ISSN: 2008-5079 / EISSN: 2538-2365
DOI: 10.22034/AAUD.2023.360499.2713

Research Paper

Teaching Light Design in Modern Housing: Comparison between Student Groups, Designers and Professors*

Parisa Baharloo[a]- Shervin Mirshahzadeh[b]- Behrooz Mansouri[c]**

[a] Ph.D. in Architecture, Islamic Azad University of Central Tehran Branch, Tehran, Iran.

[b] Assistant Professor of Architecture Department, Islamic Azad University of Central Tehran Branch, Tehran, Iran (Corresponding Author).

[c] Assistant Professor of Architecture Department, Islamic Azad University of Central Tehran Branch, Tehran, Iran.

Received 04 September 2022; Revised 20 July 2023; Accepted 10 August 2023; Available Online 21 December 2023

ABSTRACT

As the most substantial place in our life, modern housing includes the life soul and is not a simple physical body and structure but is a shelter free of any environmental tensions of the work and life outside of it. Houses have some spaces with various qualities and functions to meet the needs of their occupants. Daylight is used as an inspiring and visual quality source in the space within different techniques, so the design and efficiency of this light require teaching how to use it in modern housing. This study aims to extract the components of teaching light design in modern housing and examine their teaching priorities. The research method is a mixed qualitative-quantitative method in that data reduction techniques (open and axial coding) are used through ATLASTI software in its qualitative step to reduce data and extract the components. Sampling of individuals is done through the snowball method based on the opinions of experts in the qualitative step. In the quantitative step, PN modeling and statistical inferential tests are used through JMP software to extract the factor contribution rate of the component among 384 members. The results indicate components of the arrays, light movement, and knowing the materials have the highest effect while components of correspond with the change of light angle in teaching light design in modern housing.

Keywords: Teaching, Light Design, Modern Housing, Student Group, Designers Group, Professors Group.

* This paper is derived from the first author's Ph.D. thesis titled "Determining the Components of Teaching Daylight Design in Modern Housing with Emphasis on the Semiotic Ideas" guided by the second author, and advised by the third author in 2022.

** E_mail: she.mirshahzadeh@iauctb.ac.ir

1. INTRODUCTION

As the settlement place, housing is considered one of the basic needs after food and clothing in Maslow's Pyramid. The meaningful element of light plays a vital role in valuing the physical factors of houses and is also one of the determinants and underlying factors in the space. There is an inevitable connection between the sense of place and visual perception. Designers pay attention to the appearance of the building in most modern residential buildings because this element represents the physical and material aspects of the buildings and the role of natural light that is the symbol of life in the building is no longer seen (Momtahen and Nari Gomi 2018, 53-68).

Many of today's houses are designed regardless of context factors, such as climate and culture, so all of them have the same body and are built anywhere and similar lights are used for all spaces. Therefore, similar lightings are used in the design of buildings without considering the optical range related to each space (Mirjani and Nadimi 2019, 5-20).

However, excessive use of glass and the creation of transparent spaces would eliminate the light features. In the design of modern residential buildings, light entry hierarchy has not been considered regarding the need of each space in different climates of Iran (no wise look at light), and only decorative aspects of illumination in houses have received attention (Rockcastle and Andersen 2014, 320-333).

It is undeniable that natural light is always changing; therefore, the soul and body of man depend on the natural flow of movement and time, which are metrics used to test people. The substantial issue of the difference between natural and artificial lights originates from this case: artificial light can be matched with a natural timer because it does not include the movement in hours, seasons, and so forth (Javani et al. 2018, 55-65). All mentioned factors are the issues we face in the design process. Also, the increasing use of simple artificial lighting has made architects forget the effects of natural light and ignore its potential. This elimination not only increases energy consumption costs and threatens the environment but also affects the health, comfort, and productivity of users (Qayyomi Bidhendi and Sepehri 2016, 25-40).

Now, proper light design is an essential factor in houses across the country. Hence, the field of this important topic in an academic environment not only is a research aspect but is necessary because determining principles and criteria of the desired design of a building not only improves the visual quality but also promotes the culture and identity levels in housing architecture society. Moreover, the available studies, and relevant theoretical foundations, light design in housing is not seen in the architecture training through audience-architecture communication. Therefore, this study compares the viewpoints of students, designers, and professors by assessing light design training in modern housing to teach light design in contemporary housing and find the components of light design teaching in modern housing.

2. BACKGROUND

Moazzeni et al. (2020) conducted a study titled "Assessment optical patterns affecting the quality of life of residents of residential units using fractal geometry" to evaluate the quality of life of occupants in residential units based on the relevant effective components, by using fractal geometric skylights. In the research method, they used both rationalistic and argumentative (inductive and deductive) and scientific approaches. The available theories on light, optical entries, and fractal geometry designed and implemented in 8 samples of buildings are taken as independent variables, while the components of optical quality in the residential unity space of mentioned buildings based on the metrics affecting the quality of life are considered as dependent variables. In general, the research results were divided into three groups objective, subjective, and objective-subjective components the subbranches of each were classified and valuated. Finally, under theoretical literature and high scores given by the desired comments of residents in most of the quality-of-life components, findings indicated that optical entries (skylights) that fractal geometry patterns were used in them were highly effective in improving the quality of sense of place.

Javani et al. (2019) carried out a study titled "Daylight, stimulator of Happiness and Psychological Health of the Inhabitants of Residential Compounds, case study: Various Residential Complexes in the City of Isfahan" to determine the relationship between daylight and psychological health of inhabitants living in residential complexes to discover these relationships between daylight and satisfaction of residential complexes in Isfahan. To determine the happiness status, Oxford and Fordyce's happiness assessment instrument was used. Findings express the significant difference between the satisfaction and happiness of inhabitants living in residential complexes and the amount of light entering each unit. It seems that optimal and purposive design of daylight in residence space is effective in improving the quality of psychological health and happiness of users.

Khorrami (2018) carried a thesis under the title of "Effect of Interior Design on Daylight Access in Office Buildings" to examine various changes in interior space affecting daylight access in office buildings with open plans by using the Radiance Software based on the annual simulation of Daysim. Also, the light control system has been considered to achieve more reliable simulation results. The climate

studied in this paper is the hot and dry climate of Tehran where most office buildings with open plans in Iran exist. For this climate, 64 office buildings with various features of ceiling reflection, wall reflection, furniture arrangement, partition' height, and façade direction are considered. Daylight autonomy and continuous daylight autonomy are the variables measured for these modes and compare various simulation modes. The simulation results indicate that optimal use of daylight helps to save 80% of electricity consumption depending on the features of the interior space. Compared to the first row of the table, the second row of the office's table considerably receives less light, and the electricity consumption can be reduced in this area by downsizing the height of the partition and increasing the ceiling reflection.

Hashempoor and Gholizadeh Orang (2015) carried out a study titled "Evaluation of light emersion in mosque architecture Case study: the central axis of Tabriz City (Golastan Garden to Abrasan crossroad)" to examine the qualitative variables, spirituality, holiness, and guidance. The quantitative elements are equivalent to the light concept and its effective role, progress, and expression of truth, direction, dimensions, number of skylights, altitude from the land surface, the color of skylight coating, etc. are used as independent variables. The concepts were chosen and evaluated by associated enterprises. It seems that the mystical concept of light would be easier in the case of designing apertures in the main body of the mosque regarding specific skeletal features, such as higher altitudes from the horizon, southward placement, smaller size, and opposite value. The research results confirm this hypothesis indicating that users would feel the concepts more legibly in this case.

