Budownictwo i Architektura 24(3) 2025, 15-30

DOI: 10.35784/bud-arch.6953
Received: 16.12.2024; Revised: 27.05.2025;
Accepted: 04.06.2025; Available online: 30.09.2025

Orginal Article

Natural and hybrid lighting effects on architecture students' creativity: a case study in Mostaganem

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Abstract: Lighting is a critical factor influencing creativity and productivity in educational environments, particularly for architecture students, whose work demands both technical precision and imaginative exploration. This study investigates the impact of architectural design and lighting conditions on creativity within eight drawing workshops at the Department of Architecture, Mostaganem, Algeria. The methodology combined architectural surveys to document spatial characteristics, photometric measurements to objectively assess natural and hybrid lighting quality, and the Torrance Test of Creative Thinking (TTCT) to evaluate students' creative performance. Findings revealed significant disparities in lighting conditions across the workshops, with Workshop 2 exhibiting optimal illumination and Workshop 4 demonstrating critically insufficient levels. Improved lighting conditions were shown to significantly enhance creativity in geometric tasks, particularly in fluency, flexibility, originality, and elaboration. However, for figural tasks requiring complex representational skills, lighting improvements alone had a limited effect, suggesting that higher-order creative processes depend on additional cognitive and instructional support. The study concludes that well-designed lighting is essential for fostering creativity in precision-based tasks, while more holistic approaches integrating environmental and pedagogical enhancements are necessary for advanced creative outcomes. These findings provide actionable insights for optimising educational spaces to support the cognitive and creative demands of architecture students.

Keywords: natural lighting, drawing workshop, creative thinking, architecture student

1. Introduction

Natural light plays a pivotal role in shaping the functionality and aesthetics of built environments. Achieving balanced lighting conditions – neither excessive nor insufficient – is essential for fostering visual and psychological comfort. Proper lighting enhances the perception of objects, colours, textures, and spatial forms, enabling users to interact effectively with their surroundings [1,2].

This balance requires a nuanced understanding of natural light's physical properties, such as intensity, directionality, and spectral composition, as well as strategic adjustments to ensure optimal luminance and visual comfort for the specific functions and activities of the space under consideration [3]. Additionally, artificial light has a considerable impact on the psychological well-being of occupants. A well-designed lighting system encourages relaxation, promotes alertness and focus, and reduces visual discomfort [4]. A hybrid lighting approach offers a flexible solution for maintaining consistent illumination while accommodating diverse design and climatic conditions. This method combines natural and artificial light, enhancing visual comfort and boosting cognitive performance [5].

The design of educational spaces profoundly influences students' cognitive and creative abilities, with lighting emerging as one of the most significant environmental factors [6,7], [8]. Adequate lighting supports circadian rhythms, improves concentration, reduces visual fatigue, and fosters a more engaging learning environment [8,9]. Recent research suggests adopting a transdisciplinary approach that integrates nature, positive psychology, and creative thinking to enhance students' well-being in educational environments [10].

Drawing and other creative activities demand lighting environments tailored to their unique requirements [11]. Despite the importance of art, graphic design, and architecture education, many Algerian institutions lack purpose-designed spaces, limiting students' ability to develop and express their creative potential [12]. Poorly lit classrooms, unsuitable for tasks requiring precision and prolonged focus, hinder both learning outcomes and creative development [13,14].

Furthermore, the assessment of creativity is a complex process that relies on a range of approaches and methods related to the discipline's specific requirements [15-17]. In architecture education, the evaluation involves assessing students' ability to generate innovative design ideas while addressing functional, aesthetic, and contextual constraints. It entails a balance between subjective and objective criteria, considering originality, spatial organisation, conceptual depth, and technical proficiency. Instructors must recognise the evolving nature of architectural practice, embracing diverse approaches and cultural perspectives [18,19].

Accordingly, the creative thinking approach emerges as a relevant method to evaluate and enhance students' creative abilities across various disciplines [20], including biology [21], chemistry [22], art, engineering, and architecture [23,24]. These tools enable educators and researchers to evaluate students' cognitive and emotional processes that underlie creativity, offering insights into their potential for original thought. Among the most prominent methods are Guilford's Alternative Uses Test (AUT) and the Torrance Tests of Creative Thinking (TTCT) [25-27]. A recent study related to creative thinking in the architecture design studio highlighted the usefulness of these tests, especially when combined with experimental measures and simulation software [28].

Therefore, the present research explores the intricate relationship between architecture students, their workshop environments, and the impact of natural lighting on their cognitive and creative outputs. The investigation implements a multi-phase methodological framework, integrating qualitative and quantitative approaches for data collection, analysis,

and interpretation. The framework is designed to uncover how variations in natural lighting conditions influence students' performance and perceptions. By examining representative case studies, this research highlights best practices for integrating natural light into educational spaces to foster creativity, productivity, and overall well-being.

1.1. Photometric measures overview

Photometric measures are essential tools for assessing and analysing lighting conditions within architectural spaces. These metrics help quantify the behaviour and distribution of light, whether natural or artificial, to optimise visual comfort, energy efficiency, and aesthetic outcomes in buildings [1]. Among the various photometric measures, this study focuses on three key metrics.

