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THE STUDY OF LIGHT IN A KINDERGARTEN CLASSROOM

Abstract: *Natural light is essential in the design of a kindergarten class, but it must also be accompanied by an an artificial lighting system. Therefore using DiaLUX Evo, a kindergarten class was modeled with a specific zoning, where different types of light and building locations depending on the cardinal points were tried. Analyzing the information gathered, it was concluded that the best solution is option 3 in terms of location depending on the cardinal points and in terms of light color it was found that neutral light is optimal for a kindergarten classroom.*

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Keywords: *kindergarten, natural light, artificial light, DiaLUX Evo, children.*

1. INTRODUCTION

The studied kindergarten class has a zoning of the space and a furniture designed according to the area. The style of the class is simple with a pastel color palette to be able to adapt to any space, as well as to allow the change of the atmosphere's space through different decorations [9].

Space, material and color are dependent on light: it's intensity, it's angle of incidence, it's radius, it's refraction, it's reflection. Engineers, architects, psychologists and educators have examined over time the role that lighting has on children's behavior [1].

Children spend 5 or 8 hours a day in a kindergarten class and the environment can became a guide or an obstacle [9].

2. LIGHT

Light is a radiation or complex of electromagnetic radiations emitted by incandescent or luminescent bodies and which impresses the human eye. A child's visual sense is stimulated in the learning environment by using light, color, texture and material [6].

There are 2 types of lighting: artificial lighting and natural lighting [7].

Natural light has positive effects on the human body and through natural lighting the interior space has a permanent contact with the outside world through windows and doors. The use of natural light in larger amount is associated with a higher performance of the students, but also brings lower maintenance costs [1].

There must also be an artificial lighting system that meets the needs when natural lighting is not enough. Improper lighting can lead to headaches, eye fatigue and fatigue. The norm in Romania for classrooms lighting is 150 lux for incandescent lighting and 300 lux for fluorescent lighting.

Visual comfort in the classroom is indicated when students and teachers can continue working in the classroom without experiencing visual discomfort. Good lighting, either natural or artificial, is characterized by the quantity and quality of lighting [8].

3. FIELD OF APPLICABILITY

The research can be studied for the analysis of natural light depending on the location of the building facing north, but also the study of the most appropriate type of light color for children. The research can also be analyzed as an example for the position, size and type of windows.

4. RESEARCH STAGES

The first stage of the research was the documentation about natural and artificial light and the documentation about positioning, type and size of the windows. Using DiaLUX Evo 9, the modeling of the kindergarten followed.

By placing the classroom in different places depending on the north and trying different types of light, studies were extracted from DiaLUX Evo 9. The second stage involved analyzing the studies and drawing conclusions for the best positioning of the class and choosing the type of light.

5. METHODS USED

The methods used for research are of 2 types: theoretical documentation and practical documentation.

The study of the bibliography, of the norms in force and of the specialized documents presupposed the theoretical documentation [2], [3], [4], [5].

In the practical documentation, the DiaLUX program was used for modeling the kindergarten and its location according to the north, but also the location of different types of artificial light.

The 2 types of documentaries involved the extraction of several studies, which were analyzed to find the optimal solution in positioning the classroom and choosing the type of artificial light.

6. STUDY OF NATURAL LIGHT ACCORDING TO THE LOCATION OF THE CLASS TOWARDS THE CARDINAL POINTS

6.1 Option 1

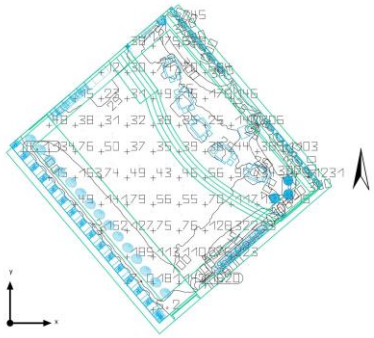

Figure 1 Option 1 – Kindergarten plan.

In option 1, the required 500 lx isn't reached, reaching an average of 174 lx. The uniformity of light is 0.012, as can be seen in Figure 1. In figures 2, 3 and 4 it can be seen that the light is distributed unevenly, but the light is maintained at all times of the day.

Figure 2 Option 1 – 8:00.

Figure 3 Option 1 – 12:00.

Figure 4 Option 1 – 16:00.

6.2 Option 2

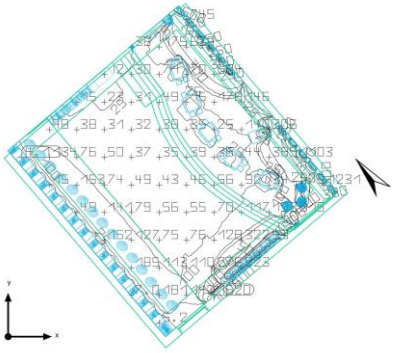

Figure 5 Option 2 – Kindergarten plan.