Hoomani Rad and Sharafi Nafar (2015) conducted a study under the title "An investigation on the ergonomic proportion and spirituality of daylight in the architecture of mosques" to find the qualitative and quantitative effects of daylight on people's satisfaction when praying in two grand mosques from the Safavid dynasty called the Imam and the Sheikh Lotfollah due to artistic use of light qualitative features in creating a sense of spirituality. These two mosques were chosen and compared with two contemporary mosques called Ghoba and the great mosque of Shahrak-Gharb. For this purpose, the global index for ergonomic lighting survey and its analytical SPSS software and ELI calculator were used to convert qualitative information to quantitative data. The research findings indicate that qualitative improvement of visual perception is achieved through designing appropriate skylights. Daylight is an effective factor in improving the sense of spirituality and its quantity and quality specify the satisfaction of people during the pray. Ultimately, it must be mentioned that the science of spatial ergonomics as introduced by Western researchers in 2010 had been presenting itself in the thoughts and designs of ancient Iranian architects, and ergonomics could be named as the native knowledge of Iran.

The review of the research background shows that light design training by using semiotic analysis for making the architecture design meaning-based has a weak background. The research background shows that some theoretical analyses and practical models must be found that can evaluate the light as a factor in space that makes it meaningful, so architects must learn these principles.

3. THEORETICAL FOUNDATIONS

The meaning-based design is one of the underlying but unknown topics in architecture (Mohammad and Tafazzoli 2018). Design is an artistic process that occurs in the mind and has a multidimensional identity, so its phases and processes must be found (Amini et al. 2019, 61). Learning architecture becomes meaningful based on the learning design (Mirjani and Nadimi 2019). Academic learning architecture was individualistic from the beginning (Momtahen 2018, 55); however, learning architecture in a natural process is not in line with academic professor-centered teaching that is derived from objective educational implementation. Hence, ordinary academic learning methods cannot be effective for learning architecture design. In this case, the studies that develop and enhance the architectural design learning techniques can use the potential for developing constructivist educational implementation approaches (Panahi et al. 2014, 27). Therefore, constructivist educational implementation comprises resources and protects the learning processes. It also emphasizes considering some principles, such as the active participation of the learner in the learning processes, incorporating learning in the original and actual cases, and solving learning issues based on social interactions (Qayyoomi et al. 2016, 28).

Accordingly, meaning-based bias in learning audience-centered design is optimally consistent with semiotic vision in the constructivist teaching environment based on the attention to design components of settlement place. The reason is that not only does housing include social and cultural aspects of society but also a place for living and spending a longer time in it. Therefore, qualitative improvement of housing plays a considerable role in meeting needs and making dwellers satisfied with their livelihood. However, the role of identity in residential spaces was ignored in the past, while man found their identity in the place they lived.

3.1. Light in Architecture

Like other inseparable elements of ancient Iranian architecture (water, earth, and air), light also has three material, psychological, and spiritual aspects. In this case, light has the highest rank. This vital element has

not only a functional role in measures taken by the building's architect but also converts it to a different and unique space (Shafiei et al. 2013, 24-41).

"Light is not just a material element but is a symbol of divine reason and spiritual essence that enters inside the material's concentration making it valuable and desired for living place of the man (Tregenza and Wilson 2011) and Pope believes that beauty and light has inseparable connection as it is seen in Iran, daylight has persuasively developed the role that tradition has given to it with a tangible and creative way," Nasr writes about the light (Panahi et al. 2014, 25-34).

In his book called (optic) (Al-Hosn), Ibn al-Haytham defines beauty as the outcome of interaction between 22 factors: light-color constancy, distance between objects, place of objects, hardness of materials, appearance, dimension and size, discontinuity or continuity, movement or stillness, transparency or opacity, shade or illumination, visual beauty or ugliness, similarity or dissimilarity. Among the mentioned factors, only light and color (that color is an appearance of light) are considered with the stimulating potential in a single form while other factors are meaningful when interacting with each other (Veitch 2001, 124-140).

The quality of presenting light in architecture expresses the architecture and intermediates its perception. Dimensions, performance, and the elements attached to each space would define the rate and quality of the light in that space and used openings. In this regard, no similar feature is seen between skylights used in two different spaces. Light entry places in Iranian architecture either send the light into the space directly or the light enters the space after passing through the controller layer (Omidfar and Chamilothori 2019). This intermediary layer can be a latticed and or semi-transparent surface that can change the quality of light depending on the target space. These kinds of skylights include maximum light entryways into the space because they provide the light presence with proper and desired quality in the space. In ancient Iranian architecture, the skylight is not the only case but the purpose is to complete its meaning. How light enters the space, passes through it, and plays a role along with shadow indeed completes the light presence process. In this process, various factors define the final quality of light, including surfaces, color, materials, and available elements and arrays (Newsham et al. 2005, 93-112).

Although it is not possible to investigate surfaces in the architecture without considering their natural features, such as color, direction, materials, etc., as a separate element in interaction with other factors depending on "exposure to the light or in absence of it," the rate of light and "time of being affected by it," surfaces affect the meaning and perception of building a body of the architectural works (Moscoso et al. 2015, 1-13).

Integrated, porous, upper and lower surfaces with arches and semi-columns reflect an abstract surface through some elements such as columns, cross surfaces with optical pores, and finally the diverse surfaces morphologically with the behaviors they indicate in adjacency to the light and with shadow and light mixtures. Light presence includes a series of qualities that target the process of perceiving a sense of place based on the needs and goals of the design for that space (Lam 1986, 253).

The outcome of light entry to different surfaces not only diversifies the visual view and creates various spaces but also increases space light and reflects it in a better way (Khorrami 2017), and this process occurs over the day when light angle changes preventing a stagnant space. The effect of the light on the consecutive arches and columns in a space not only creates order but also leads to continuity and spatial hierarchy. It seems that light presence is more apparent in this case revealing its important presence in the absence of light (Humani Rad and Sharfi Nefer 2014, 1-13).

The visual depth created by the shadow between lines in a surface would give more depth to the surface. Various optical spots in the walls, movement of shadows, and diversity of elements' shapes in connection with light over the day make the space more dynamic and livable. All of the mentioned interventions and consistencies reveal light in the building as the main essence, so architecture work would be meaningless in the absence of light and such interventions (Hashempour and Qolizadeh Orang 2015, 101-114).

The type of materials in terms of being transparent or matte, polished, bright or dark would determine the light behaviors, such as reflection, diffusion, refraction, transmission, or absorption of light each of them creates various spaces that are proper for people to live. Light radiation on the polished surfaces and its reflection on other surfaces would transmit the light entered from space so that the light is not interrupted until it reaches the considered target and passes through foreseen places. Henry Corbin calls these polished materials "tile mirrors" (Schon 1987). Some materials such as brock and wood create a calm space optically by absorbing light and minor reflection of it. With its bright color, plaster doubles the space illumination and mirrors reflect the light and make the space mysterious enhancing the space geometry beyond the real borders. With a little angle change, glasses direct light and change the quality of light depending on their colors. Arrangement of these materials adjacent to and combined would lead to spatial diversity and narrate the light transmission story based on the desired roles (Van Erp 2008).