Firstly, the Light Transmission measure (LT) quantifies the percentage of visible light passing through a glazing unit, such as windows or glass panels. This index is crucial for evaluating how much natural light enters an indoor space. A higher LT value indicates greater transparency and an increased influx of natural light, contributing to brighter interiors. Conversely, a lower LT value signifies reduced transparency [29].

Secondly, the punctual illumination level refers to the localised light intensity measured at specific points within a space. This is assessed using a systematic grid, where the area under consideration is divided into a predefined number of equal rectangular sections. Measurements are taken at the centre of each section to ensure uniformity.

According to the NBN L 14-002 norm issued by the Belgian Bureau for Standardisation [30], the number of measurement points is determined by the index of the room K, calculated using the following formula (Eq. 1):

$$K = \frac{ab}{h\,(a+b)} \tag{1}$$

where a and b are the width and length of the structure, and h is its useful height.

Thirdly, the average illuminance level represents the mean light intensity across the entire evaluated area. It is calculated as the arithmetic mean of all measured illumination points within the grid, using the following equation (Eq. 2):

$$E_{avge} = \frac{E_1 + E_2 + \ldots + E_n}{N} \tag{2}$$

where: E_{avge} is the average lighting in the room (lux); E_1, E_2 are the punctual lighting levels at different points in the room (lux); N is the number of measurement points for the different illumination levels.

1.2. Torrance Tests of Creative Thinking

The Torrance Tests of Creative Thinking (TTCT), developed by Paul Torrance, are widely recognised for assessing creativity based on four key parameters: fluency, flexibility, originality, and elaboration [31]. The tests are divided into verbal and figural components. The verbal tasks require written responses to hypothetical scenarios, while the figural tasks involve completing geometric shapes or creating meaningful drawings. These tasks

emphasise participants' ability to generate and refine ideas, encouraging creative problem-solving and attention to detail. The TTCT has been extensively applied in educational settings to identify creative potential, design enrichment programmes, and foster cognitive development.

Although the TTCT is a robust and adaptable tool, its implementation presents several methodological and logistical challenges. A recurring concern is scoring subjectivity, especially when assessing originality and elaboration. Evaluators may interpret additional details in drawings differently, leading to variability in results. To mitigate this, standardised scoring scales offer weighted assessments that help reduce subjective biases (Tab. 1).

Table 1. Weighted scores of the Creative Thinking test. *Source:* [32]

Scores	Assessment
0, 1, and 2	Basic
3, 4, and 5	Average
More than 6	Excellent

Creative thinking is influenced by various factors, including environmental conditions, task design, and the learner's cognitive and emotional readiness. Amégan (2009) emphasised the role of systematic training and appropriate task exposure in enhancing creativity [33]. In architectural education, this calls for a multidisciplinary approach that integrates artistic, technical, and psychological perspectives to evaluate the influence of parameters such as visual comfort and lighting.

Therefore, the TTCT employs a structured methodology to measure creativity through its four parameters "FFOE" [32]:

1. Fluency: The number of ideas generated, with points assigned based on idea quantity.
2. Flexibility: The diversity of ideas, rated by the number of distinct categories addressed.
3. Originality: Assessed based on the statistical rarity of responses, with a scale distinguishing between trivial, slightly original, and fully original ideas.
4. Elaboration: Evaluated by the aesthetic quality and number of additional details enhancing the response.

Moreover, creativity in design tasks can be assessed using geometric and figural drawing tests. The Geometric Drawing Test requires students to create an architectural form by composing geometric shapes. This evaluates their ability to innovate within spatial and structural constraints while managing internal tensions and demonstrating originality in their designs. Meanwhile, the Figural Drawing Test involves transforming given lines into meaningful 2D images or façades. This test assesses students' skills in combining shapes, proportions, and details while considering the workshop's luminous atmosphere. By encouraging intuitive and creative completion of incomplete figures, it enhances students' design abilities [34].

2. Methodological approach

This study adopts a three-phase methodological approach to examine the relationship between architectural design, lighting conditions, and creative thinking within eight drawing workshops in the Department of Architecture, Mostaganem, Algeria.

The first phase focuses on spatial data collection, using an architectural survey to document the workshops' spatial and material characteristics, including layouts, dimensions, and window properties. The second phase provides an objective assessment of lighting conditions through precise measurements, evaluating parameters such as light transmission, illuminance levels, and distribution patterns to analyse the interplay between lighting and architectural features.

The final phase takes a subjective approach, using the Torrance Test of Creative Thinking (TTCT) to assess students' creativity in terms of fluency, flexibility, originality, and elaboration, offering insights into how environmental factors influence cognitive and creative processes. This integrated approach combines objective evaluations of spatial and lighting conditions with subjective analyses of creative performance (Fig. 1).

