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Evaluation of the Effect of Natural and Artificial Light on the Establishment of Space Perception on Students

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Abstract
As limiting physical elements, like roof, walls, floors, distinguish interior space from external environment, they constitute the geometric definition of space. However, the presence of spaces that can be detected even in the absence of partial or no physical space limiters indicates that we need more than this geometric definition. The element of light that gives space the third dimension is one of the sensory factors and it is epideictic for other features such as color and texture. Although usage of artificial lighting and daylighting is a vital element in the perception of space, it is a domain that is handled after geometric and functional organizations are designed in the architectural process. Hence, lighting design is considered as an area of expertise and given importance in the last years of architecture and interior architecture education. In fact, it is possible to integrate light into the design process from the beginning of design education like other physical elements of space.
In this study, the question of how lighting knowledge can be integrated into the architectural design process as an element of space is discussed; and effects of lighting design on the studio phase, is conveyed by overlooking the students' projects. In the first half of the course, the students were asked to experience the changes on luminance level created by natural light via changing the position, location and dimension of surface voids belong to shell of fixed volume that was given to student. The second half of the course focused on artificial lighting, and the students were asked to create an integrated lighting design for their term project in the design studio, in parallel with their concept and organizational schemata. At the end of the term, it was observed that lighting design has become a part of the whole design process from the material to the organization.
This study aims to highlight the importance of lighting design courses in undergrad curriculum and emphasize the contribution of lighting design knowledge in students' spatial perception by sharing the experimental lighting education process integrated to the design studio course in ABU, 2017-2018 spring semester.

Keywords: Lighting Design, Architecture and Interior Architecture Education.

1. Introduction

As Altan (2005) quotes from Joedicke, when there is no limiter defining space, the space is replaced with emptiness; and when the distance between restrictive elements is insensible, the space replaced with object. Hence, the lower and upper boundaries of the volumetric dimension which can be considered as space, are vacuity and object. The boundaries that isolate the spatial volume from the external environment, forms the geometry of the space. Surface features such as texture, color of physical elements of space like roof, floors, walls and fixtures elements constitute the quality of the space and they are fundamental to comprehend the space. Apart from this, it is possible for individuals to perceive the space independent from physical elements subjectively through sensory stimuli. According to the

perception capacity of the person, the image of space may differ depending on the personal experiences. The concept of space constitutes as a result of perception based on function, culture and senses. (Akten and Akoğlu, 2017). As Gezer reported in his study (Gezer, 2012), the concept of space cannot be confined to a standardized definition because of existing variables such as space-experiencing individuals and stimuli.

According to Göker (Göker and Aytıs, 2010), seeing is the primary sense in perception spaces. The organ that is first stimulated in visual perception is the eye and reaches the vision center in the brain with the reflection of light from objects and surfaces; then color, shape perception occurs with the vision event. The physical boundaries of the space become perceived by light. The person sees and perceives the boundaries, location, surface characteristics and meaning of their environment by light. The physical presence of the space is constant. However, the daylight which gained through with the openings in the building shell may vary throughout the day. Different effects can be obtained by changing the intensity and direction of light within the space. According to this, the perception of space varies by time and scale, the type of light, and its movement in the space (Yılmaz et. al., 2005).

People spend their time in a built environment where they can use for different purposes and functions in their daily lives. Their environment has many physiological and psychological effects on individuals. One of the main objectives of architecture is to create qualified places where individuals feel peaceful.

For this reason, artificial lighting and daylighting are the elements that should be included in the design process as a design element in order to leave the desired effect on the users. Lighting courses in architecture and interior design education in Turkey are given under the Physical Environment Control classes which are mainly based on the sustainability and passive systems. In this study, the positive effects of daylight and lighting courses on design studios, not only as a technical data but also as a design knowledge learned through experience, have been explained in this study.