In addition to some factors such as time, architecture style, available materials, construction field, and architectural building, tape also is effective in selecting the color of materials. "The appearance is

caused by the presence of light and color elements that their reflections follow some geometric rules such as harmonic proportions" (Lam 1986).

3.2. Light Design in Housing

In design, daylight is used at two general and specific levels, the general level considers the themes that can be generalized to most of buildings and design frames, while its specific type provides the solutions for daylight use based on the performance and users. The designer is responsible for paying attention to both levels because none of them is singly responsive. Unfortunately, some fixed and old principles are repeatedly applied to the illuminance design for a building without considering the tangible difference between different buildings and the micro or macro-climate conditions of their contexts. Therefore, such repetitions must be eliminated to achieve a perfect design for the illuminance of buildings (Mohammad and Tafazzoli 2018, 5-24).

The outcome of light entry for different levels not only diversifies visual view and creates various spaces but also increases the light of house space reflecting it in a better way, and this process occurs over the day when light angle changes preventing a stagnant space. The effect of the light on the consecutive arches and columns in a space not only creates order but also leads to continuity and spatial hierarchy. It seems that light presence is more apparent in this case revealing its important presence in the absence of light. The visual depth created by the shadow between lines in a surface would give more depth to the surface. Various optical spots in the walls, movement of shadows, and diversity of elements' shapes in connection with light over the day make the space more dynamic and livable. All of the mentioned interventions and consistencies reveal light in the building as the main essence, so that architecture work would be meaningless in the absence of light and such interventions (Moazeni et al. 2019, 122-137).

The type of materials in terms of being transparent or matte, polished, bright or dark would determine the light behaviors, such as reflection, diffusion, refraction, transmission, or absorption of light each of them creates various spaces that are proper for people to live. Light radiation on the polished surfaces and its reflection on other surfaces would transmit the light entered from space so that the light is not interrupted until it reaches the considered target and passes through foreseen places. Henry Corbin calls these polished materials "tile mirrors" (Darya Lal et al. 2008).

Some materials such as brock and wood create a calm space optically by absorbing light and minor reflection of it. With its bright color, plaster doubles the space illumination and mirrors reflect the light and make the space mysterious enhancing the space geometry beyond the real borders. With a little angle change, glasses direct light (Beamish 2002, 133-142), and change the quality of light depending on their colors. The arrangement of these materials adjacent to and combined would lead to spatial diversity and narrate the light transmission story based on the desired roles (Kasraei 2008).

In addition to some factors such as time, architecture style, available materials, construction field, and architectural building, tape also is effective in selecting the color of materials. "The appearance is caused by the presence of light and color elements that their reflections follow some geometric rules such as harmonic proportions (Danai 2012, 5). Seyyed Hasan Nasr explains that color appears in contrast with the light, and as natural light and its undecomposed form is the symbol of divine existence and intellect, colors would also symbolize the various aspects of existential actions (Hong 2002). Lights in the mind and soul of a person create some modes that are matched with their qualitative and symbolic reality. As light has always been in the ancient architecture of Iran, some states of perceiving the nature of color and its consistencies that are interconnected with light are seen in all Iranian arts (Arjomandi 2011, 25).

Arrays in Iranian architecture would reveal the effect of light on the space through the brickwork, plasterwork, stonework, and tilework by using the light and shadow technique converting the simple geometric interior space to a diverse space with rhythm and focal point in the desired place. In one case, it imposes simplicity, arrays, and monotony, while bringing the elegance and complexity of that movement and emotion into the space (Amini et al. 2019, 54).

This is the round-trip process between arrays and light presence that reveals each of them perfectly. Radiating on arrays, light can be imagined presenting a beautiful harmony between arrays and motifs. Interacting with the light and dual behavior of light reflection or absorption, these arrays induce an emphasized presence in a certain way by symbolizing the light and diversifying the space with their various motifs (Boyce 2003).