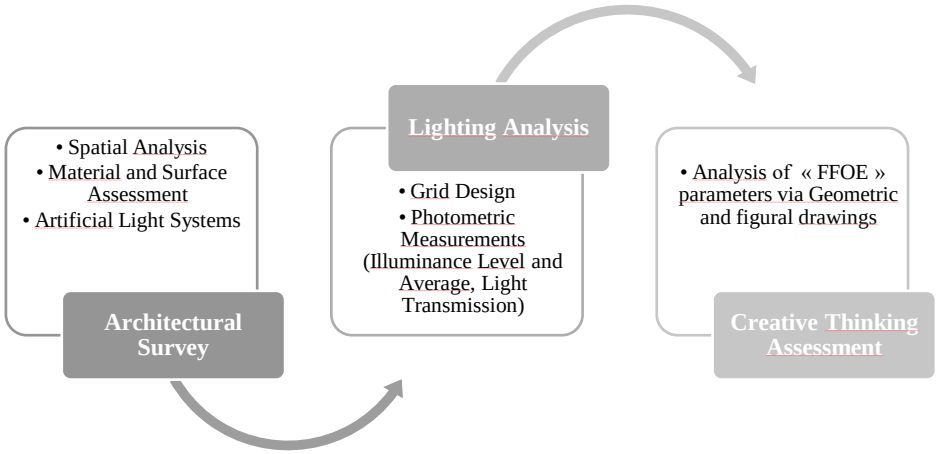

Fig. 1. The methodological approach flowchart

2.1. The architectural survey

The initial phase involves a comprehensive examination of the eight drawing workshops in the Department of Architecture in Mostaganem, Algeria. Situated in the north-western coastal region, the department offers a unique architectural and environmental context. This phase includes spatial analysis, in which the layouts, dimensions, orientation, and organisation of the workshops are documented. Materials and surfaces were assessed for their reflective and absorptive properties, with a focus on their interaction with both natural and artificial light.

Furthermore, the artificial lighting systems, including their design, placement, and functionality, were also analysed to understand their contribution to the workshops' overall lighting quality.

2.2. Lighting analysis

The second phase evaluates the lighting conditions in the same workshops, focusing on the interplay between natural and artificial lighting systems. To ensure a comprehensive assessment, two sessions of measurements were conducted: the first exclusively for natural lighting conditions and the second for hybrid lighting setups. A systematic 3×3 rectangular grid was initially considered for data collection, in line with standard practice. However, five

key measurement points were selected within the workshops – front, back, centre, left, and right – along with a sixth point placed outside to record external lighting levels (Fig. 2).

In our study, the calculated K index ranged between 1 and 1.9, which, according to EN 12464-1, typically requires nine measurement points to evaluate illuminance uniformity [35]. Nevertheless, the chosen five-point configuration was based on the functional layout of the educational space, targeting zones where students are most actively engaged in drawing tasks. Peripheral areas, such as corners, were excluded as they are not commonly used for learning activities and often lack a clear view of the board. While this approach simplifies the standard method, it remains consistent with the intent of related norms by focusing on accurate assessment of lighting in the most relevant and occupied visual zones.

Measurements were conducted under clear sky conditions and in accordance with the protocols of the luminous environment. Illuminance levels were measured at the height of the drawing tables, specifically 85 cm above the floor, to reflect the actual working plane used by students. The measured data was primarily based on variations in light transmission and instantaneous punctual illuminance levels. Therefore, the data was used to calculate average illuminance levels, providing insights into the adequacy of the lighting for educational and creative activities.

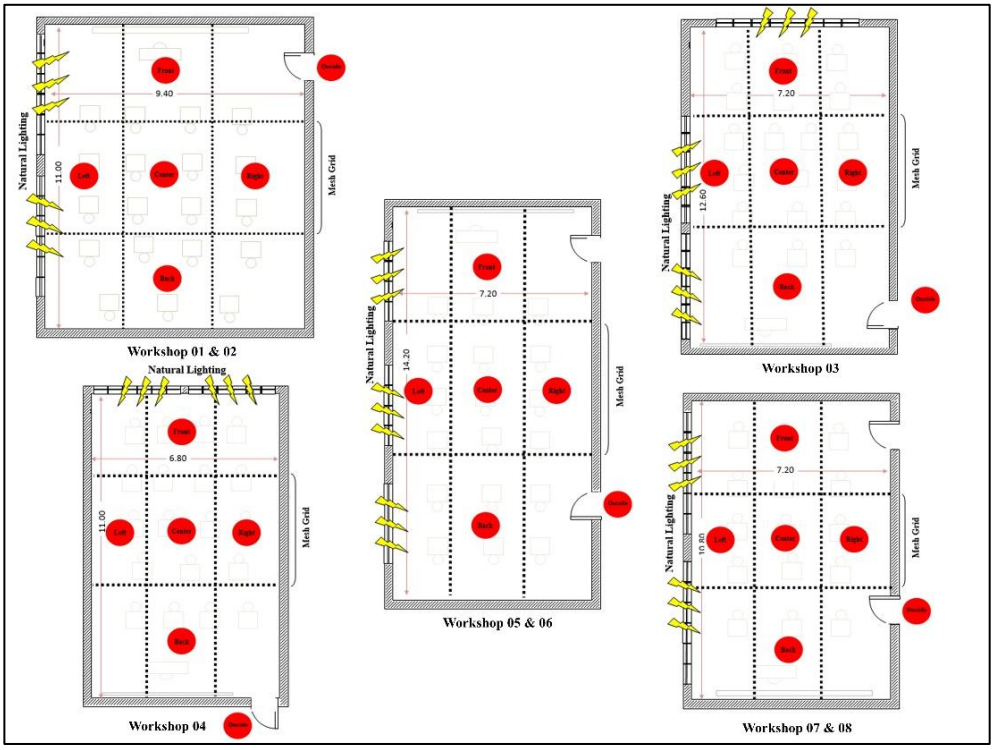

Fig. 2. Graphical representation showing the plan of the different workshops, the meshing grid, the measurement points, and the positions of the illumination levels. *Source:* own study

This analysis highlighted how the quality and distribution of light influence the usability, atmosphere, and creative potential of the workshops. This objective assessment was further conducted to selectively identify the most and least favourable drawing workshops in

terms of lighting conditions. This selective approach aimed to evaluate how these varying conditions influence students' performance in creative thinking tests.

