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LIGHT QUALITY EVALUATION IN DRAWING WORKSHOPS THROUGH NATURAL AND ARTIFICIAL LIGHTING'S COMBINATION: CASE STUDY, BLOCK 06 WORKSHOPS AT THE UNIVERSITY OF TÉBESSA

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ABSTRACT

Daylight is a crucial element in architectural design. The evaluation of daylighting in buildings serves two main objectives. The first is to achieve visual comfort through daylighting, which is most suitable for human physiology. The second objective is to examine energy efficiency and control energy consumption. Daylighting strategies can significantly reduce energy consumption and greenhouse gas emissions by decreasing the lighting and electrical cooling needs of buildings (Jean-Louis Scartezzini, 1993). Appropriate architectural design not only provides access to inspiring visual outdoor information but also contributes significantly to sustainable development by replacing and displacing electrical energy consumption in buildings (Suzel BALEZ 2007).
Our study investigates the performance level of the combination of both natural and artificial lighting in design workshops, using both comparative and experimental approaches. The importance of the study aims at reducing energy consumption and energy costs by utilizing natural lighting when possible. Therefore, the overall objective of this research is to improve the quality of light in the indoor space by combining natural and artificial lighting to create a more uniform and balanced lighting. Additionally, this research aims to create a more pleasant indoor environment for occupants through the use of natural light, which can contribute to their well-being and health.

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1. Introduction.

Architecture and light are fields that have been interdependent throughout history. Lao-Tse stated that "architecture is not four walls and a roof; it is also, and above all, the air that remains inside, the space that these enclose." According to ONS and ENET (2012), most people in Algeria spend 50% to 70% of their time inside buildings for work and 40% to 90% for other activities. Additionally, according to APS, people in industrialized countries spend 80% to 90% of their time in indoor spaces.

Several studies have documented the importance of light on health by reducing fatigue and improving alertness. The value of the lighting environment in the workplace reflects the performance of the occupants. Users of architectural design studios need homogeneity and uniformity in the lighting environment (Wang et al., 2009). Having sufficient quality and quantity of light is an important criterion for good user performance (Balez, S. 2007). Additionally, the balance between natural and artificial lighting should enable users to perform their work comfortably and minimize errors during any activity (Ander, 2003).

The importance of light in architecture began at the dawn of time. The difference between light and night was the first way that helped humans on earth distinguish between their requirements in both situations. The workshops of architectural drawing at the University of Tebessa, the object of our study, consider the various characteristics of the luminous environment and different activities that take place. Our objective is to check the lighting of the workshops of drawing compared to recommended standards and highlight the determining criteria for a functional lighting environment of the university space.

1.1. Presentation of the case study.

Tebessa, formerly known as Theveste, is a city located in Algeria and was an important Roman city. It is situated 40 km away from the Tunisian border (Fig. 1). The Tebessa region was established as a wilaya in 1974 and covers an area of 13,878 km2 with a population of around 671,274 inhabitants as of the end of 2010, giving it an average population density of 48 inhabitants per km^2. The city's altitude varies between 800 m and 1000 m (Fig. 2).

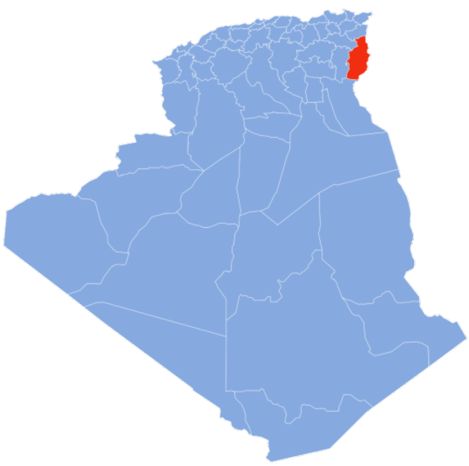

Fig. 1. Position of the Tébessa region in relation to the Algerian territory.

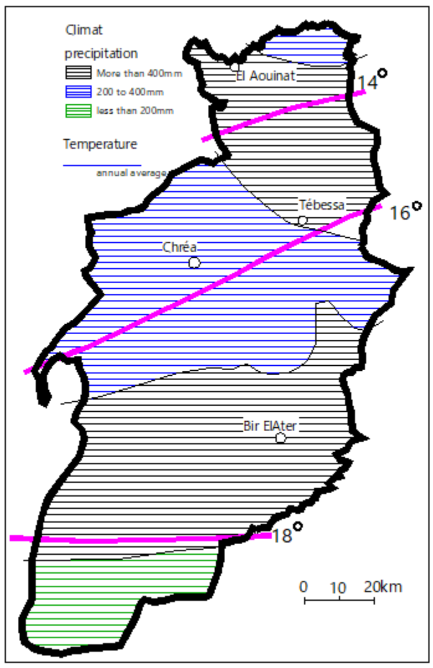

Fig. 2. The climatic framework of Tébessa.

"The map shows the administrative division of the wilaya of Tébessa. The source of the map is the P.D.A.U. wilaya of Tébessa from 2003.

Larbi Tébessa University is a multidisciplinary Algerian university that is located 9 km west of Tébessa city centre (Fig. 3). It includes six faculties, and the architecture program is housed within the faculty of science and technology."

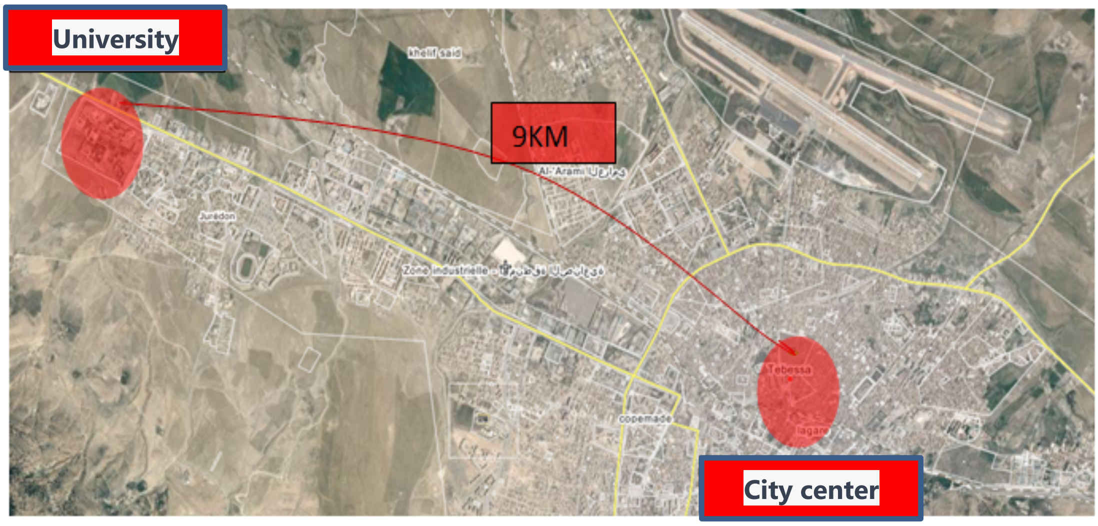

Fig. 3. Situation of the university in relation to the city centre.