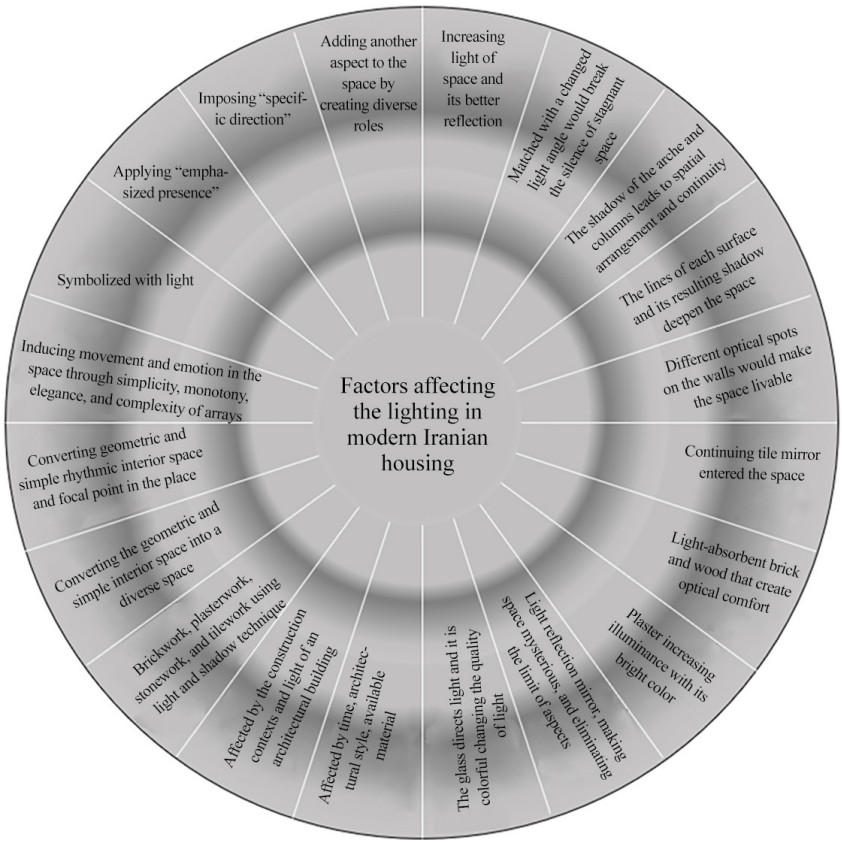


Fig. 1. Factors Affecting the Lighting in Modern Iranian Housing

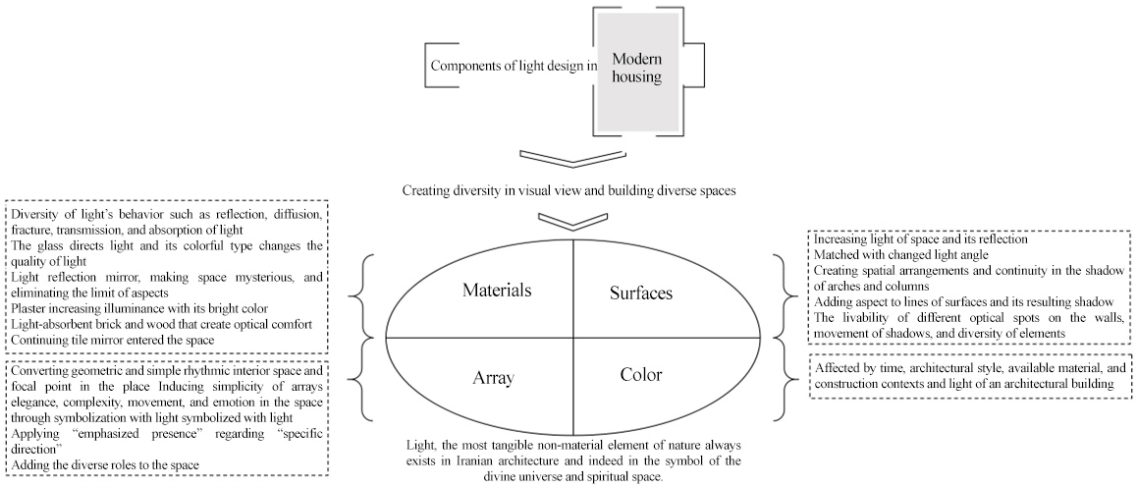


Fig. 2. Conceptual Model

4. METHOD

This is applied research in terms of nature with mixed qualitative-quantitative method and causal-comparative approach. In the qualitative method, the semi-structured interview is used to scrutinize variables extracted from foundations and assign underlying variables to the case study. The obtained results are then inserted into ATLASTI software to facilitate the coding process, and the open coding for data extraction is described and interpreted based on a living approach. The interviewees have been chosen based on the table below and inclusion criteria of them include available academic research papers about the topic and expertise of the interviewees in this field. The interviewees are introduced based on the snowball technique.

Table 1. Expertise of Interviewees

Interviewees	N	Frequency	Cumulative Percentage
Architecture Professors	16	34.8	34.8
Landscape Architecture Professors	9	19.5	54.3
Urban Design Professors	12	26.2	80.5
Urban Planning Professors	9	19.5	100
Sum	46	100	-

In the quantitative step, the obtained variables are used in a questionnaire designed based on the Likert Scale and distributed among education experts in the field of architecture. In the first phase of the study, a questionnaire must be used that is designed regarding the goal-content Table 1. In the second phase and with the correlation method, the components resulting from the questionnaire were used, and the answers were designed based on a four-point scale to find the relationship between variables specified in the survey method. To achieve the goals and content of Table 1, three steps of the Delphi method are actualized by the housing design teaching field from the most popular universities in Tehran. The sampling method is used in the quantitative phase for statistical society, the upper limit of the Morgan Table which comprises 384 members is used for sample adequacy. The validity of the instrument equaled CVR=0.76 and Cronbach's alpha of 0.78 was used for the reliability of the instrument. For this purpose, the regression coefficient of determination and graphical correlation coefficient are used.

Table 2. Goal-Content Table of Teaching Light Design in Modern Housing

Content / Goal	Factor 1: Context Factors for Light Design in Teaching Housing Design	Factor 2: Methods to use Light in Teaching Housing Design	Factor 3: Effect of Factors Affecting Lighting Quality in Housing Design
Teaching Qualitative and Quantitative Concepts of Light	Light and color physics Psychological-perceptual processes Biological-mental processes	Light measurement quantities Ascending composition Descending composition	Rhythm Matched with light angle change Diverse optical behavior, such as reflection, movement of shadows, and diverse shapes of elements
Teaching the Necessary Presence of Light in Architectural Design	Need for illuminance Why illuminance is needed Monotony of illuminance Symbolization of light Direction Visual connection Diversity and change	Directing the building Size of windows and how to install them Set of windows Controllers Quantity of illuminance Size of translucent windows	Color of glasses Arrays Simbolozed with light Applying emphasized presence Creating a diffuse and uniform light Shadow and reflection
Teaching Design with Daylight	Light in the urban arrangement Cross altitudes and roof forms Artificial lighting	Surfaces of central courtyards Surfaces of terrace, balcony Roof surfaces Radiation angle	Reflection, diffusion, fracture, and light transmission Elegance and complexity Emphasized the presence of light Light direction Light effect intensity proportions and radiation destination
Teaching Skylight Elements	Types of skylights based on their location Ceiling skylights-lighting from top Wall Lighting Slopped windows Types of glasses	Suitable design to create optimal illuminance Creating skylight efficiency Single-window beneath the roof Window beneath the back-breaking roof	Emphasis on a specific space with optical contrasts Light movement Optical balance

Content / Goal	Factor 1: Context Factors for Light Design in Teaching Housing Design	Factor 2: Methods to use Light in Teaching Housing Design	Factor 3: Effect of Factors Affecting Lighting Quality in Housing Design
Teaching Light in Planning and Design of Housing Construction	Color of surfaces Light reflection Desired illuminance Light color matched with the space	The balance between electrical light and daylight Multi-part of space due to different illuminance Optical contrast Light direction	Light transmission and absorption Diffusion Increasing light of space and reflection Deepening the lines of each surface and the shadow resulting from it Fracture Adding diverse motifs Creating Geometry Adding simplicity
Teaching Quality and Lighting and Lightening Instruments in Traditional and Contemporary Architecture of Iran	Building appearance Different colors of constant objects in different contexts Geometry and coexistence of components of houses	Type of materials Illuminance rate Monotone distribution Illuminance intensity Glare control Contrast appearance (limiting indirect glare) Suitable color matched with eyes Proper contrast Lack of severe shadows	Brightness of environment Playing brilliance Light quality control Time appearance Light transmission and absorption Diffusion Increasing space light and reflection Adding dimension to lines of each surface and shadow resulting from it Knowing materials

According to the relationship between goals and four contents in Table 2, these factors are marked with stars and one question has been designed for each star. The questionnaire derived from Table 2 is used to evaluate the ideas of students and designers.

5. RESULTS

In the qualitative step, in addition to components extracted from Table 2, interviews are coded and components of light design teaching are extracted in this phase. After doing interviews, the results are imported into the software to ease the process, and coding is done based on the data adjustment and interoperation to modify the data. Figure 3 indicates the components extracted from the interviews' transcripts.

