants of lighting quality II: Research and recommendations*. National Research Council of Canada, Ontario.
31. Veitch, J.A. and Newsham, G.R. (1998) 'Determinants of lighting quality I: State of the science'. *Journal of the Illuminating Engineering Society*, 27(1), pp. 92-106. https://doi.org/10.1080/00994480.1998.10748215
32. Veitch, J.A. (2012) 'Work environments'. In: Clayton, S. (ed.) *The Oxford handbook of environmental and conservation psychology*. New York: Oxford University Press, pp. 248-275. https://doi.org/10.1093/oxfordhb/9780199733026.013.0014
33. Wang, Q., Xu, H., Gong, R. and Cai, J. (2015) 'Investigation of visual fatigue under LED lighting based on reading task'. *Optik*, 126(15-16), pp. 1433-1438. https://doi.org/10.1016/j.ijleo.2015.04.033
34. Wilkins, A. and Boyce, P. (2018) 'Visual discomfort indoors'. *Lighting Research and Technology*, 50, pp. 98-114. https://doi.org/10.1177/1477153517736467
35. Zuhaib, S., Manton, R., Griffin, C., Hajdukiewicz, M., Keane, M.M. and Goggins, J. (2018) 'An indoor environmental quality (IEQ) assessment of a partially-retrofitted university building'. *Building and Environment*, 139, pp. 69-85. https://doi.org/10.1016/j.buildenv.2018.05.001

Author's biography

Ayşe Nihan Avci, Ph.D, is an assistant professor at the Department of Interior Architecture, Faculty of Architecture at Çankaya University. Her research interests include artificial lighting systems, circadian lighting design, human-centric lighting, OLED lighting, light and colour, visual comfort, health and well-being.

Contribution

Conceptualization, A.N.A.; methodology, A.N.A.; software, A.N.A.; validation, A.N.A.; formal analysis, A.N.A.; investigation, A.N.A.; resources, A.N.A.; data curation, A.N.A.; writing—original draft preparation, A.N.A.; writing—review and editing, A.N.A.; visualization, A.N.A.; supervision, A.N.A.; project administration, A.N.A.; funding acquisition, A.N.A. Author has read and agreed to the published version of the manuscript.