1.2 Presentation of the workshop blocks.

Our research is centered on the design workshops of architecture, specifically on two continental blocks: block 06 and block H. From block 06, we selected two workshops to study that are situated on the ground floor and, therefore, receive less natural light compared to those located on the upper floors of block H. We deliberately chose two workshops with different light orientation and external shading conditions (Fig. 4.), although our study is limited to the internal lighting environment exclusively.

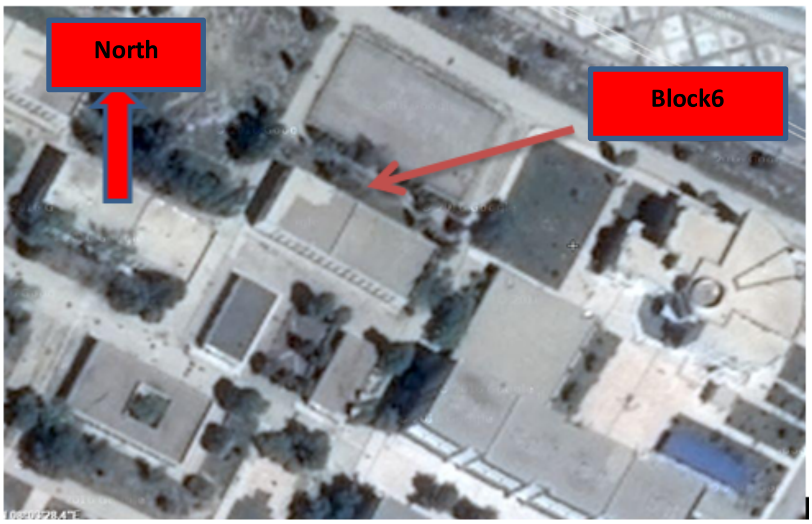

Fig. 4. Situation of block 06 at the University of Tebessa.

1.3 Criteria for the choice of workshops.

Our study focuses on two workshops from block 06, with workshop 1 being the first sample. This rectangular workshop measures 15.55 x 7.40 meters and has grey vertical interior walls. There are two windows measuring 2 x 1.5 meters each, located at a height of 1 meter on the south-west façade (Fig. 5). The windows are made of clear transparent glass, 4mm thick, and have a white frame that divides each window into 6 unequal parts.

The electric lighting system of workshop 1 consists of 18 luminaires, each containing two 1.2 meter long fluorescent tubes with a power of 36 watts.

Fig. 5. Photos that show the openings in the facade that are relevant to the study.

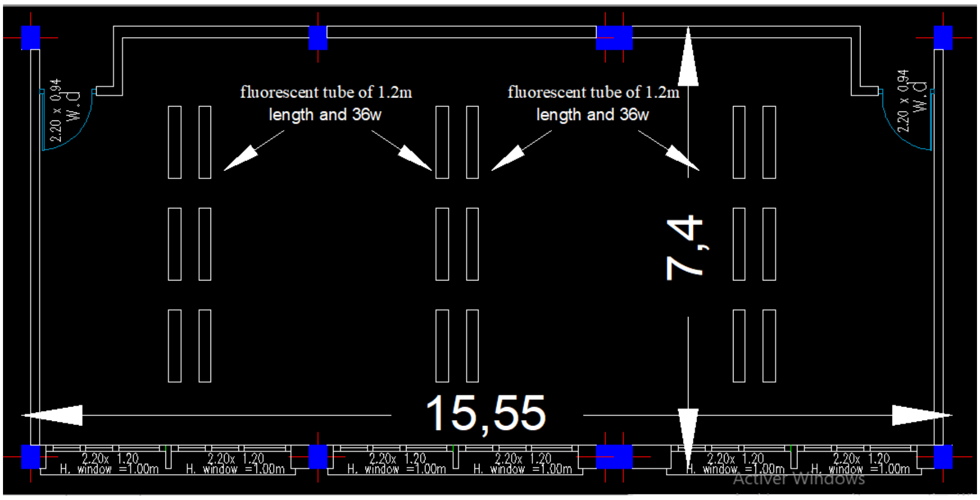

Fig. 6. The electrical lighting system in workshop 1 (made by the author).

The second sample corresponds to workshop 02, rectangular in shape (15.55X 7.40 m), its vertical interior walls are grey and include windows (2X 1.5 m) placed at a height of 1m on the north-east façade. The type of glass is clear 4 mm thick. The window is framed in white and divided into 06 unequal parts.

The electrical lighting system consists of fluorescent tubes of 1.2m length and 36 w power, 18 luminaires are placed in the workshop where each luminaire integrates two fluorescent tubes (Fig. 6).

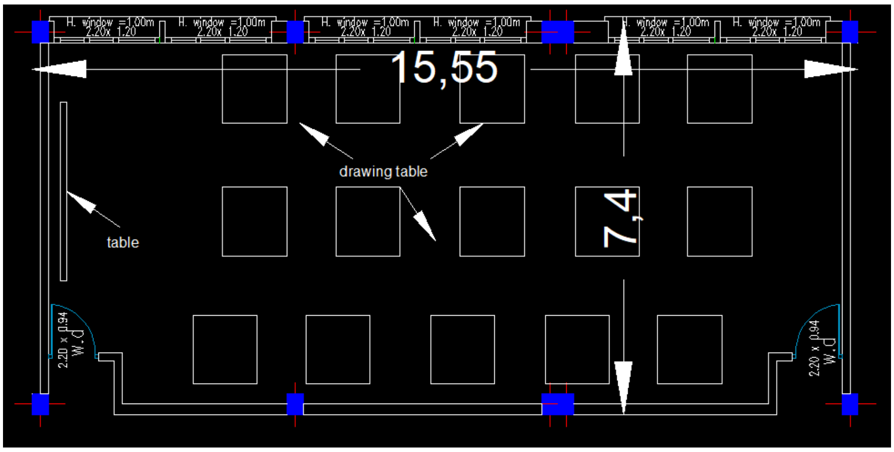

Fig. 7. Position of drawing Table in workshop plan variant 02.

1.4.1 The luminaire plane and the room index. The luminaires are located in a horizontal plane (Fig. 8), called the "luminaire plane", situated at height h above the useful plane. From this quantity it is possible to define the dimensional characteristic of the room: the index (of this room), noted here K, which is: K = a. b / h (a + b) a and b being the sides defined by the diagram.

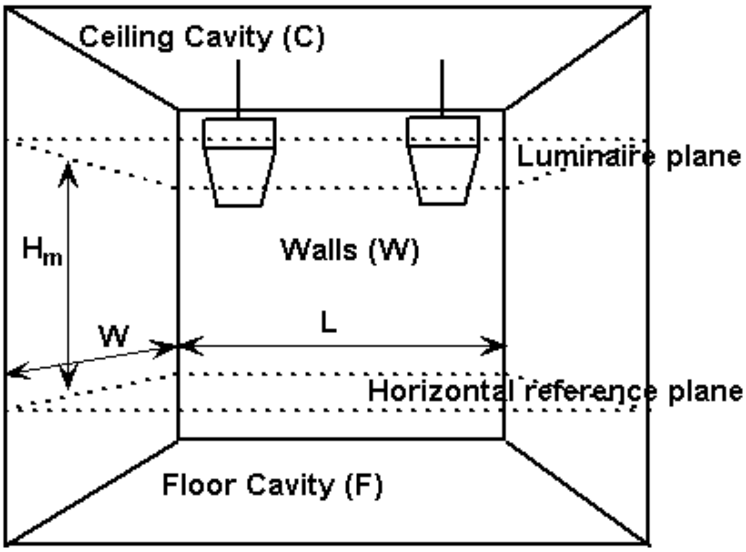

Fig. 8. Characteristics of the room: length, width, total height.