2.3. The test of Creative Thinking

The final step examines the influence of architectural and lighting conditions on students' creativity, using the Torrance Test of Creative Thinking (TTCT) as the primary evaluation tool. The TTCT focuses on four key components: fluency (the generation of numerous ideas), flexibility (the ability to shift perspectives), originality (the creation of unique ideas), and elaboration (the depth and detail of ideas). This assessment combines cognitive and emotional processes fostered by the teacher to enhance students' learning while explicitly engaging their creative thinking.

The TTCT evaluation involves 19 students and consists of two 30-minute drawing tests designed to connect environmental factors with creative performance in architectural education. This sample size reflects the full capacity of the drawing workshop, which typically accommodates around 20 students due to spatial constraints and the use of large individual tables. Similar sample sizes are common in TTCT and divergent thinking studies, particularly in design-related fields, where in-depth analysis under controlled conditions is prioritised. Therefore, the geometric drawing test involves completing a geometric composition to develop an architectural work, promoting spatial reasoning and design synthesis. The figural drawing test challenges students to create a meaningful 2D image or façade from given lines, emphasising originality, creativity, and attention to detail. These tests provide both quantitative and qualitative data, helping to establish a link between the lighting and spatial conditions of the workshops and the creative potential of their users (Fig. 3).

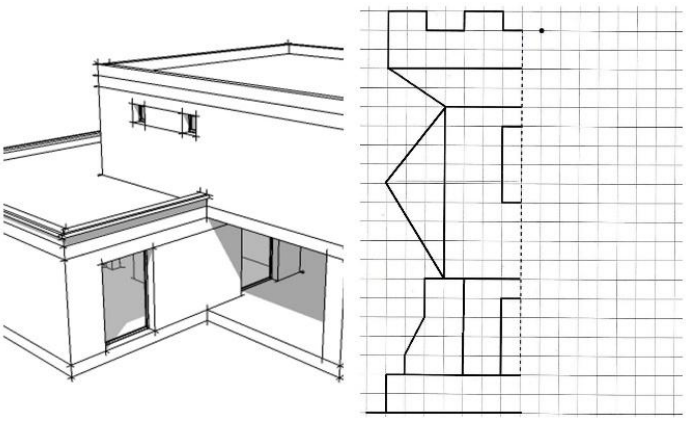

Fig. 3. The sample used for the Geometric (left) and Figural (right) drawing tests. *Source:* own study

Furthermore, these tests were conducted in two contrasting workshop environments to evaluate the impact of lighting conditions. The first scenario featured poor lighting with the lowest illuminance levels, creating an unfavourable atmosphere, while the second had adequate lighting and a more conducive environment. The objective is to compare students' performance in these two settings, highlighting the influence of lighting quality on creative outcomes.

3. Results and discussion

3.1. Architectural survey

The floors of these workshops are made of matte-finished granite, while the ceilings are coated with matte white paint. The walls are painted in light tones, ranging from pure white to off-white and pale pinkish-white hues.

The windows are all rectangular in shape and vertically oriented, with a recessed configuration and no embrasure. They feature single glazing with low-emissivity glass and are equipped with operable wooden frames. The following table outlines the key features of each drawing space, including window design parameters.

Table 2. Key characteristics of workshops and their windows. *Source:* own study

	Workshop characteristics					Windows characteristics			
ID	Dimensions (m)	Area (m^2)	Height (m)	Depth Index	Orientation	Dimensions (m)	Units	Area (m^2)	Opening Ratio (%)
01	9.40x11.00	103.40	2.43	3.86	South-West	0.70x1.33	12	11.172	11
02	9.40x11.00	103.40	2.43	3.86	South-West	0.70x1.33	12	11.172	11
03	7.20x12.60	90.72	2.9	2.4	North-West	0.60x0.70	20	8.40	10
04	6.80x11.00	74.80	2.9	3.8	North	0.60x0.70	12	5.04	7
05	7.20x14.20	102.24	2.43	2.96	North	0.70x1.33	16	14.896	14.6
06	7.20x14.20	102.24	2.43	2.96	North	0.70x1.33	16	14.896	19.8
07	7.20x10.80	77.76	2.43	2.96	North	0.70x1.33	12	11.172	14
08	7.20x10.80	77.76	2.43	2.96	North	0.70x1.33	12	11.172	14

The recommended opening ratio for such spaces is 20% [36]. However, based on data collected from the architectural survey, all the drawing workshops fall below this minimum threshold, resulting in a critical condition with highly inadequate lighting. The depth index evaluates whether the interior depth of a space is well-lit or remains dark, depending on its dimensions, design, and the general configuration of openings. In our case studies, only Workshop 03 achieves a depth index below the reference value of 2.6, which indicates proper lighting. This is due to its design, featuring openings on two lateral walls, allowing for balanced illumination on both sides and sufficient light penetration to the rear of the space. In contrast, the remaining workshops have a depth index exceeding 2.6, creating extensive shadowed areas and poor overall lighting.