2. The Effects of Lighting on Interior Design and Its Location in Design Education

The positive and negative effects of space on men depend on the interior comfort conditions and the quality of the space. Therefore, in architectural spaces, process of influencing each other of spatial impact together with exterior environmental conditions depending on location should be thought during design phase and internalized integrated approach. (Yüksel, 2018)

The light which effects the surface, color and texture characteristics of the building elements that constitute the quality of the space, and the grasp of the shape and physical boundaries of the space, must be in sufficient amount for the actions taken in the space. Moreover, it should provide visual comfort in the interior, which should not be insufficient to see or cause problems such as excessive light, glare and reflection that prevent seeing. Spaces should benefit from daylight depending on their location, climate and orientation of the architectural mass. However, in both cases, artificial and daylighting should not be considered separately. Lighting design, can be applied as general lighting, regional lighting, functional, decorative lighting and kinetic lighting for interiors (Dodsworth, 2015). For an accurate and effective lighting design, it is necessary to create the desired atmosphere in the spaces as well as sufficient illumination level for function.

In providing the visual comfort conditions that enhance visual perception in interior spaces, the quantity and quality of lighting, and the surface properties on which the light reflects gain importance.

In this respect, natural lighting of interior space depends on size and position of façade openings, the shape and the dimension of the room and color and texture (Kurtay 2012) of reflectance of inner surfaces.

In spite of being such a powerful design tool and important component of comfort, the place of lighting courses at undergrad curriculum is very limited in both Turkey and the world. Since it is very complex subject technically, lighting knowledge is considered as a specialty and mostly left to graduate education. Therefore, the undergrad students could not take advantage of lighting knowledge in their studio projects. However, the way to be successful in space design is to get to know human perception mechanisms and their control strategies well. As Sevinç et al (2015) who examine building physics courses in 59 interior design course catalogs in Turkey, stated that lighting design course is given as a compulsory subject in 17 departments and elective courses in 10 universities (Sevinç et. al.,2016). In another study, which examined the curriculum of 44 Interior Architecture departments, 11 of which are state universities (Saraf, 2013). Daylighting and Lighting Design courses are compulsory in only 9 universities, while 13 universities offer it as elective.

Along with the increasing energy need in the world, the subjects of sustainability and physical environment control have been included in many the undergraduate curriculums. Therefore, while artificial lighting courses are planned within the scope of building physics that aim to provide more visual comfort and energy efficiency, in natural lighting course passive heating systems with daylight saving methods are emphasized. In most of the lighting courses, curriculum is based only on artificial and natural

luminosity calculations for the minimum luminosity required according to the function of the space, although it should be considered together with the design of the space. However, as Yılmazer and Yener (2001) conveyed that it would be much more useful for students to learn lighting information as rules of thumb instead of formulas and calculations; because energy efficiency and comfort are not sufficient criteria for lighting design of a space and calculations can just provide comfort conditions, but not the spatial effect desired to be created. For this reason, the Lighting Design course mentioned within the scope of this study, is based on the practical experience and the physiological and psychological characteristics of illumination on space.

3. Investigation of Student Projects

In the 2017-2018 spring semester, Lighting Design course, which was carried out with the 2nd grade students in the Interior Architecture Department of Antalya Bilim University, was discussed in two parts; natural lighting and artificial lighting design. The aim of this course is to provide the application of lighting education through practical experience using computer simulation, and to enable the students use lighting knowledge as a design tool in order to create the desired atmosphere with the physiological and psychological effects of the space. Therefore, at the beginning of lighting design course, course outline was prepared after the decision of carrying it out accordingly with design studio courses.

In the introduction of course, the physiology of light was firstly introduced; light, object and eye components and vision were explained. The role of variables such as direction and the angle of direction, intensity of light, finishing material properties of the object on detection capacity of the eye and the perception of an object was discussed interactively with students in the form of mutual questions via examples. Additionally, color perception was taken into consideration depends on physiological characteristics of light, and using light in architecture, forms and gestalt theory was investigated over examples. As shown in Figure 1. direction of light can be changed the perception of the edges as into smooth or sharpen it has also an effect on our visual capacity to see whole or part of the form.