1.4.2 Reflection factors. The light emitted by the luminaire is reflected in part by the walls of the room being lit.This factor is in percentages: the reflection factors of the ceiling, walls and floor.

1.4.3 Transmittance factor. This characterises the window and depends on the quality of the glazing, e.g. single glazing (3mm): 0.9 double glazing 0.81.

1.4.4 Daylight factor. As the amount of natural light can vary significantly, a proportional relationship is introduced between the illuminance outside and that available inside the room (Fig. 9). This is called the daylight factor and is calculated as follows: DF = (Ei / Eo) x 100% where (Eint = horizontal illuminance inside the room Eext = horizontal illuminance outside in an open area) Example: Eext = 5000 lx Near a side opening, we can have a Fj of 5% => Eint = 250 lx . The daylight factor can be broken down as follows:

DF = DFD + DFRE + DFRI in %
DFD: direct component of the sky
DFRE: external reflected component
DFRI: internal reflected component

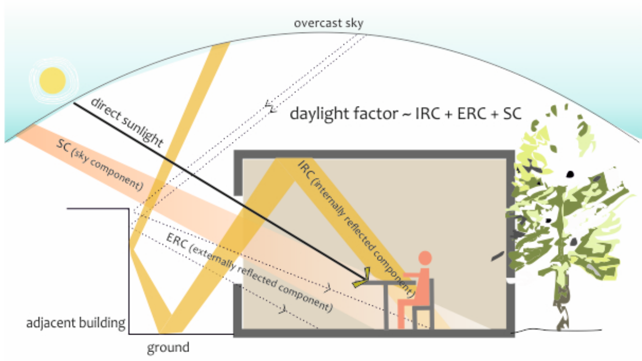

Fig. 9. Figure shows the Daylight Factor components (source: Daylighting Part 1).

2. Méthode and Matérials.

There are currently many numerical simulation tools available, the majority of which use physical calculation algorithms but with a variable level of accuracy. Among all the simulation tools available, we chose Dialux according to the following criteria:

- The Dialux software is adapted to the objective of our problem, which is the verification of the performance of the combination of natural and artificial lighting in design studios.
- The ease of use of the software compared to others and the availability of the software itself and all the data required to run the simulation with it.
- Dialux simulates both types of lighting (natural and artificial) under any type of sky. It simulates any type of simple or complex geometry.

2.1 Simulation protocol.

An ideal evaluation takes into account the variable aspect of natural light, whether over a day or over the year. However, to simulate all light possibilities over a year would be an unrealistic task. A more realistic approach is to choose a few days in the year to simulate daylighting, these days represent the extreme and average values found over a year, through a simulation of a few hours according to a typical working day for each day. This approach is recommended in some recent international lighting protocols (Atif, 1997; Velds & Christoffersen, 2000. Cited by Dubois M-C, 2001b).

The days simulated are therefore 22 December for the winter solstice, and 21 September for the autumn equinox. The sky condition will be set as overcast for winter and intermediate for autumn. The simulated hours on Dalux will be 10:00 a.m., 2:00 p.m., which correspond to a typical workday in the workshop. The windows have been closed.

The first step: from our simulation we loaded the workshop plan (dimensions x.y.z) after we created the room by (choice of window type, type of glazing, type of wall, ceiling and floor materials).we created our objects: drawing tables, tables ...the space creation is from the library of dialux the choice must be similar to our state of place.

The second step: We inserted the orientation of our space and the type of lights and their positions.

The third step: After modelling the workshops and their environment that may influence the natural and artificial lighting we launched the simulation. The results are expressed visually in 3D to appreciate the space as a whole and also in plan with explicit tables. With the result of the simulation of the state of the place of the drawing rooms we will check the combination of natural and artificial lighting of the useful planes (horizontal and vertical and the sources of light like the computer screen) with the chosen standard.

For the illumination levels of the working planes we have chosen the centre of the drawing tables and the centre of the table. The height of the horizontal working plane is 80 cm and 30 cm for the vertical. We will check the level of illumination in relation to the layout of the useful planes, i.e. the possible work surfaces in the drawing room.

3. Results and discussion of the data.
3.1 Workshop 1: South-West orientation.
* For daylighting simulation only: September 21 at 10:00 am.

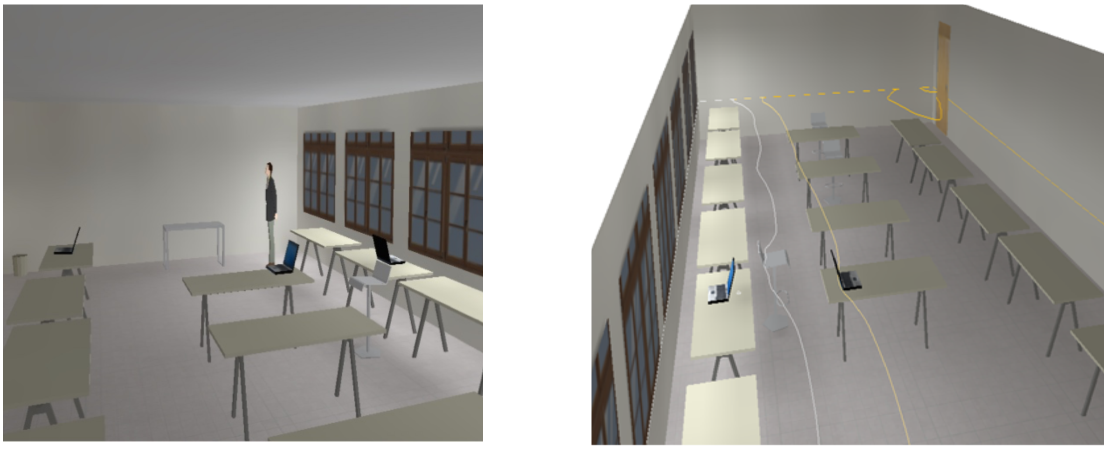

Fig. 10. Image showing Illuminance levels correspond to the useful horizontal plane 0.80 cm correspond to Workshop 1 on 21 September at 10 am.

The simulation data shows that only the tables near the window of workshop 01 receive a sufficient amount of light compared to the minimum standard of a drawing workshop which is (500 lux) and that the tables placed on the opposite wall receive a small amount of light equivalent to (100 lux) (Fig. 10). The rest of the tables receive an average amount of light compared to the standard (300 lux).