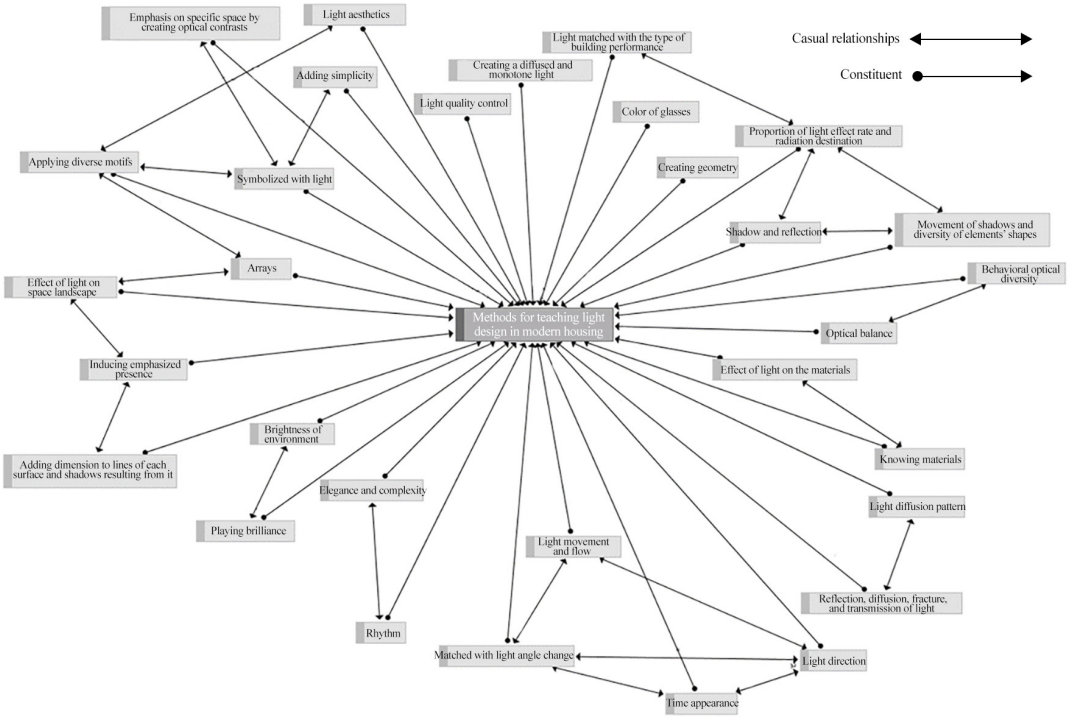


Fig. 3. Codes Extracted from Interview Transcript (Components of Daylight Teaching in Housing) based on the Data Reduction Techniques

5.1. Quantitative Results

According to descriptive statistics, 253 members (72.1%) are men and 98 members (27.9%) are women from the age range of 18-30. In this step, the analyses are done based on the factors used in tradition and modernism. The process is done as follows, a question is designed for indicators of each factor (5), and each question is answered based on the 1-5 scale. The total score given to indicators of a factor means the score each person gives to the considered quality. Therefore, the score may vary between 5 and 25. Accordingly, a classification is done in which, individuals who have given scores 1-5 to a factor have estimated it weak, score 12-18 indicates moderate level, and score 19-25 indicates a good idea of them. The most important factors are reported in the frequency chart shown below. Among the components for teaching light design in modern housing, the lowest rate (1258) belongs to time appearance, while the highest rate (1901) is given to the effect of light on the materials.

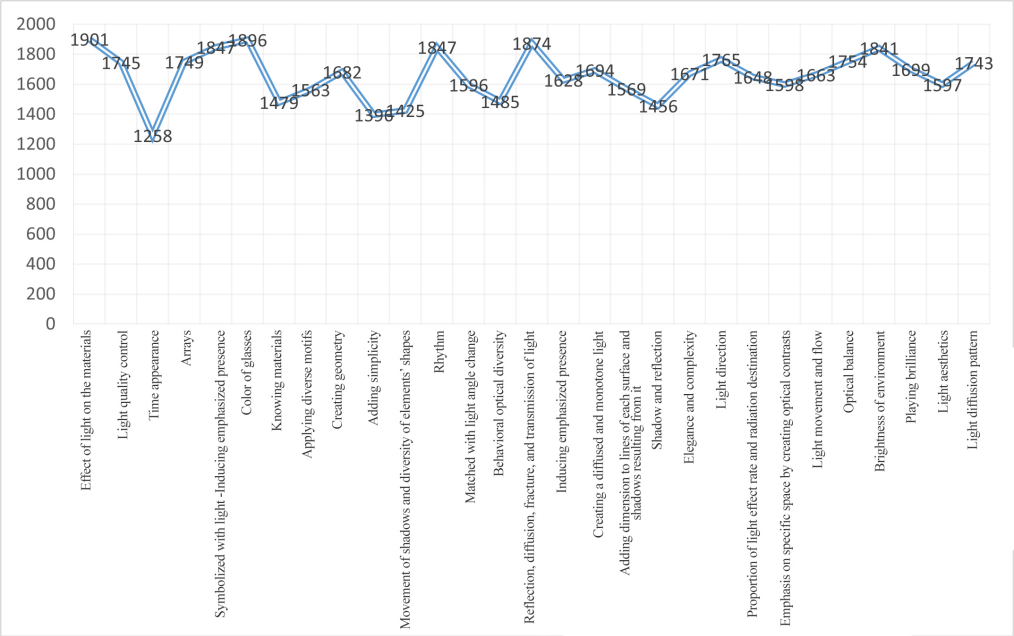


Fig. 4. Frequency of Light Design Teaching's Components

5.1.1. Spearman Correlation

The results of the questionnaires are valued and inserted into the JMP software. Regression and correlation relationships are used for analysis. The two-sample Kolmogorov-Smirnov Test is used to determine parametric and non-parametric types of data.

Table 3. Kolmogorov-Smirnov Test to Examine Normality of Light Design Teaching Components

Variable	Mean	SD	Z Kolmogorov-Smirnov	p
Components of Light Design Teaching	31.25	2.83	0.762	0.432

As seen in the Table above, the Kolmogorov-Smirnov Test is significant (p=0.432) for the score given to components of light design teaching; therefore, these components do not have a normal distribution, so non-parametric analyses must be used for it. Table 3 indicates the correlation between variables. As it is seen, there is a positive and significant correlation between components of daylight design in modern housing at a level of 0.01. Among components of light design teaching, the highest correlation (0.889) belongs to rhythm, while the lowest rate (0.344) is for time appearance.

Table 4. Correlation between Components of Teaching Light Design in Modern Housing

Dimension	Variable	Spatial Users	
		Correlation Coefficient	Sig.
Components of Light Design Teaching	Effect of Light on the Materials	0.743	0.000
	Light Quality Control	0.574	0.000
	Time Appearance	0.344	0.000
	Arrays	0.739	0.000
	Symbolized with Light-Inducing Emphasized Presence	0.675	0.000
	Color of Glasses	0.569	0.000
	Knowing Materials	0.746	0.000
	Applying Diverse Motifs	0.807	0.000
	Creating Geometry	0.542	0.000
	Adding Simplicity	0.654	0.000
	Reflection, Movement of Shadows, and Diversity of Elements' Shapes	0.895	0.000
	Rhythm	0.889	0.000
	Light Matched with the Type of Building Performance	0.733	0.000
	Behavioral Optical Diversity	0.743	0.000
	Reflection, Diffusion, Fracture, and Transmission of Light	0.574	0.000
	Inducing Emphasized Presence	0.744	0.000
	Creating a Diffused and Monotone Light	0.739	0.000
	Adding Dimension to Lines of each Surface and Shadows Resulting from it	0.529	0.000
	Shadow and Reflection	0.679	0.000
	Elegance and Complexity	0.654	0.000
	Light Direction	0.741	0.000
	Proportion of Light Effect Rate and Radiation Destination	0.689	0.000
	Emphasis on Specific Space by Creating Optical Contrasts	0.746	0.000
	Light Movement and Flow	0.802	0.000
	Optical Balance	0.799	0.000
	Brightness of Environment	0.827	0.000
	Playing Brilliance	0.736	0.000
	Light Aesthetics	0.712	0.000
	Light Diffusion Pattern	0.766	0.000
	Light Matched with the Type of Building Performance	0.782	0.000

5.2.1. Regression

An internal correlation matrix of variables is used to apply linear or multivariate regression. After the correlation matrix was illustrated, it was found that no linear relationship exists between facto; hence, multivariate regression must be used.