In option 2, the required 500 lx isn't reached, reaching an average of 174 lx. The uniformity of light is 0.012, as can be seen in Figure 5. In figures 6, 7 and 8 it can be observed that the light is dim at 8 o'clock, but in the rest of the day it is at an acceptable level.

Figure 6 Option 2 – 8:00.

Figure 7 Option 2 – 12:00.

Figure 8 Option 2 – 16:00.

6.3 Option 3

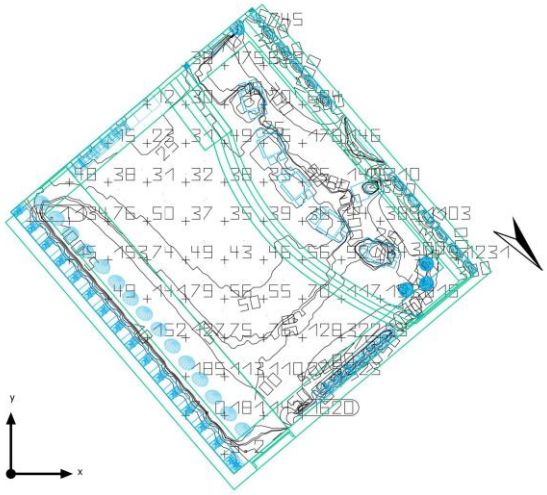

Figure 9 Option 3 – Kindergarten plan.

In option 3, the required 500 lx isn't reached, reaching an average of 174 lx. The uniformity of light is 0.012, as can be seen in Figure 9. In figures 10, 11 and 12 it can be seen that the light is at a good level only at 12:00, but in the rest of the day the lişghting is not enough.

Figure 10 Option 3 – 8:00.

Figure 11 Option 3 – 12:00.

Figure 12 Option 3 – 16:00.

6.4 Option 4

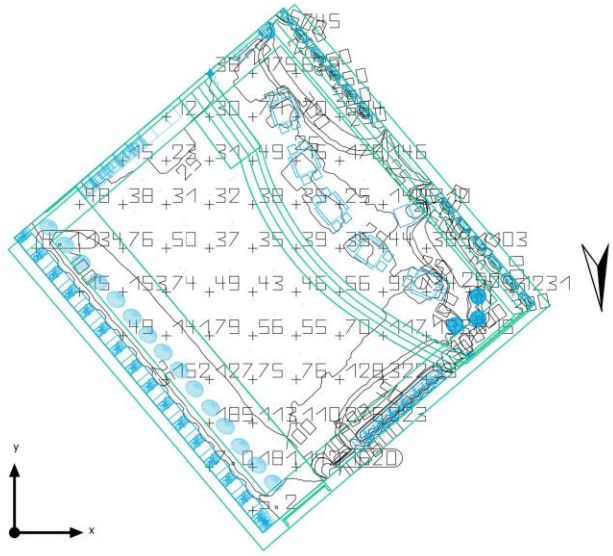

Figure 13 Option 4 – Kindergarten plan.

In option 4, the required 500 lx isn't reached, reaching an average of 174 lx. The uniformity of light is 0.012, as can be seen in Figure 13. In figures 14, 15 and 16 it can be observed that the light is at a high level and uneven at 12 o'clock. At 8 o'clock it is very weak and at 4 o'clock it is acceptable.

Figure 14 Option 4 - 8:00.

Figure 15 Option 4 – 12:00.

Figure 16 Option 4 – 16:00.

6.5 Conclusions

For all options the values are identical. All of them reach 174 lx with a uniformity of 0.012 and the following identical values:

- Ground area: 188.96 m²
- Reflection factors: Ceiling: 70.0 %, Walls: 17.9 %, Floor: 13.5 %
- Light loss factor: 0.80 (fixed)
- Clearance height: 2.276 m - 2.800 m

Analyzing the figures presented above, it can be seen that there is a clear difference, even if it does not exist in the data:

- Option 1 is the brightest, but the light is distributed unevenly, which is not indicated.
- Option 2 has low lighting and is not evenly distributed.
- Option 3 has a dim light at 8 o'clock, at 12 o'clock it has suitable light and evenly distributed and at 16 o'clock the light is not evenly distributed.
- Option 4 has low lighting and is not evenly distributed.

In conclusion, the most suitable option turns out to be option 3 due to the uniformity of the natural light. But the classroom will need improvement with an artificial lighting system for the early hours.