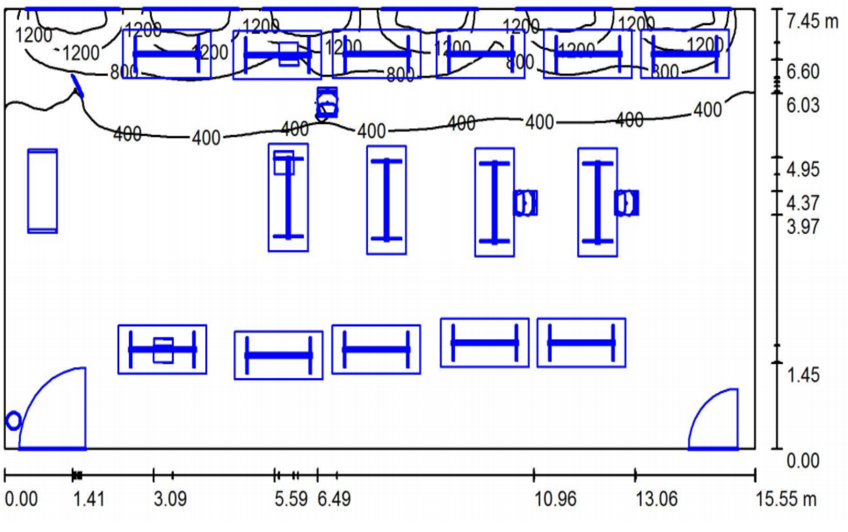

Fig. 11. Plan showing the amount of light expressed by the illuminance level.

Table. 1. Showing the illuminance result for the daylighting combination: 21 September at 10:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	362	87	1996	0.239
floor	67	232	90	775	0.385
ceiling	70	170	90	374	0.526
walls	68	180	88	609	/

The large difference in the amount of light expressed by the minimum illuminance (362 lux) and the maximum illuminance (1996 lux) causes a problem of uniformity in the workshop01 and the distribution of daylight is unbalanced as a result of the way in which the openings are distributed, their shape and size or type of glazing. It should also be noted that the size of the space has a direct influence on the uniformity of the distributed light.

For the combination of natural and artificial lighting: 21 September at 10 am.

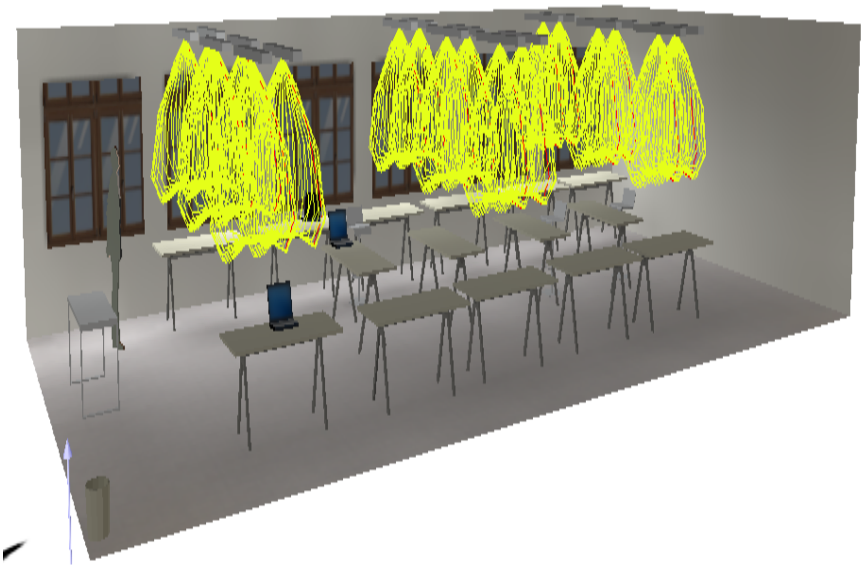

Fig. 12.The illuminance levels correspond and the luminous flux distribution to the useful horizontal plane 0.80 cm.

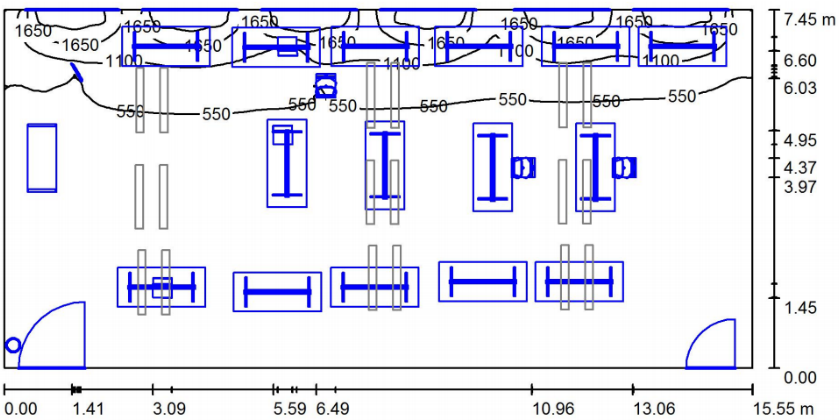

Fig. 13. Plan showing the amount of light expressed as the illuminance level.

Table. 2. showing the illuminance result for the combination of natural and artificial lighting: 21 September at 10:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	497	119	2738	0.239
floor	67	319	123	1063	0.385
ceiling	70	233	123	513	0.526
walls	68	246	121	835	/

The simulation results of the combination of natural and artificial lighting show that the average amount of light presented by the illuminance levels is almost at the standard (497 lux), at the plan level the simulation shows that the light propagation on the horizontal working plane (drawing tables) is irregular in relation to the dimensions of the space, which will cause a problem of uniformity in relation to the light distribution.

According to the results and the interpretation with the international standard, the distribution of the luminous flux does not cause any visual disturbance and the projection of the light is of rational conduct.

Table. 3. Table showing the illuminance result for the combination of daylight and artificial lighting: 21 September at 10:00.

Surface	Average illumination(lx)	Reflectance (%)	Average luminance (cd/m2)		
	Direct	indirect	total		
useful plan	251	111	362	/	/
floor	133	99	232	67	50
ceiling	0.00	170	170	70	38
Wall 1	62	97	159	68	34
Wall 2	78	115	193	68	42
Wall 3	0.00	169	169	68	37
Wall 4	82	149	231	68	50

usefulness uniformity
Emin/Eeverage: 0.239 (1:4)
Emin/Emax: 0.043(1:23)

The simulation result shown in the table above shows a large difference between the direct (251) and indirect (111) illuminance at the working plane, which will create problems of glare and eye strain. Indirect lighting and the resultant reflection at different walls and planes. This great difference in indirect (reflected) lighting is caused by the uniform colour of the different walls, which is repelled by the recommendations for gradient colours and games between pale and bright colours, where each wall must have a different colour.

For the daylighting only simulation: 21 September at 2 pm.