Moreover, each workshop is equipped with six artificial lighting units, evenly distributed across the space to provide uniform illumination. The lighting system utilises T8 fluorescent tubes, each with a diameter of 26 mm and a standard length of 120 cm, operating at 36 watts. These tubes are fitted with G13 bases, characterised by two pins spaced 13 mm apart. They emit a neutral white light with a typical colour temperature of 4000K, suitable for work environments that require visual clarity without causing glare or discomfort. The fixtures are powered by electronic ballasts, which contribute to improved energy efficiency, reduced flicker, and more stable lighting performance.

3.2. The photometric measurements

3.2.1. Light transmission (LT)

The light transmission (LT) values for the eight workshops analysed indicate a high degree of natural light penetration, ranging from 85.07% to 93.20% (Fig. 4). These values are characteristic of clear single glazing with a thickness of 6 mm, which is known for its excellent transparency.

The variations in LT among the workshops are minimal, with Workshop 04 showing the lowest value at 85.07%. This difference is attributed to factors such as external shading, surface cleanliness, and other environmental conditions. Overall, the glazing provides adequate daylighting, essential for maintaining well-lit environments suitable for workshop activities.

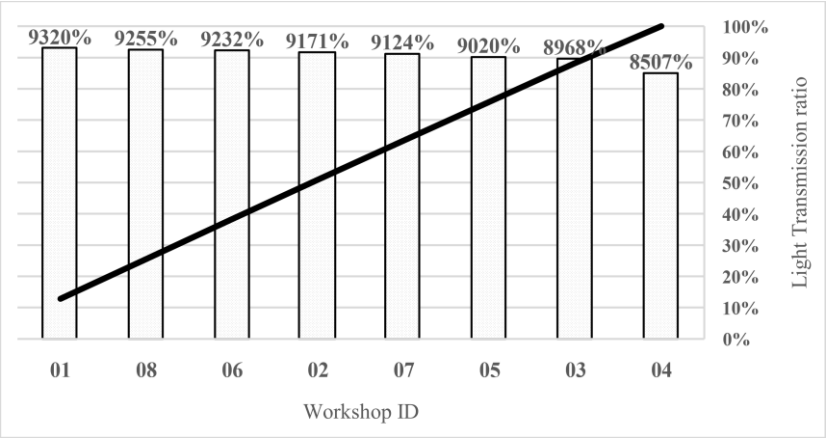

Fig. 4. Pareto histogram of the average Light Transmission ratio across the eight workshops. *Source:* own study

3.2.2. Punctual illumination level

The punctual illumination levels were measured for both natural and hybrid lighting systems to ensure consistent and reliable assessment across the analysed workshops. The data collection process, conducted in adherence to the measurement protocol outlined in the methodology section, is summarised in the following table.

Table 3. Punctual illumination values of natural and hybrid lighting. *Source:* own study

	Natural Lighting						Hybrid Lighting					
ID	Outside (lux)	Front (lux)	Centre (lux)	Back (lux)	Left (lux)	Right (lux)	Outside (lux)	Front (lux)	Centre (lux)	Back (lux)	Left (lux)	Right (lux)
01	2750	713	172	110	93	161	3750	1024	316	185	188	330
02	3300	1150	183	163	146	208	4730	1425	350	282	325	380
03	1684	232	90	85	83	122	1702	234	219	150	114	232
04	624	09	03	03	03	04	857	52	86	38	18	101
05	347	130	31	26	18	27	320	118	72	172	43	28
06	308	212	47	38	53	25	264	164	208	167	149	96
07	782	465	57	50	63	43	825	680	278	210	207	67
08	141	82	19	21	20	15	280	165	221	162	42	138

These findings underscore the inadequacy of relying solely on natural light in enclosed or deep interior spaces and demonstrate the effectiveness of hybrid lighting in creating visually comfortable and functionally efficient environments.

3.2.3. The average illuminance level

The calculated metrics of the illuminance levels highlight significant variations across the eight workshops under natural and hybrid lighting, as depicted in the comparative graph (Fig. 5). It presents two distinct scenarios:

- The most favourable case is observed in Workshop 2, where the illuminance level surpasses 500 lux. This value aligns with international standards, which recommend a minimum of 500 lux for optimal lighting conditions in drawing workshops, ensuring visual comfort and efficiency [36].
- The least favourable case occurs in Workshop 4, where the illuminance level falls below 100 lux, significantly under the recommended threshold. Such inadequate lighting fails to meet the minimum standard of 500 lux, compromising comfort and functionality in the workspace.

Additionally, most other workshops fall short of the required 500 lux under natural lighting, with hybrid lighting improving conditions but still proving insufficient in many cases.