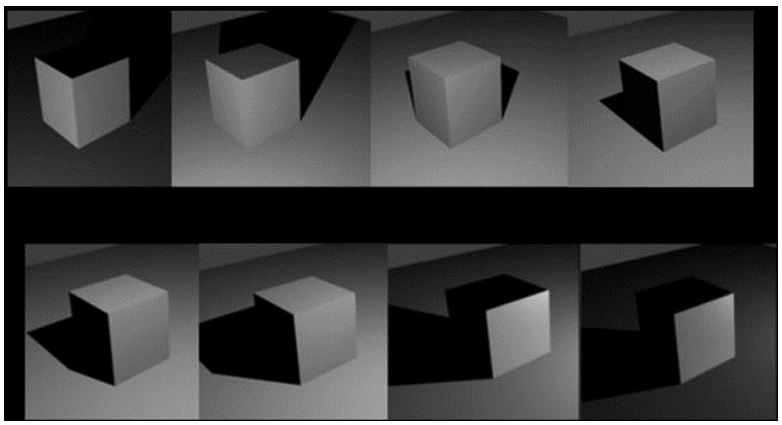

Figure 1. Example image of the effect of light on object perception from the lesson module

At the first assignments, students are asked to make a critique on what they liked or disliked in lighting design in any private or public space that chosen by themselves, by using adjectives such as dim, gloomy, dynamic, luminous, etc. Students also were expected to evaluate if lighting principles are proper or not according to function of the space.

3.1 Natural Lighting

In the second part of the course related with natural illumination, the effect of daylight in space was taught by explaining orientation of light, protection and benefiting from sun, and relation between building envelope and daylight. After explaining the principles of natural lighting and its role in architecture, students were expected to experience the effect of daylight on space, and a related assignment was prepared for it. In the assignments students were asked to model a digital space of fixed dimensions as 5x10x3 meter and experience the change in illumination level by changing the control the variables such as window size, window direction, window location on the shell and finishing materials respectively as presented in Figure 2 and Figure 3.