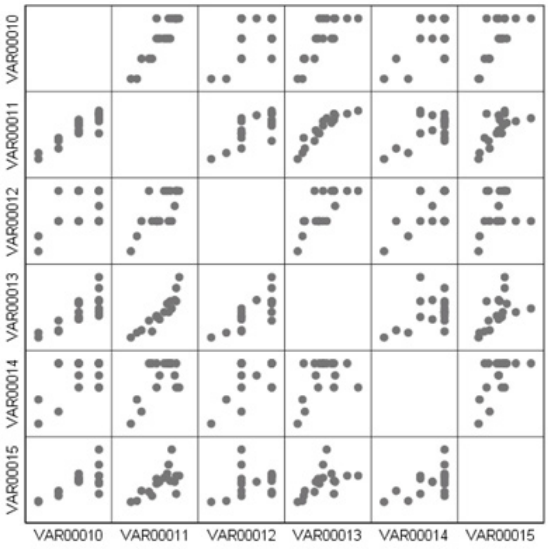


Fig. 5. Matrix of Correlation between Factors

According to the results obtained from the regression table, the highest factor contribution (1.000) belongs to components of arrays, light flow and movement, and knowing materials, while the lowest rate (0.467) belongs to match with light angle change.

Table 5. Results of Multiple Regression and Stepwise Regression Coefficients

Scale	Coefficient of Determination	F	B	β	t	Sig.	df
Effect of Light on the Materials	0.615	527.222	1.000	0.781	46.522	0.000	383
Arrays	1.000	405.122	1.000	0.732	42.152	0.000	383
Time Appearance	0.846	217.343	1.000	0.662	40.223	0.000	383
Light Quality Control	0.746	199.943	1.000	0.648	38.239	0.000	383
Symbolized with Light-inducing Emphasized Presence	0.762	201.612	1.000	0.664	8.958	0.000	383
Color of Glasses	0.383	643.623	1.000	0.662	11.134	0.000	383
Shadow and Reflection	0.753	849.683	1.000	0.652	18.441	0.000	383
Light Flow and Movement	1.000	349.603	1.000	0.665	19.144	0.000	383
Creating Geometry	0.571	184.945	1.000	0.483	49.173	0.000	383
Adding Simplicity	0.770	276.748	1.000	0.464	47.963	0.000	383
Reflection, Movement of Shadows, and Diversity of Elements' Shapes	0.795	199.943	1.000	0.452	46.226	0.000	383
Rhythm	0.893	499.034	1.000	0.463	47.228	0.000	383
Light Matched with the Type of Building Performance	0.467	673.643	1.000	0.662	21.341	0.000	383
Behavioral Optical Diversity	0.750	489.782	1.000	0.720	25.215	0.000	383
Reflection, Diffusion, Fracture, and Transmission of Light	0.674	489.782	1.000	0.543	19.215	0.000	383
Inducing Emphasized Presence	0.567	489.782	1.000	0.420	18.215	0.000	383
Creating a Diffused and Monotone Light	0.573	382.412	1.000	0.663	20.321	0.000	383
Adding Dimension to Lines of each Surface and Shadows Resulting from it	0.732	656.782	1.000	0.410	25.876	0.000	383
Knowing Materials	1.000	673.643	1.000	0.662	21.341	0.000	383
Elegance and Complexity	0.754	513.244	1.000	0.568	27.245	0.000	383

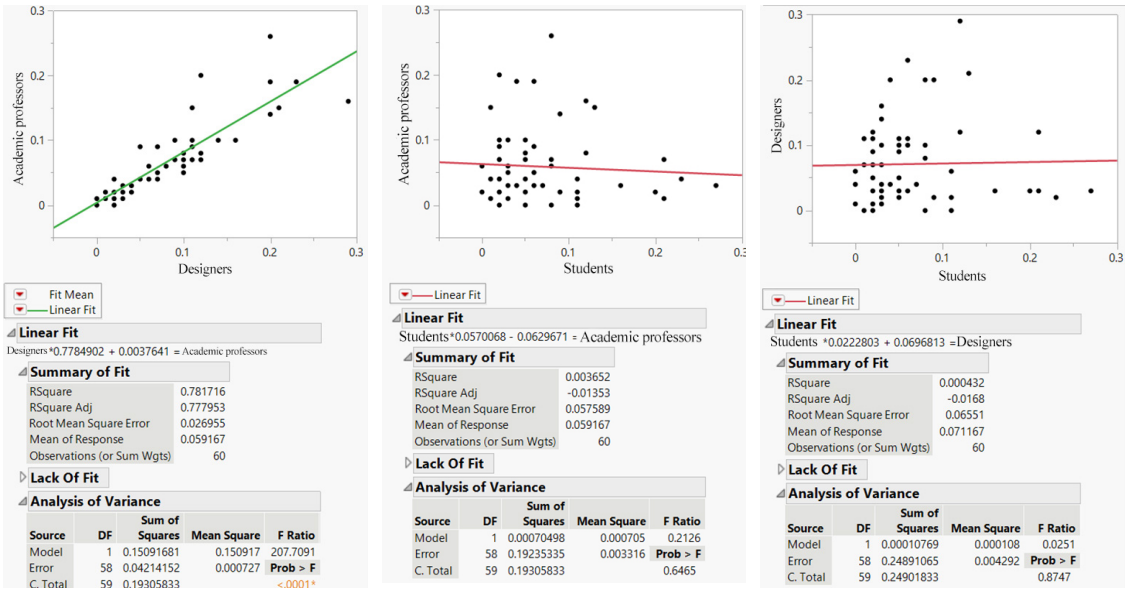
Scale	Coefficient of Determination	F	B	β	t	Sig.	df
Light Direction	0.741	578.874	1.000	0.599	26.314	0.000	383
Proportion of Light Effect Rate and Radiation Destination	0.698	534.624	1.000	0.534	23.498	0.000	383
Emphasis on Specific Space by Creating Optical Contrasts	0.821	497.877	1.000	0.566	28.742	0.000	383
Applying Diverse Motifs	0.817	426.365	1.000	0.487	26.478	0.000	383
Optical Balance	0.823	568.248	1.000	0.499	21.478	0.000	383
Brightness of Environment	0.759	639.145	1.000	0.508	22.486	0.000	383
Playing Brilliance	0.728	645.285	1.000	0.546	21.875	0.000	383
Light Aesthetics	0.788	687.234	1.000	0.579	19.657	0.000	383
Light Diffusion Pattern	0.714	647.214	1.000	0.583	25.342	0.000	383
Light Matched with the Type of Building Performance	0.692	641.489	1.000	0.594	24.478	0.000	383

6. DISCUSSION

According to the results obtained from descriptive values and comparing them with inferential values, inferential values must be considered for analyzing the results and effect of components mentioned for the light design of modern housing. According to the results obtained from correlation tables, the component of teaching rhythm through light in modern housing can significantly affect the other components making architecture students involved in other scopes for creating rhythm through daylight. A rhythm with repeating regular shapes and lines in the buildings can appear in the frame of the spatial body or structure by using repetitive spaces in residential architecture. Daylight mixed with shadow can add rhythm to the architecture of modern housing. In the regression results, some components of teaching light design have coefficients of 1.000 of which, light flow and movement in different parts of the body and space in spatial shapes and structure can enter various modes to the space regarding the skylight type (near the floor or ceiling). In teaching components of daylight design, consideration of fracture and its type in transparent and semi-parent materials is an important case in the design of modern housing. Finally, teaching light design in modern housing is considered based on the correlation between respondent groups. The results show that a gap exists between the ideas of academic experts and professors with students, so individuals have entered the professional market, and the need for various components of design teaching must be changed. However, a correlation (0.781) exists between groups of designers and university professors.