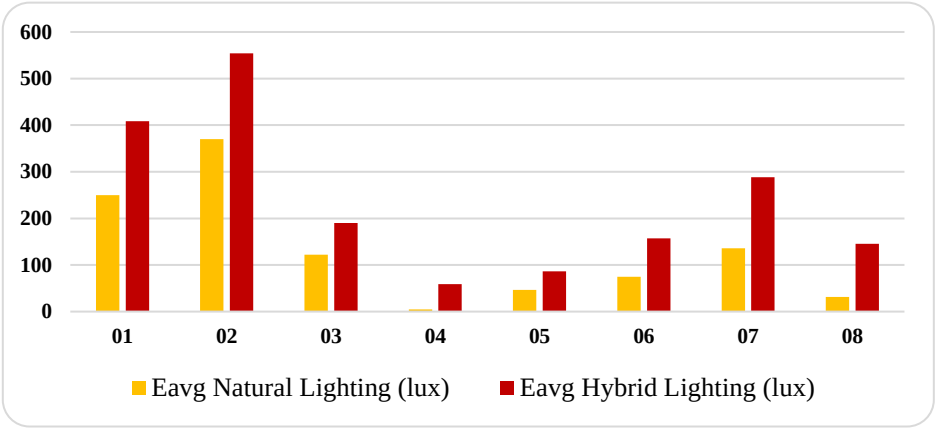

Fig. 5. Histograms of the average illuminance level of Natural and Hybrid Lighting calculated for each workshop. *Source:* own study

3.3. Torrance creative thinking

The analysis of students' drawings revealed notable differences in creative output influenced by the lighting environment. In Workshop 4 (Case 1), characterised by inadequate lighting conditions, the drawings were generally basic, composed of simple geometric forms and elementary volumetric shapes. While the compositions were coherent, they remained limited in complexity, especially considering the academic level of the architecture students.

Conversely, when the same test was conducted in Workshop 2 under improved lighting conditions (Case 2), the results showed a clear enhancement in graphic quality. The drawings demonstrated greater compositional complexity, more precise detailing, and a higher level of refinement. These observations suggest that enhanced lighting conditions can positively influence students' engagement, encouraging more thoughtful and sophisticated creative outcomes (Fig. 6).

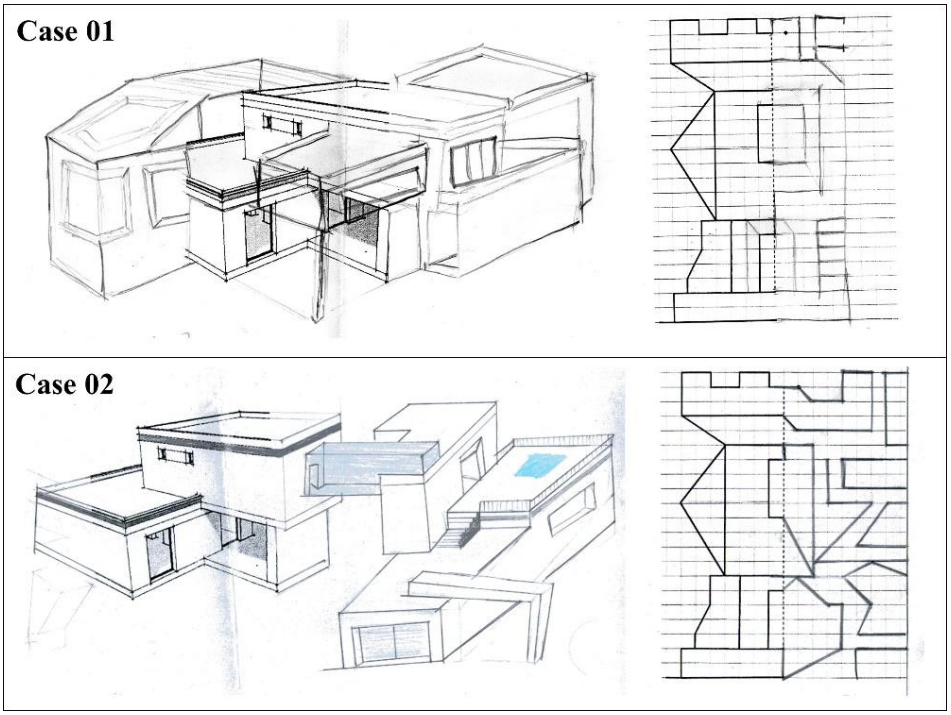

Fig. 6. Sample of Geometric and Figural drawings by two students under the worst and best lighting conditions. *Source:* own study

3.3.1. Fluency

The results demonstrate that lighting comfort significantly enhances students' fluency in geometric drawings but has a limited impact on figural drawings (Fig. 7). Under poor lighting, most students performed at the "Average" or "Basic" levels in geometric tasks, with only 5.26% achieving "Excellent" fluency. Improved lighting raised this percentage to 42.11%, suggesting that optimal lighting supports the precision and clarity essential for geometric tasks requiring accurate lines and shapes.

In figural tasks, which involve complex and representational forms, lighting comfort led to modest improvements but did not elevate students to the "Excellent" level. While 84.21% of students scored at the "Basic" level under poor lighting, better lighting increased "Average" scores to 57.89%. This suggests that while lighting enhances attention to detail, mastering figural drawing may require advanced interpretive skills and additional instructional support.