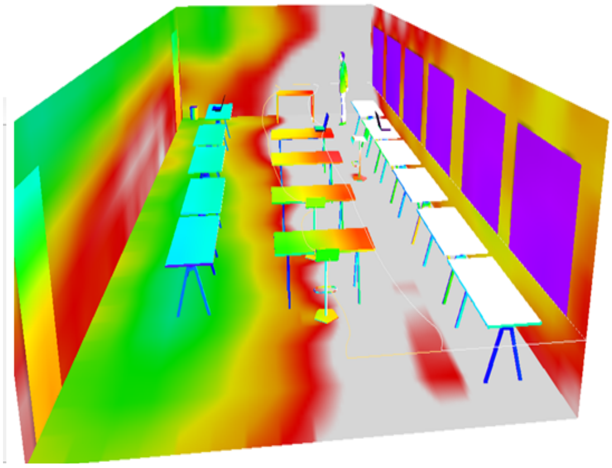

Fig. 14. Simulation with Dialux for Workshop 1 daylighting only: 21 September at 2 pm.

This simulation shows that workshop 01 is divided into two different parts, the light intensity in these two parts is not homogeneous, from the window wall to the half of the second row the light intensity is 80cd/m². The amount of light is sufficient in the half of the workshop, the other part, the light intensity is equal to 40cd/m² thus an insufficient amount of light. These data are translated by the result of the distribution of openings in relation to the dimensions of the space. The presence of natural light alone in the drawing room is insufficient to achieve the required task standard.

For the simulation of natural and artificial lighting: 21 September at 2 pm.

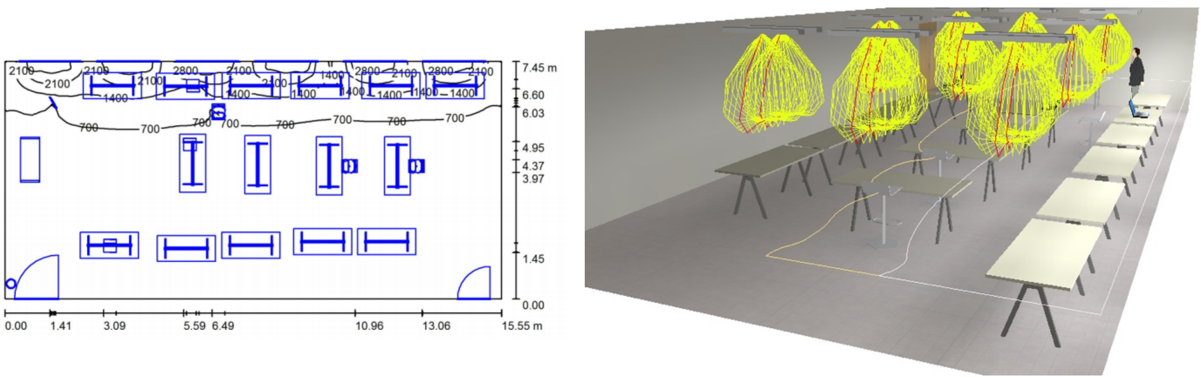

Fig. 15. Simulation with Dialux of the illuminance and luminous flux of natural and artificial lighting: 21 September at 2 pm for workshop 1.

Table. 4. Showing the illuminance result for the combination of natural and artificial lighting: 21 September at 2 pm.

Surface	Average illumination(lx)			Reflectance (%)	Average luminance (cd/m2)
	Direct	Indirect	total		
useful plan	730	190	619	/	/
floor	228	170	397	67	85
ceiling	0.00	291	291	70	65
Wall 1	106	165	271	68	59
Wall 2	134	197	331	68	72
Wall 3	0.00	289	289	68	63
Wall 4	140	255	396	68	86

The comparison between the results of daylighting simulation alone, and the results of the combination of daylighting and artificial lighting, leads us to understand the performance of both on the one hand and to make a general statement about the distribution of light and its relation to the shape of the space on the other.

For daylighting simulation only: 22 December at 10:00.

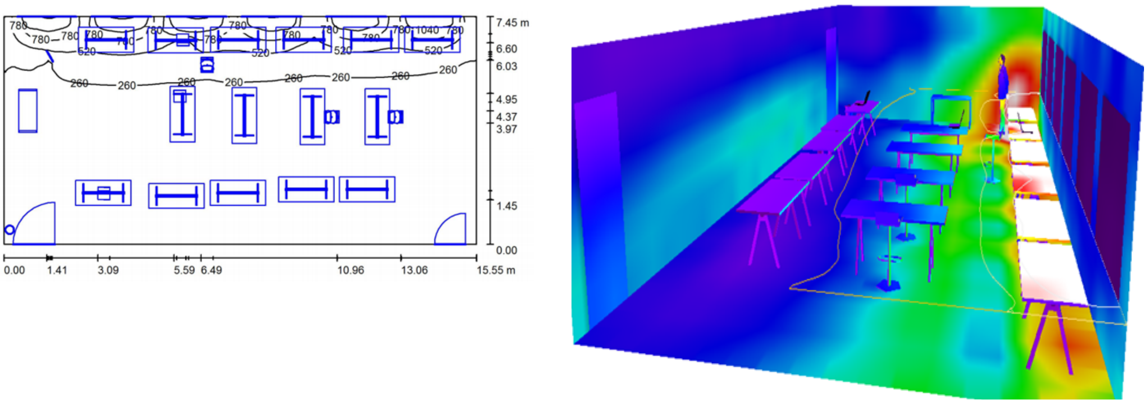

Fig. 16. Simulation with Dialux for daylight-only workshops 1: 22 December at 10 a.m.

Table. 5. Showing the illuminance result for daylighting: 22 December at 10:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	246	59	1357	0.239
floor	67	158	61	527	0.385
ceiling	70	116	61	254	0.526
walls	68	122	60	414	/

For the combination of natural and artificial lighting: 22 December at 10 a.m.

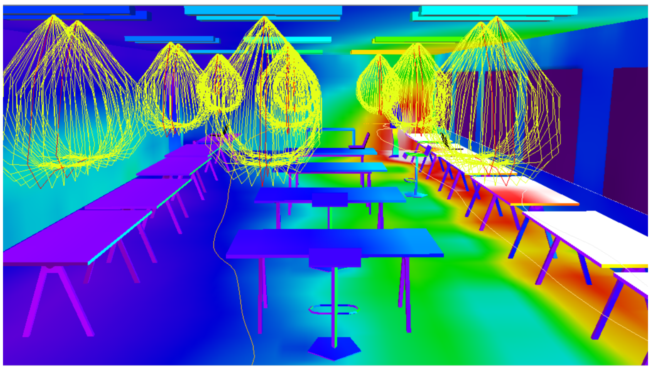

Fig. 17. Simulation avec Dialux de l'éclairement et du flux lumineux d'un éclairage naturel et artificiel:
22 décembre à 10h pour l'atelier 1.

Table. 6. Table showing the illuminance result for the combination of daylight and artificial light: 22 December at 10:00.

Surface	Average illumination (lx)			Reflectance (%)	Average luminance (cd/m2)
	Direct	Indirect	Total		
useful plan	170	75	245	/	/
floor	90	67	158	67	34
ceiling	0.00	115	115	70	26
Wall 1	42	66	108	68	23
Wall 2	53	78	131	68	28
Wall 3	0.00	115	115	68	25
Wall 4	56	101	157	68	34

For daylighting simulation only: 22 December at 2 pm.