7. ARTIFICIAL LIGHT

7.1 Warm white

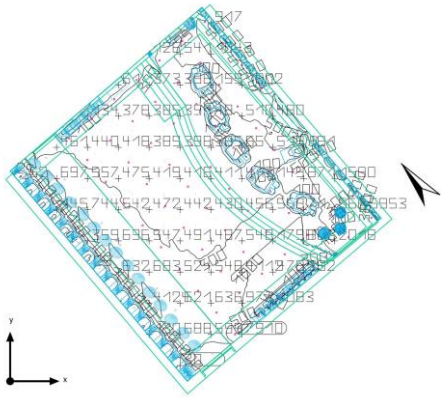

Figure 17 Warm white – General plan.

The warm white luminarie was evenly distributed throughout the class with a higher concentration on the board, as it can be seen in Figure 17. The luminaire has a

power consumption of 14.3 W and a luminous efficacy of 55.6 lm/W.

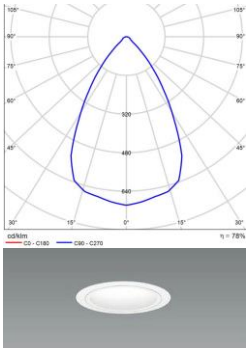

Figure 18 Warm white luminaire.

With this luminaire, the light output ratio meets a 807 lx, a uniformity of 0.017, but the glare reaches 21.6 which is not optimal. The consumption is between 1750 - 2750 kWh/a, but in the Figure 19, it can be seen the color of the light and what effect it has on the class.

Figure 19 Warm white.

7.2 Neutral white

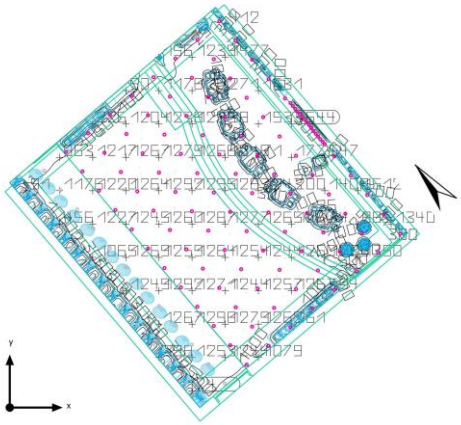

Figure 20 Neutral white – General plan.

The neutral white luminaire was evenly distributed throughout the class with a higher concentration on the board, as it can be seen in Figure 20. The luminaire has a power consumption of 24.0 W and a luminous efficacy of 102.6 lm/W.

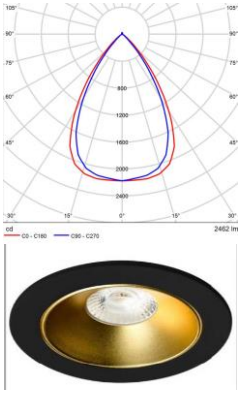

Figure 21 Neutral white luminaire.

The light output ratio meets a 1186 lx which is very bright. This luminaire has the uniformity of 0.009, which is low, but the glare reaches 20.7. The consumption is between 4550 – 7250 kwh/a. In Figure 22, it can be seen that the light is evenly distributed, being accentuated in the board area.

Figure 22 Neutral light.

7.3 Daylight white

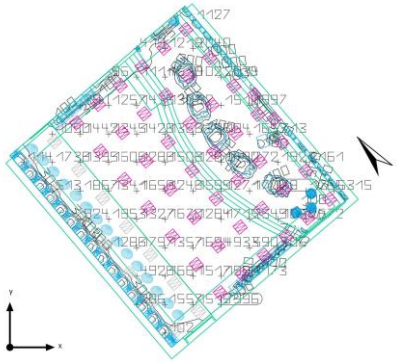

Figure 23 Daylight white – General plan.

The daylight white luminaire was evenly distributed throughout the class with a higher concentration on the board, as it can be seen in Figure 23. The luminaire has a

power consumption of 47.0 W and a luminous efficacy of 110.1 lm/W.

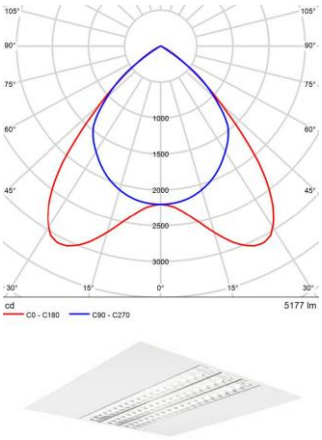

Figure 24 Daylight white luminaire.

With this luminaire, the light output ratio meets a value of 1611 lx, a uniformity of 0.011, but the glare reaches 21.1 which is not optimal. The consumption is between [3600 -5700] kWh/a, but in the Figure 19, it can be seen the color of the light and what effect it has on the class.