Table 6. Graphical Correlation between Questionnaire's Respondents

Graphical Correlation



Ultimately, PN modeling is done to find the effects of components on different groups, which indicates that designers and academic professors give lower scores to components, while students give higher rates to components.

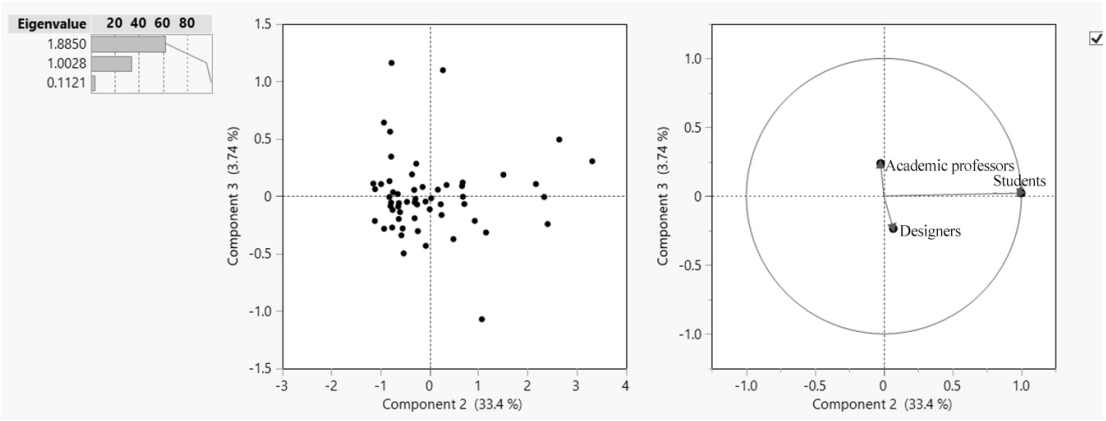


Fig. 6. PN Modeling for Different Respondent Groups

7. CONCLUSION

The continuous light plays a vital role in evaluating the physical factors of architecture and is also one of the underlying and determinant elements for the space. There is an interconnection between the physical space of architecture and visual perception and visual perception results from the light received by the nerves of the eyes and brain. However, this study relied on not giving identity to contemporary architectural spaces, and it can be stated that it is one of the past attitudes that has been ignored during this period. Now, the aspects that make space meaningful are less seen in the buildings; for instance, the desired connection between building and daylight that plays the role of body and soul in the space is less seen in the modern buildings. In most modern architectural works, only the physic and body of buildings are seen that represent the material presence while the role of natural light presenting the life and living in the space is hardly observed. The important point is a single practical attitude or formalist approach. Since natural light radiation has not changed rather than the past, the quality of using this meaningful element is necessary for modern houses based on the ancestors' experiences. Moreover, the increasing use of nonrenewable resources, such as easy artificial lighting has made designers forget the effects of natural light and ignore its potential.

According to research findings, teaching some components including arrays, light flow, and movement and knowing materials has more effect on teaching light design in modern housing. The arrays in Iranian architecture would reveal the maximum effects of light in the space in the frame of brickwork, plasterwork, stonework, and tilework by adopting light and shadow techniques. In this case, arrays can convert the simple and geometric interior space to a diverse and rhythmic space with a focal point in the desired place. On the one hand, the simplicity of arrays creates monotony, while their elegance and complexity bring movement and emotion to the space on another hand. This round-trip process between arrays and light presence would reveal each perfectly. Radiating on arrays, light can be imagined and observed as a beautiful dance with arrays among motifs. When contact with light and dual behavior of light reflection or absorption, these arrays would pose "emphasized presence" in a "specific line" through "symbolization" with the light.

The light flow and movement in modern housing determine the movement route in spatial connections that can appear as an emphasis on a line or concentration on a certain point. Also, it is used in its monotone type to emphasize direction-less cases. Movement and change in light direction in a building would lead to spatial diversity of bright, semi-bright space and brightness and darkness removing the monotony and stagnation of the building. This case is a factor creating livability and dynamism for a work creating a better living place. Movement leads to livability and dynamism either over the day or in connection with architectural elements installed for fracturing light routes in the long term and over time. It prevents stagnation and repetition without any change.

In exterior spaces where sufficient light exists, matte and reflection-less materials are mostly used allowing individuals to be present in the courtyard without receiving reflection from the surfaces and its resulting glare. This visual comfort is a factor in making the courtyard a space for pause, not a space just for meeting needs and passing through it. On the contrary, polished materials with higher reflection potential are used in interior spaces to diffuse light in the space alarming the performance change and

determining the privacy of the space, so residents can more tangibly feel that they have passed through the courtyard and reached the interior space. The polished rate of materials is measured based on the materials available in outside space and the use of each space. For instance, mirrors are used in addition to bright materials in guest-room space to bring more glory.

Iranian architects must use software and new technologies, review and apply the experiences of ancestors, find substantial criteria in teaching design, and know how to use light in residential spaces to adopt it in the best way and create a new trajectory in using natural light in contemporary architecture. Such architecture can meet all practical and spiritual needs of users in maximum use of natural light and intelligent control over the artificial light of modern buildings.

ACKNOWLEDGMENTS

This article wasn't supported by any financial or spiritual sponsors.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

MORAL APPROVAL

The authors commit to observe all the ethical principles of the publication of the scientific work based on the ethical principles of COPE. In case of any violation of the ethical principles, even after the publication of the article, they give the journal the right to delete the article and follow up on the matter.

PARTICIPATION PERCENTAGE

The authors have participated in the research process to an extent.