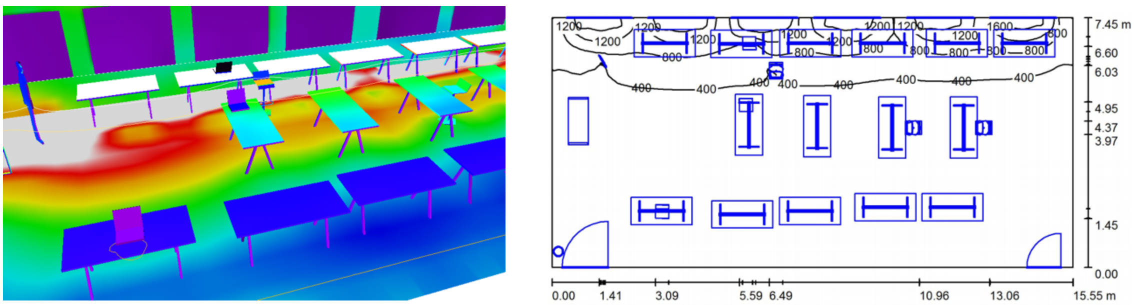

Fig. 18. Daylighting simulation with Dialux: 22 December at 2pm for workshop 1.

Table. 7. Table showing the result of daylighting: 22 December at 2 pm.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	357	85	1968	0.239
floor	67	229	88	764	0.385
ceiling	70	168	88	369	0.526
walls	68	177	87	600	/

For the combination of natural and artificial lighting: 22 December at 2pm.

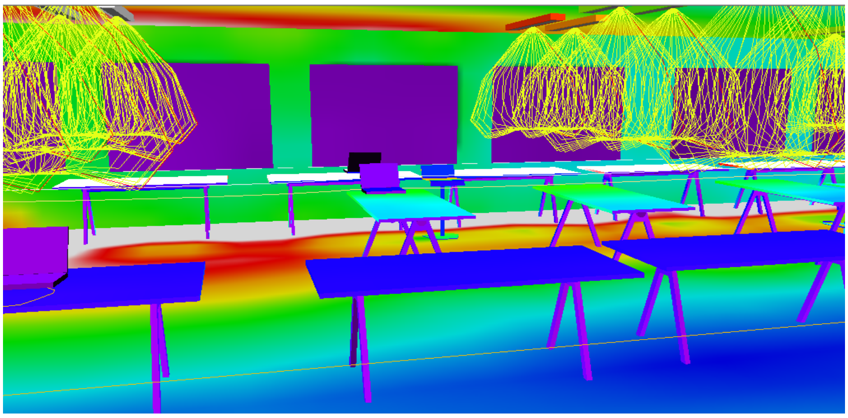

Fig. 20. Simulation with Dialux of natural and artificial lighting: 22 December at 2pm for workshop 1.

Table. 8. Table showing the illuminance result for the combination of daylight and artificial lighting: 22 December at 2 pm.

Surface	Average illumination(lx)			Reflectance (%)	Average luminance (cd/m2)
	Direct	Indirect	Total		
Useful plan	248	109	357	/	/
Floor	131	98	229	67	49
Ceiling	0.00	168	168	70	37
Wall 1	61	95	157	68	34
Wall 2	77	113	191	68	41
Wall 3	0.00	167	167	68	36
Wall 4	81	147	228	68	49

On 22 December at 10 a.m. Workshop 01 has not yet received any direct daylight; however, at 2 p.m. the same workshop receives a quantity of light equal to the norm in any point of the useful plane, near the windows the average illuminance is 500 lux but opposite the windows the illuminance is demined (85 lux), so the insufficiency of daylight in winter and the dimensions of the space in workshop 01 engender a problem of uniformity of the light.

3.2 Workshop 02. North-East orientation.

For the daylighting simulation only: 21 September at 10 a.m.

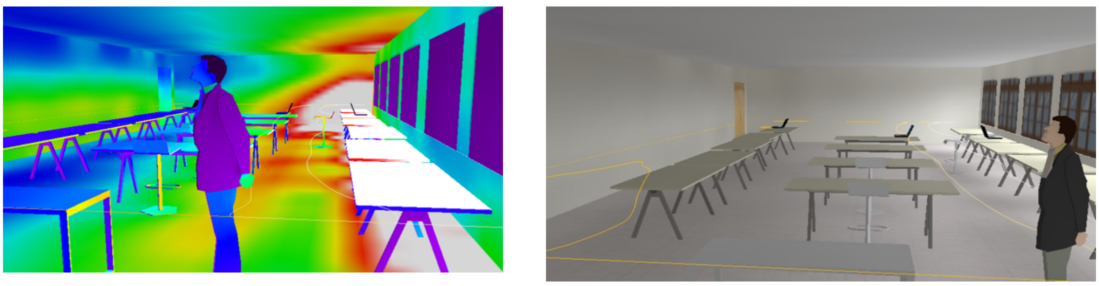

Fig. 21. Daylighting simulation with Dialux: September 21 at 10am for workshop 2.

On September 21st at 10am, the sun will be positioned in the southeast sky for a classroom that is oriented northeast. This means that natural light will primarily enter through the windows facing southeast and will be less present in the windows facing northwest.

In this case, natural light is not sufficient to provide adequate lighting, and it is important to choose artificial lighting sources that complement natural light and minimize shadows and contrasts.

For the combination of natural and artificial lighting: 21 September at 10 a.m.

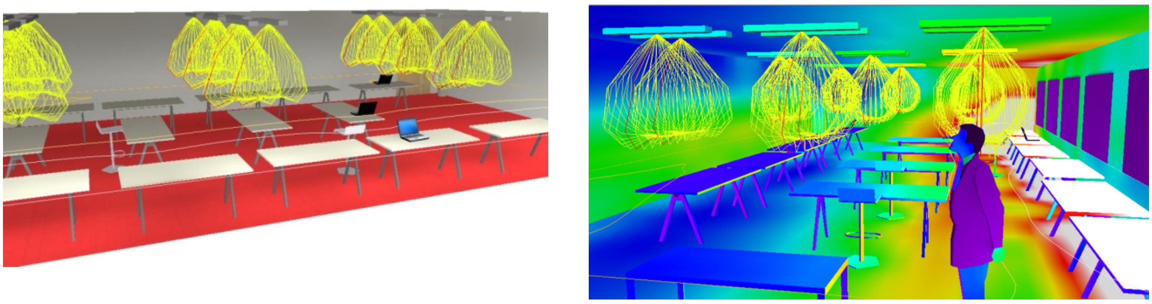

Fig. 21. Simulation with Dialux of natural and artificial lighting (illuminance level and luminous flux distribution): September 21 at 10 am for workshop 2.

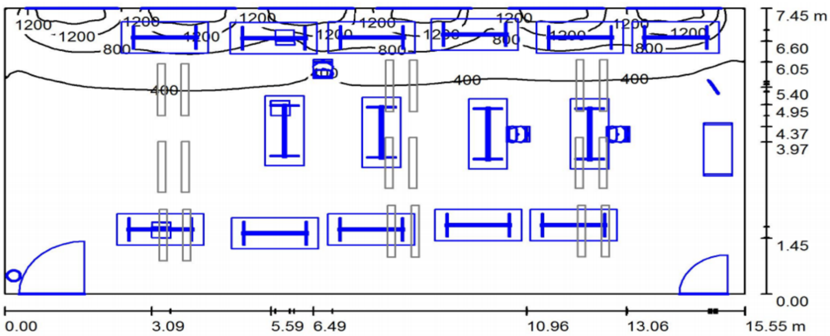

Fig. 22. Plan showing the level of illumination on the horizontal working plane in workshop 2 on 21 September at 10 a.m.