The observed improvements align with Torrance's (1974) emphasis on cognitively stimulating environments, confirming that favourable conditions positively affect creative fluency, particularly in structured tasks like geometric drawing [37].

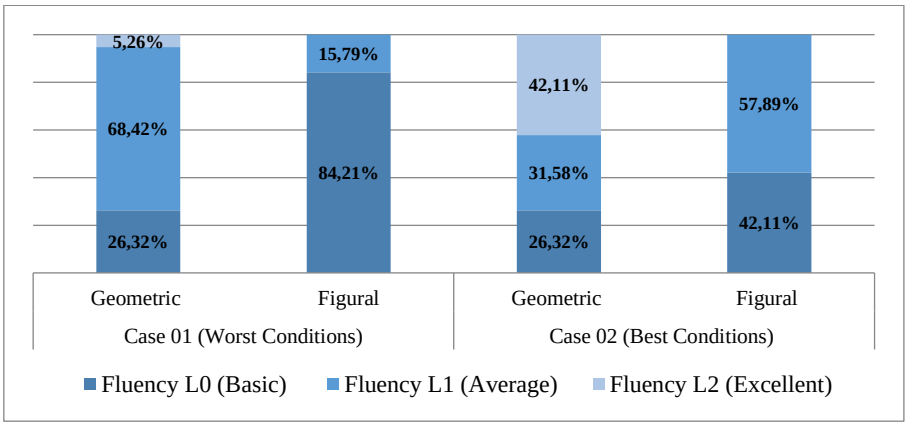

Fig. 7. A stacked graph representing the results of the geometric and figural tests – Fluency parameters. *Source:* own study

3.3.2. Flexibility

The stacked graph illustrates that lighting comfort significantly boosts students' flexibility in geometric drawings but has a limited effect on figural tasks (Fig. 8). In poor lighting, 26.32% of students achieved only "Basic" flexibility, while 10.53% reached "Excellent". Better lighting reduced the "Basic" category to 5.26% and increased the "Excellent" level to 36.84%, indicating improved adaptability and responsiveness in modifying geometric forms.

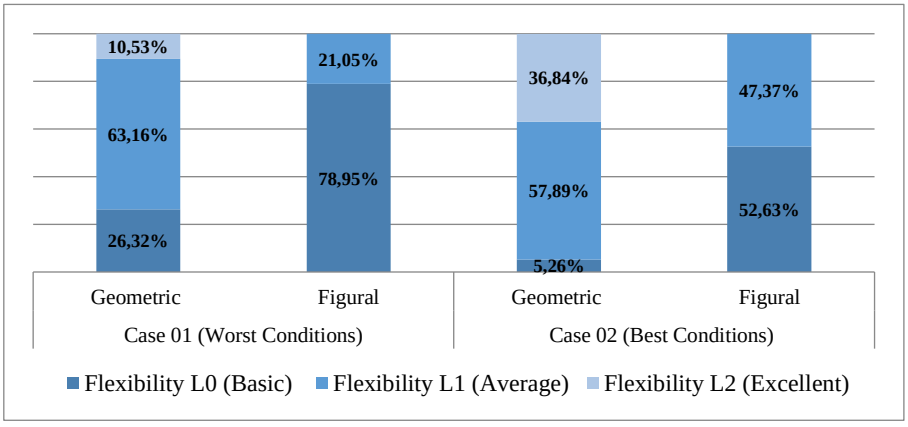

Fig. 8. A stacked graph representing the results of the geometric and figural tests – Flexibility parameters. *Source:* own study

In contrast, flexibility in figural drawings showed minimal improvement. While 78.95% of students were at the "Basic" level under poor lighting, over half (52.63%) remained there even with improved lighting, with none reaching "Excellent". This suggests that figural drawing flexibility requires more complex cognitive skills, such as visual interpretation and creative adaptation. These findings reflect Guilford's (1959) theory of divergent thinking, highlighting flexibility as a measure of cognitive adaptability influenced by environmental conditions [38].

3.3.3. Originality

The analysis shows that lighting comfort enhances originality in geometric drawings, though its impact on figural tasks remains limited (Fig. 9). Initially, 42.11% of students scored at the "Basic" level and only 15.78% reached "Excellent" originality in geometric tasks. Improved lighting reduced "Basic" scores to 10.53% and increased "Excellent" scores to 21.05%, suggesting that better visibility encourages more innovative design elements by reducing visual strain and enabling creative focus.