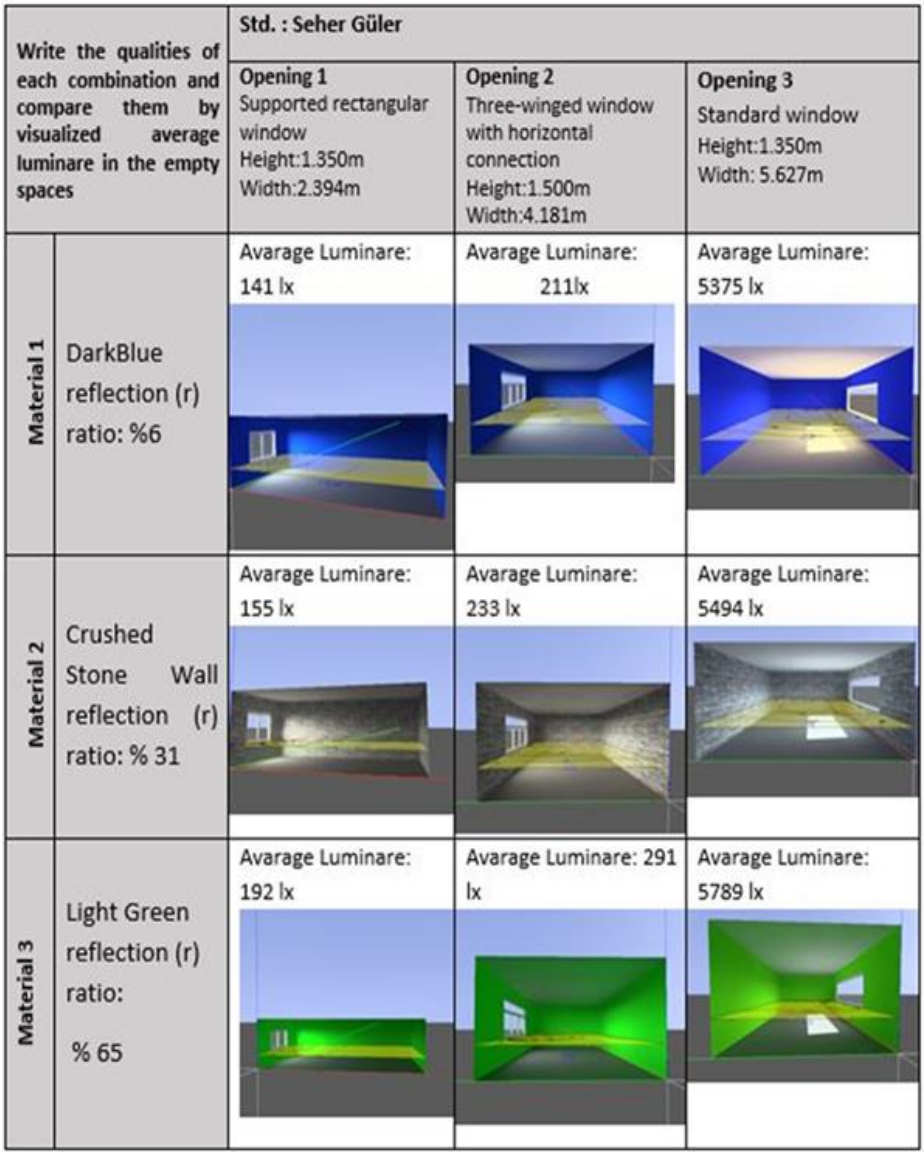

Figure 2. Example of natural lighting homework assignment

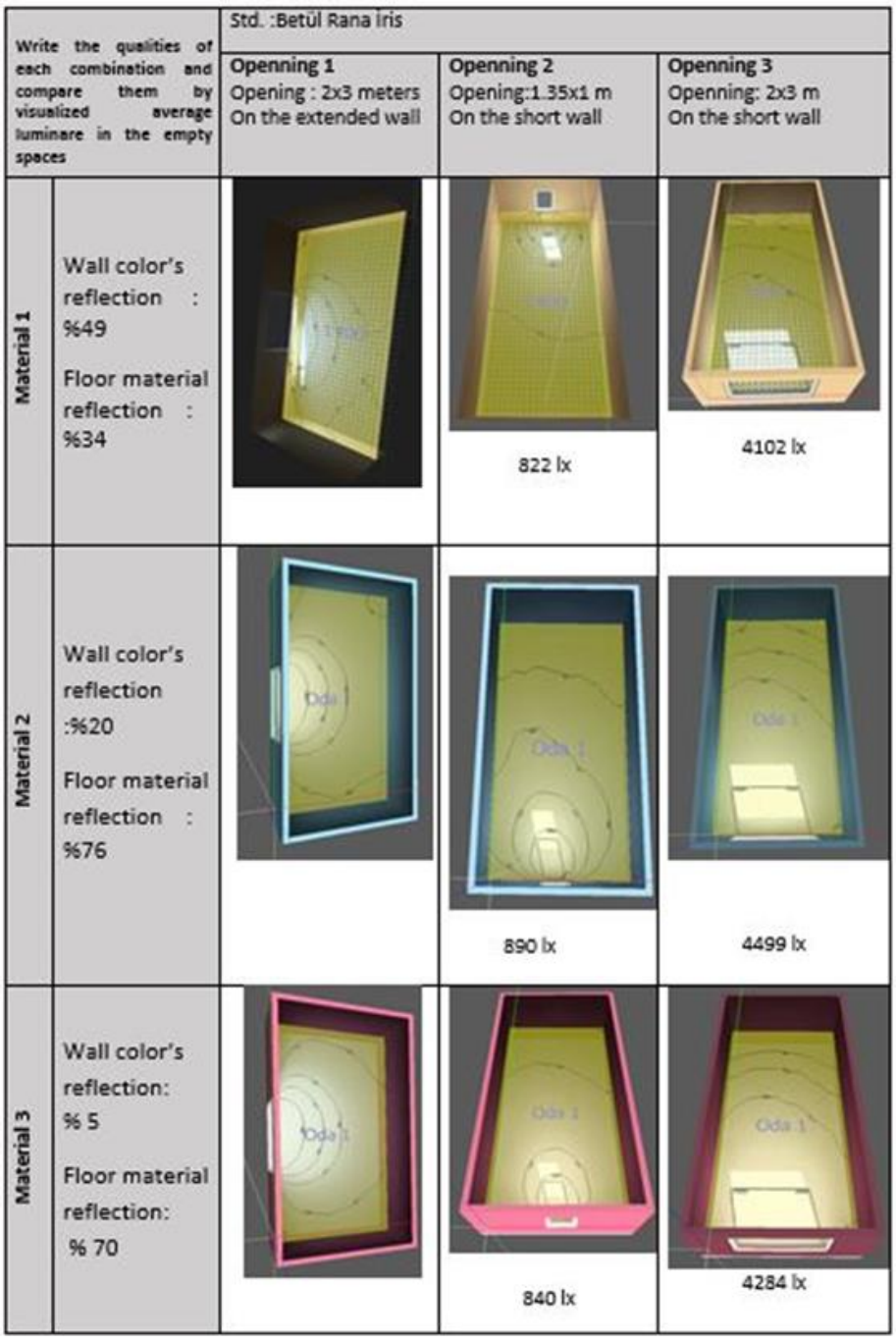

Figure 3. Example of natural lighting homework assignment

As a result of the assignment, students compared the level of luminance in the space as lux value in natural lighting that change according to location and size of openings, and surface properties like color and texture of walls and floors. It was observed that this exercise contributed to the students' knowledge about how building shell and façade design would affect the interior space through the concepts they developed in the design studio.

3.2 Artificial Lighting

In the second half of the course, it is aimed to enable the students to choose and place appropriate lighting fixtures by using a lighting software program where they can make luminance calculations. In project studio course students were expected to design a shop in which there are different kinds of subspaces like entrance, product display units, cashier desk and workshop areas. These different spaces with different

functions help students to be able to observe and try different lighting types such as accent lighting, task lighting, ambient lighting. Hence, it was decided to use studio project as case for lighting design and to carry out both lighting design ad studio courses together.

The first function in lighting design is to provide a good sight and the second function is to create an emotional environment within space by lighting (Yılmazer and Yener, 2001).. Hence, in accordance with the concepts developed in the design projects, critics were given to ensure the desired interior atmosphere and the necessary interior comfort conditions. In order to help students to experience the lighting effects in their studio projects, a software program which students can simulate their lighting design was taught to students.

The main concept and functional decisions of the students in the interior design studio were accepted within the lighting design course. In critics, the problems such as the illumination of the objects to be exhibited and the illuminated light with the elements created in the shop, window under the natural and artificial light were emphasized. Firstly, planning of lighting types and fixtures in relation with space organization and function within the space were considered as a priority. For example; the lighting design of cashier desk was considered as task lighting, and luminaire types with high luminous flux and directional ones were chosen.

In the lighting of one of the most important parts of the store the shelves where the products are exhibited, the students were asked to think about which physical qualities of the products they want to show and how they can achieve it by lighting. Then they were asked to use emphasis lighting and color of lighting for offering the products more attractive and lively, but on the other hand, avoid the negative shadows on the products. Another important part of the lighting critics was the other factors except for the lamps and luminaires that effect illumination. During the critics, mutual discussions were made on how to use lighting for enhancing the conceptual design and effect of texture, material and color preferences. Then, the luminaires that will emphasize the concept of the space and which will be used to change the physical perception positively were tried via computer simulation program. By this way, the theoretical knowledge about lighting such as diffuse, spot and integrated light, the color of the light etc. was experienced by students in digital environment and on their own designs.