Table. 9. Table showing the illuminance result for the daylighting and artificial lighting combination: 21 September at 10:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	357	82	1971	0.231
floor	67	231	87	780	0.379
ceiling	70	159	81	363	0.507
walls	68	176	85	585	/

Natural light can be intermittent and may not always provide a sufficient amount of lighting for indoor activities. The use of artificial lighting can help compensate for this by providing a constant and adjustable source of lighting according to the needs.

For daylighting simulation only: 21 September at 2 pm.

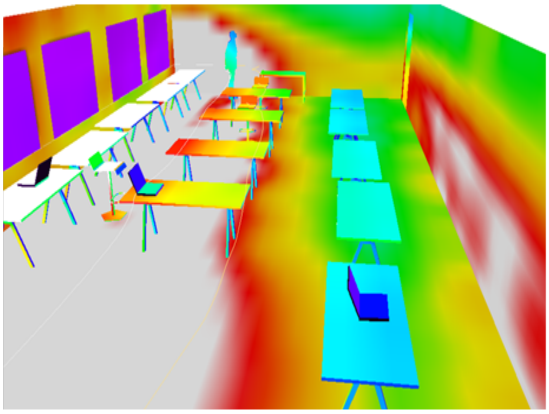

Fig. 23. Simulation with Dialux of daylighting: 21 September at 2pm for workshop 2.

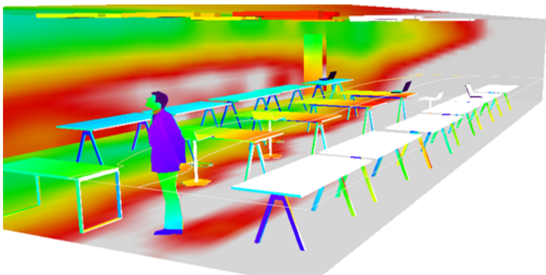

Fig. 24. Simulation with Dialux of natural and artificial lighting: 21 September at 2pm for workshop2

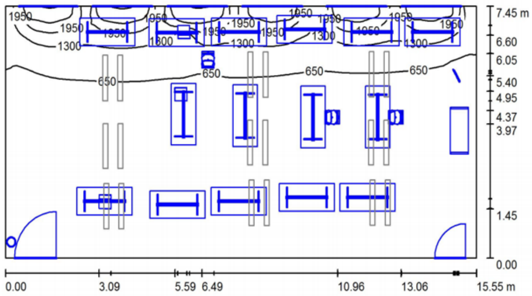

Fig. 25. Plan showing the illuminance level on the horizontal working plane in workshop 2 on 21 September at 14:00

Table. 10. Showing the illuminance result for daylighting: 21 September at 14:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	611	141	3372	0.231
floor	67	395	150	1333	0.379
ceiling	70	273	138	621	0.507
walls	68	301	145	1001	/

Table. 11. Table showing the illuminance result for the combination of daylighting and artificial lighting: 21 September at 2 pm.

Surface	Average illumination(lx)			Reflectance (%)	Average luminance (cd/m2)
	Direct	Indirect	Total		
1	2	3	4	5	6
useful plan	432	179	611	/	/
floor	230	165	395	67	84
ceiling	0.00	273	273	70	61

Table. 11. Continuation.

1	2	3	4	5	6
Wall 1	106	165	272	68	59
Wall 2	127	176	303	68	66
Wall 3	0.00	283	283	68	61
Wall 4	149	249	398	68	56

For the daylighting simulation: 22 December at 10:00.

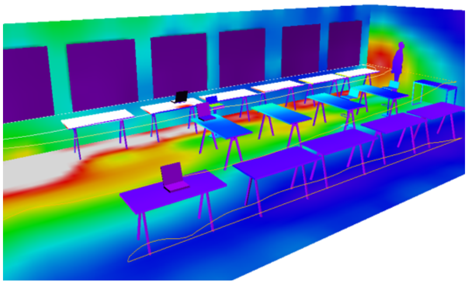

Fig. 25. Simulation with Dialux of natural lighting (illuminance level): 22 December at 10 am for workshop 2.

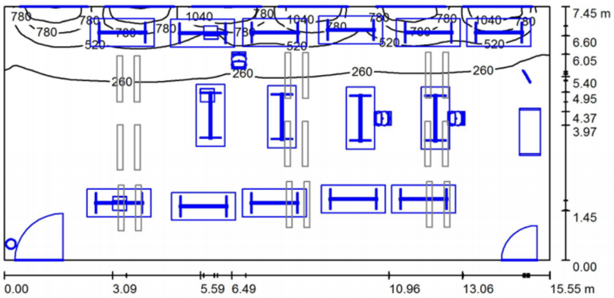

Fig. 26. Plan showing the level of illumination on the horizontal working plane in workshop 2 on 22 December at 10 a.m.

Table. 12. Table showing the illuminance result for daylighting: 22 December at 10:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	242	56	1336	0.231
floor	67	156	59	528	0.379
ceiling	70	108	55	246	0.507
walls	68	119	57	397	/

For the simulation of the combination of natural and artificial lighting: 22 December at 10:00.

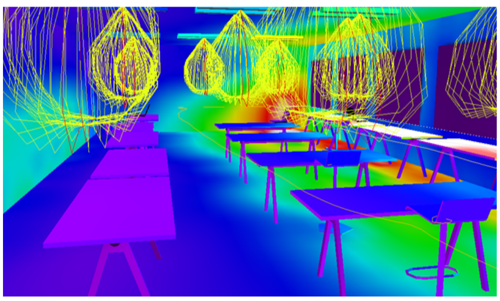

Fig. 28. Simulation with Dialux of natural lighting (illuminance level and luminous flux distribution): 22 December at 10 am for workshop 2.

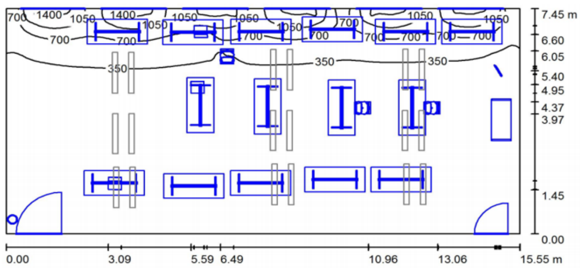

Fig. 29. Level of illumination on the horizontal working plane workshop 2 on 22 December at 10:00.

Table. 12. Table showing the illuminance result for the combination of daylight and artificial light: 22 December at 10:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	286	66	1579	0.231
floor	67	185	70	624	0.379
ceiling	70	128	65	291	0.507
walls	68	141	68	469	/

For daylighting simulation only: 22 December at 2 pm.