Figure 25 Daylight white.

7.4 Conclusions

All the types of light presented above were distributed identically in the kindergarten class obtaining different values and atmospheres.

Analyzing each type of light we can observe that:

- Warm white has a low output ratio of 807 lx, a good uniformity of 0.017 and a glare of 21.6, which is to high. In Figure 19, it can be seen that the light is not enough and the color is too warm for an active environment.
- The neutral white has a high ratio of 1186 lx, a low uniformity of 0.009 and a good glare of 20.7. In figure 22, it can be seen that the light in evenly distributed, the color is right, which produces a good working enviroment for children.
- The daylight white has an average output ratio of 1611 lx, an average uniformity of 0.011 and an average glare of 21.1. In Figure 25 it can be seen that the color is good, but the light is not strong enough to create a good working environment.

In conclusion, the most suitable artificial light turns out to be neutral white due to the uniformity and the power of light. With the neutral light, in the classroom it is created a favorable environment for learning and playing.

8. SUBSEQUENT RESEARCH

The subsequent research focuses on the study of how the light influences the colors and space of the kindergarten.

As it is well know, the light is a decisive element in how the human eye perceive colors and spaces. The light can influence the colors to be darker or more vivid and the space to be smaller or wider.

Light has a direct effect on colors and spaces, as can be seen in Figure 26. Thus, it is necessary that the light found appropriate for the classroom to be also optimal for the chosen color palette and on space.

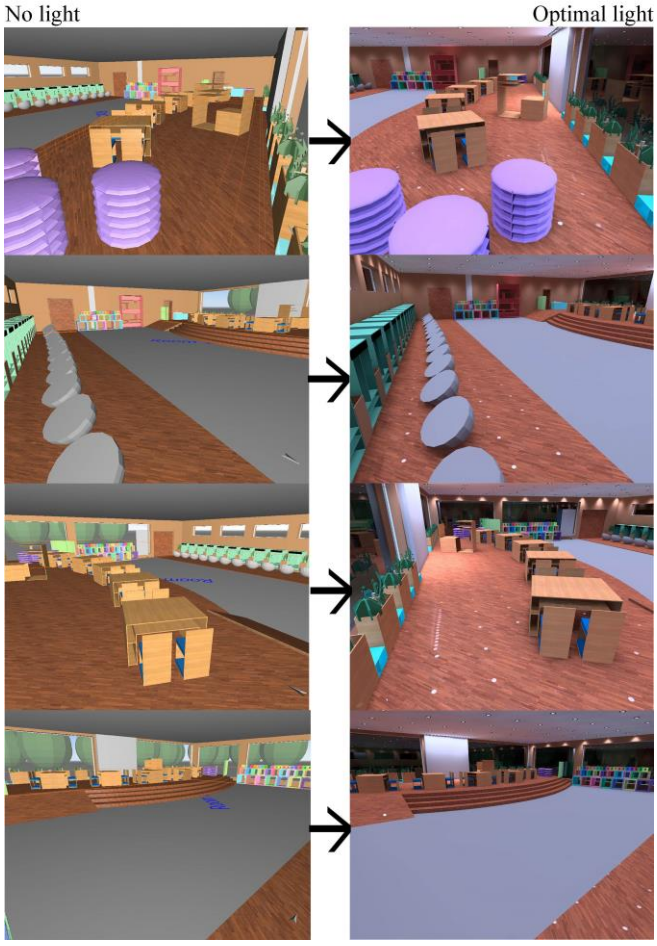

Figure 26 No light – Optimal light.

9. CONCLUSIONS

In the theoretical documentation, it was concluded that natural light has positive effects on the body and is

associated with higher performance among students, but it must be accompanied by an artificial lighting system for the days when the natural light does not cope.

Using the DiaLUX Evo program, the kindergarten classroom was modeled with large windows that keep the connection with the outside world.

The class was placed in 4 option depending on the cardinal points. Analyzing all the information extracted from DiaLUX, it was concluded that option 3, figure 5, is the optimal solution because it has a uniform distribution for most of the day.

Using option 3 as reference, in the classroom were placed 3 types of colors for the lighting system. After extracting and analyzing the data, it turns out that the most suitable light color for the classroom is neutral white. With the placement proposed in figure 20, the output ratio reaches a value of 1186 lx and it has a uniformity and a power of light that is suitable to create a good working environment for the children.

In conclusion, light is very important in any space because it directly influences colors and space, and if is not placed correctly it can cause visual discomfot and fatigue. Using option 3 and neutral light, it was created a space where children and educators can carry out with their activities with a maximum of energy due to natural light, but also a lighting system that replaces natural light when needed.

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