As shown in the Figure 4, student designed store as a perfumery and created a special wall has niches that perfumes will displayed inside. It is intended to create colored light beams with daylight through colorful transparent parts of these niches. During the night, these niches are lighted also in different colors that are categorizing different kind of floral perfumes. Student has built the design concept on light-color relation. Additionally, lighting of sub spaces orient costumers; cashier desk has highlighted with linear downlight.

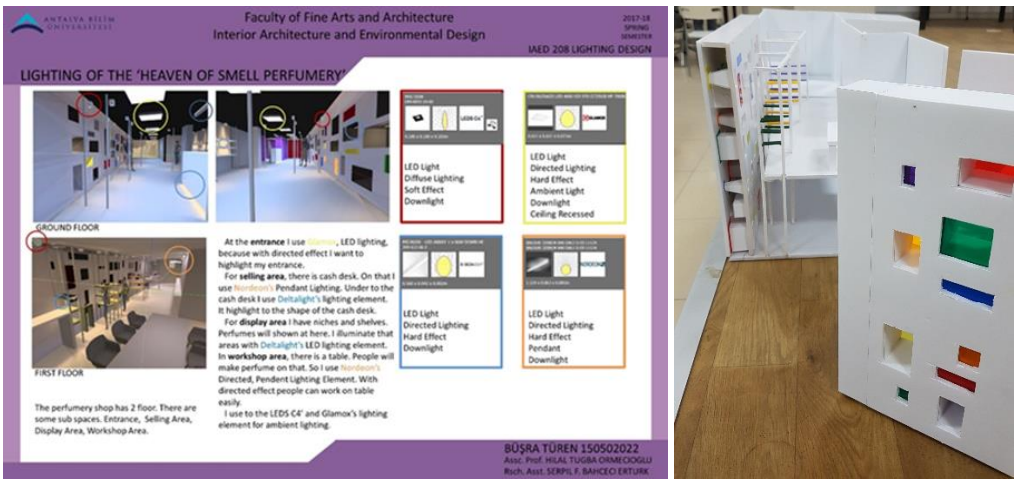

Figure 4. Student project examples and its model in studio course

Figure 5. Student project examples and its model in studio course

In the consideration of the student's project example given in the Fig. 5, student design each shelves and decide their colors according to lighting style. That product sales units are thought as closed boxes that are waiting to be opened by customers and to highlight those shelves a wall lighting is used.
Consequently, students were able to count lighting effect in their design project; and from the first jury till the end of design process they revised their project in studio accordingly, with their experience in lighting design course. The lighting design project that presented in the final jury were also found positive by the juries of the studio course. And this valuation was reflected as grade to the final evaluation of the studio course. It was emphasized that the designs would have been more elaborate and more powerful if they were envisaged by lighting from the beginning of the projects.

4. Discussion

Considering lighting education based on calculation and technical information makes it a difficult course for lower classes in interior architecture education. Nevertheless, giving lighting courses in later semesters or in master education causes a lack of information in studios. The students cannot experience this knowledge in studios when they learn designing in the early phases of their education, and they cannot develop their ability to use lighting as a design tool at the beginning of their professional life. In the design process, the mental construction of the space can only be made with known and controllable data and students cannot comprehend the lighting knowledge that they perceive it as a complex technical problem, hence, they reduce their lighting design knowledge to decorative selection of the luminaire. Therefore, the integration of lighting courses into studios in the early stages of the undergraduate education process, like other basic building courses, has the potential to have a positive impact on students' design ability. Especially in recent years, the visualization of the lighting effect by making the digital simulation of the space with software, gave the opportunity to teach the lighting course through experience. Instead of giving hardcore calculations; learning lighting design by experience after taking the theoretical information about phycology and physiology of lighting with fundamental info about seeing metabolism, lighting physics and perception, will make permanent contribution to students' designer identity.

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