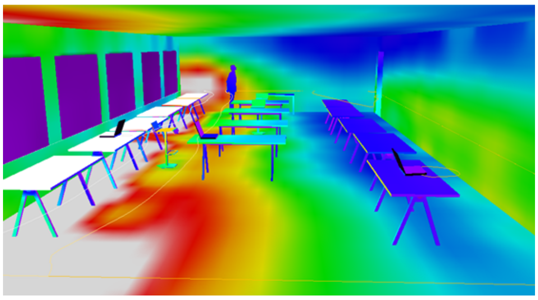

Fig. 30. Simulation with Dialux of natural lighting (illuminance level): 22 December at 2 pm for workshop 2.

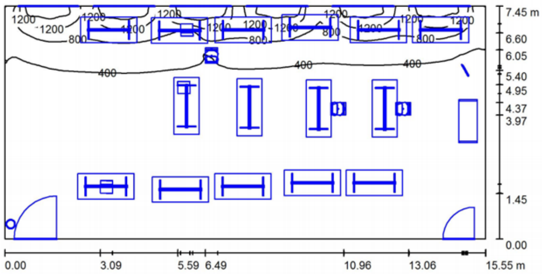

Fig. 31. Plan showing the level of illumination on the horizontal working plane workshop 2 on 22 December at 14.00.

Table. 13. Table showing the illuminance result for daylighting: 22 December at 2 pm.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	356	82	1968	0.231
floor	67	230	87	778	0.379
ceiling	70	159	81	363	0.507
walls	68	176	84	584	/

For the simulation of natural and artificial lighting: 22 December at 2 pm.

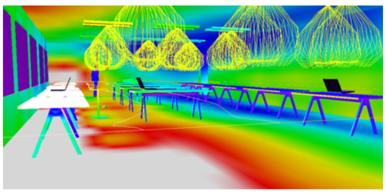

Fig. 32. Simulation with Dialux of natural and artificial lighting (illuminance level): 22 December at 2 pm for workshop 2.

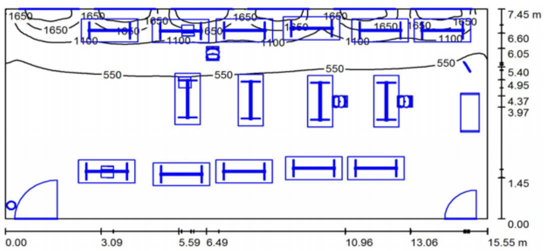

Fig. 33. Plan showing the illuminance level on the useful horizontal plane for workshop 2 on 22 December at 14:00.

Table. 14. showing the illuminance result for the combination of daylight and artificial light: 22 December at 14:00.

Surface	P(%)	E *everage* (lx)	Emin (lx)	Emax (lx)	Emin /Eeverage
useful plan	/	560	156	2752	0.279
floor	67	524	209	1207	0.398
ceiling	70	319	163	584	0.511
walls	68	345	178	869	/

Table. 15. Table showing the illuminance result for the combination of daylight and artificial lighting: 22 December at 14:00.

Surface	Average illumination(lx)			Reflectance (%)	average luminance (cd/m2)
	Direct	Indirect	Total		
useful plan	252	105	356	/	/
floor	134	96	230	67	49
ceiling	0.00	159	159	70	35
Wall 1	62	96	159	68	34
Wall 2	74	103	177	68	38
Wall 3	0.00	165	165	68	36
Wall 4	87	146	233	68	50

Discussions.

Dialux simulations were conducted to check whether the levels and ratios of luminance were being met on the various supports, such as the blackboard and computer screen. In workshop 01, the reflections on the blackboard were found to be the primary source of glare for the students, causing discomfort which could potentially create problems during activities. In workshop 02, the luminance of the blackboard did not reach the recommended standard in most of the simulations carried out.

Computer screens located near the window and in the middle of the workshop were found to have a strong glare, caused by the strong penetration of light through the windows (1-3-5). Additionally, the screens opposite the window wall were too dark (6-5) according to the recommendations, which is explained in relation to the morphology and shape of the space.

As a result of the simulations, it was noted that there is insufficient daylighting alone in both workshops. However, the simulation of the combination of natural and artificial lighting showed that this combination provides the recommended standard in the drawing workshops. The presence of daylight is essential, but solutions must be found to avoid glare and visual disturbance for rangers near windows. The presence of artificial lighting in workshop 02 facing north-east is mandatory to reach the recommended standard, especially in winter. Additionally, it is necessary for workshop 01 to reach the standard during the first hours of the day.

Glare was found to affect all students in different positions in both workshops, making it the major visual disturbance. The work supports causing the most glare were, in order, the blackboard, computer screen, and tables near the windows. However, the degree of visual discomfort caused varied from workshop to workshop depending on the orientation of the windows.

Visual fatigue affected students in workshop 01 facing south-west due to the increased sunlight (depending on light intensity and temperature), but a deferential finding was noted for workshop 02 facing north-east. The tables near the windows received a hyper amount of light, while the tables opposite the windows acquired a low amount of light, which was below the norm. The tables placed in the middle of the workshop were divided into two categories, the first one being bright and the second one dark, creating a problem of uniformity in both workshops.

The morphology of the spaces and its dimensions influence the extent of visual disturbance, as does the size and orientation of openings. The glare on the board showed that the luminaires were poorly distributed, and the tint of the walls needed to be changed to play on the influence of the reflection. The study of the angle incident on the board is also important concerning artificial lighting. Reflections on the screen, whether caused by daylight or lamps, were mainly the result of not respecting the recommended norms and the distribution of openings in relation to the morphology of the space.

4. Conclusion.

In a teaching space, interior lighting plays a crucial role in facilitating communication between teachers, students, and their peers (Joanne Emer, 2011). However, the majority of teaching spaces tend to focus solely on the level of illumination on the work surface, neglecting the importance of lighting ambience and the varying illuminance levels required for different educational categories due to differences in visual performance (Narboni, 2006; Joanne Emer, 2011).

To address issues related to lighting environment, such as glare, reflection, hyper illumination, and under illumination resulting in non-uniformity, design studios must be considered at the design stage (Narboni, 2006). Regardless of the type of architectural project, artificial lighting must adhere to the same visual requirements as natural lighting to achieve the recommended light quantity standard, while also being adapted to the intended use to ensure sufficient lighting in terms of both quantity and quality (Faure, 2008). However, unlike natural lighting, artificial lighting must also aim to minimize electricity consumption from the outset. In addition to providing sufficient illumination in the absence of natural light, artificial lighting can also serve functions beyond lighting, making it a necessary and sometimes indispensable complement to natural light.

Combining natural and artificial lighting can offer many benefits for indoor spaces. The use of natural light can contribute to reducing energy consumption and electricity costs, while offering better quality of light and creating a more pleasant environment for occupants.

However, natural light can be intermittent and may not always provide a sufficient amount of lighting for indoor activities. The use of artificial lighting can help compensate for this by providing a constant and adjustable source of lighting according to the needs.

Moreover, by combining natural and artificial lighting, it is possible to minimize shadows and contrasts, which can improve visibility and visual comfort for occupants. Ultimately, the combination of natural and artificial lighting can offer an optimal lighting solution that meets the needs of occupants while reducing environmental impact and energy costs.

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