REFERENCES

- Amini, Sara, Mohammad Mansour Falamaki, and Ghazal Keramati. 2019. Typology of imagination in the process of architectural design. *The monthly scientific journal of Bagh-e-Nzar* 16(22): 53-64. DOI: 10.22034/bagh.2019.87490. [in Persian]
- Arjomandi, Hanieh. 2011. The spiritual and psychological effects of the light and color of traditional Iranian houses on the residents. Translated by Mohammad Mahdi Mirlu, Somia Asadzadeh. *Hikmat and Knowledge Journal* 6(9): 25-30. https://www.noormags.ir/view/fa/articlepage/887887. [in Persian]
- Beamish, Anne. 2002. *Strategies for international design studios: using information technologies for collaborative learning and design*. Architectural education today: Cross cultural perspectives.
- Boyce, Robert. 2003. *Human Factors in Lighting (2thed.)*. London: Taylor & Francis.
- Behrang, Darya Lal, and Rehane Hosle Dar Saber. 2008. Light in Architecture. Art Quarterly, Gilan Building Engineering System, 13th year, number 25. https://ensani.ir/fa/article/189388. [in Persian]
- Danai, Ladan. 2012. The relationship between light and contrast in interior architecture. *The third interior architecture and decoration conference*, 1-7. https://civilica.com/doc/308614. [in Persian]
- Hashempour, Parisa, and Farzaneh Qolizadeh Orang. 2015. Evaluation of how light manifests in the architecture of mosques with a case study in the middle axis of Tabriz city (Golestan Bagh to Abersan intersection). *Architecture and Urban Development* 7(11): 101-114. https://civilica.com/doc/1018126/. [in Persian]
- Hong, Yeji. 2002. The Psychology of Lighting, Architectural Lighting Journal, Zing Communications, Inc9.
- Javani, Zahra, Ramin Madani, and Isa Hojjat. 2018. day light; stimulating the happiness and mental health of residents of residential complexes; Study case: residential complexes of areas 7, 8, 12 and 14 of Isfahan city. *Armanshahr* 12(27): 55-65. DOI: 10.22034/AAUD.2019.92447. [in Persian]
- Humani Rad, Marzieh, and Ashkebous Sharfi Nefer. 2014. An exploration of the ratio of ergonomics and spirituality of daylight in the architecture of mosques, *Armanshahr* 8(2): 1-13. https://www.armanshahrjournal.com/article_39281.html. [in Persian]
- Kasraei, Fereydoun. 1387. Forty keys of light in interior architecture. published by Fereydoun Kasraei. [in Persian]
- Khorami, Faraz. 2017. The effect of interior design on access to daylight in office buildings, Master's thesis, Department of Fine Arts-Faculty of Architecture, University of Tehran. [in Persian]
- William, Lam. 1986. *Sunlighting As a Formgiver for Architecture*. Van Nostrand Rinhold, New York.
- Mirjani, Hamid, and Hamid Nadimi. 2019. Active experience model in architectural education, A method to gain practical knowledge through design-oriented experience of architectural examples. *Journal of Iranian architecture studies* 7(14): 5-20. https://jias.kashanu.ac.ir/article_111806.html. [in Persian]
- Moazeni, Masoud, Sahar Tofan, and Dariush Sattarzadeh. 2019. Evaluation of light patterns affecting the quality of life of residents of residential units using fractal geometry. *Andisheh Memari* 4(7): 122-137. DOI: 10.30479/AT.2020.12074.1381. [in Persian]
- Mohammdi, Ali, and ZahraTafazzoli. 2018. Design as a re-reading of "Design" conceptual metaphors. *Soffeh* 28(4): 5-24. https://soffeh.sbu.ac.ir/article_100450.html. [in Persian]
- Momtahen, Mehdi, and Masoud Nari Gomi. 2018. Training process within various types of architectural education (case study: enquiry of alternative educational processes through recent decade (2007-2017) in architectural schools of Iran. *Honar-Ha-Ye-Ziba: Memary Va Shahrsazi* 23(3): 53-68. DOI: 10.22059/JFAUP.2019.248477.671909. [in Persian]
- Moscoso, Caludia, Barbara Matusiak, and Kyrzyszof Orleanski. 2015. Analysis of stereoscopic images as a new method for daylighting studies. *ACM Transactions on Applied Perception (TAP)* 11(4): 1-13. https://www.researchgate.net/publication/271436631_Analysis_of_Stereoscopic_Images_as_a_New_Method_for_Daylighting_Studies
- Newsham, G. R., C. Richardson, C. Blanchet, and Jennifer Veitch. 2005. Lighting quality research using rendered images of offices. *Lighting Research & Technology* 37(2): 93-112. https://www.researchgate.net/publication/44061397_Lighting_quality_research_using_rendered_images_of_offices
- Omidfar, Azadeh, and Kynthia, Chamilothori. 2019. Influence of Subjective Impressions of a Space on Brightness Satisfaction: An Experimental Study in Virtual Reality, Proceedings of Simulation for Architecture and Urban Design (SimAUD). https://www.researchgate.net/publication/332353511_Influence_of_Subjective_Impressions_of_a_Space_on_Brightness_Satisfaction_an_Experimental_Study_in_Virtual_Reality. [in Persian]
- Panahi, Siamak, Rahim Hashempour, and Gholamreza Islami. 2014. The mind architecture, from the "Idea" to the "Concept". *Hoviatshahr Journal* 8(17): 25-34. https://hoviatshahr.srbiau.ac.ir/article_3165.html. [in Persian]
- Qayyyomi Bidhendi, Mehrdad, and Yahya Sepehri. 2016. A History of architectural design in Shahid Beheshti University: The Evolution Phas. *Soffeh* 26(3): 25-40. https://www.researchgate.net/publication/332353511_Influence_of_Subjective_Impressions_of_a_Space_on_Brightness_Satisfaction_an_Experimental_Study_in_Virtu-

al_Reality. [in Persian]

- Rockcastle, Siobhan, and Marilyne Andersen. 2014. Measuring the dynamics of contrast & daylight variability in architecture: A proof-of-concept methodology. *Building and Environment* 81: 320-333. doi.org/10.1016/j.buildenv.2014.06.012
- Schon, Donald. 1987. *Educating the reflective practitioner (p. 27)*. San Francisco: JosseyBass.
- Shafiei, Fatemeh, Alireza Fadeli, and Mohammad Javad Azadi. 2013. Investigating the manifestation of the code of light in Islamic architecture (based on Sohravardi's oriental view of light and emphasizing the features of Islamic mosques. *Islamic Art Journal* 1(3): 24-41. https://civilica.com/doc/1572039. [in Persian]
- Tregenza, Peter, and Michael Wilson. 2011. *Daylighting. Architecture and lightening design*. London and New York: Routledge.
- T. Van Erp. 2008. The effects of lighting characteristics on atmosphere perception. Unpublished Master thesis for the Master's degree program Human Technology Interaction, department of Eindhoven University of Technology. https://research.tue.nl/en/studentTheses/the-effects-of-lighting-characteristics-on-atmosphere-perception
- Veitch, Jennifer. 2001. Psychological Processes influencing Light quality. *Journal of The Illuminating Engineering Socicty* 30(1): 124-140. https://nrcpublications.canada.ca/eng/view/accepted/?id=21939a53-a847-47c2-9bf8-60fea01b1c1f

HOW TO CITE THIS ARTICLE

Baharloo, Parisa, Shervin Mirshahzadeh, and Behrooz Mansouri. 2023. Teaching Light Design in Modern Housing: Comparison between Student Groups, Designers and Professors. *Armanshahr Architecture & Urban Development Journal* 16(44): 167-182.

DOI: 10.22034/AAUD.2023.360499.2713
URL: https://www.armanshahrjournal.com/article_184461.html