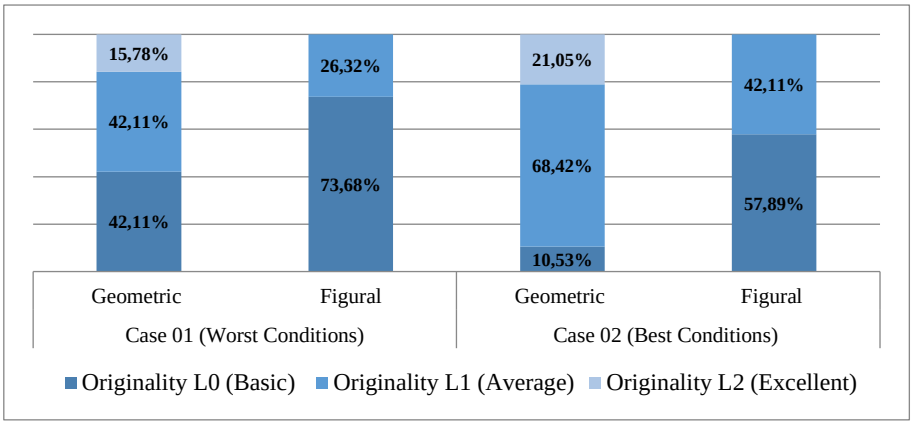

Fig. 9. A stacked graph representing the results of the geometric and figural tests – Originality parameters. *Source:* own study

However, figural drawing originality remained stagnant. Under poor lighting, 73.68% of students achieved only "Basic" originality, with none reaching "Excellent". Even after lighting improvements, 57.89% remained at the "Basic" level. This indicates that originality in figural tasks depends less on environmental factors and more on higher-order cognitive processes such as imagination and interpretive skills, possibly requiring targeted creative training.

These results support Runco et al. (2012), who argue that originality is difficult to cultivate within standardised contexts, emphasising the need for deliberate instructional strategies beyond environmental adjustments.

3.3.4. Elaboration

The outcomes indicate that lighting comfort positively affects elaboration in geometric drawings, while its impact on figural tasks is limited (Fig. 10). Initially, 15.79% of students scored "Basic" in geometric elaboration, while 31.58% achieved "Excellent". With improved lighting, "Excellent" scores reached 42.11%, and "Basic" scores dropped to 10.53%, indicating that optimal lighting promotes detail-oriented refinement by enabling clearer focus.

In contrast, elaboration in figural drawings showed only moderate improvement. In poor lighting, 78.95% of students were at the "Basic" level, with none reaching "Excellent". Better lighting reduced the "Basic" level to 47.37% and increased "Average" scores to 52.63%, though "Excellent" scores remained absent. This underlines that while lighting aids in detail work, achieving high elaboration in figural tasks requires advanced visual analysis and rendering skills.

These findings align with Sternberg's (1999) theory of elaboration, which distinguishes between cognitive processes linked to symbolic versus visual stimuli, underscoring the interplay between environmental conditions and cognitive representation mechanisms [15,18].

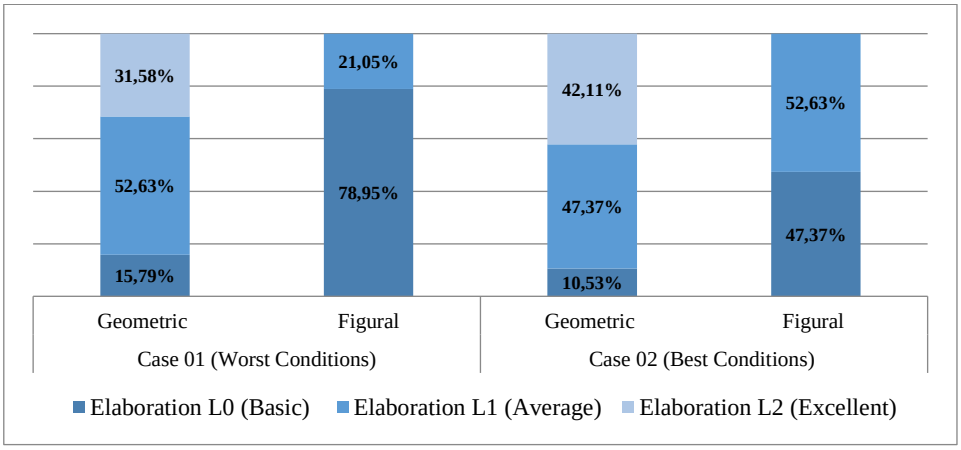

Fig. 10. A stacked graph representing the results of the geometric and figural tests – Elaboration parameters. *Source:* own study

4. Conclusion

This study examined the relationship between architectural design, lighting conditions, and creative performance among architecture students, using a mixed-methods approach that included architectural surveys, lighting analysis, and the Torrance Test of Creative Thinking (TTCT). Conducted across eight workshops at the Department of Architecture in Mostaganem (Algeria), the results identify lighting as a significant environmental factor influencing creativity, especially in tasks requiring technical precision.

Workshops with higher lighting quality (e.g., Workshop 2) outperformed poorly lit ones (e.g., Workshop 4) across all TTCT criteria – fluency, flexibility, originality, and elaboration. Enhanced lighting contributed to more detailed and innovative outputs in geometric drawing tasks, while suboptimal conditions constrained performance. However, improvements in lighting had limited effects on more interpretive tasks, such as figural drawing, where students continued to struggle with originality and elaboration. This indicates that environmental upgrades alone are insufficient to foster higher-order creative thinking.

The architectural assessment further revealed that most workshops fell short of recommended lighting standards, underlining the need to integrate natural and hybrid lighting systems alongside improved spatial design to support visual comfort and creative engagement.

Study limitations include its single-institution context, the broad applicability of the TTCT to architectural creativity, and uncontrolled variables such as spatial configuration, instructional methods, and student motivation.

Future research should examine the interaction between lighting design and pedagogical strategies, assess the long-term effects of environmental interventions, and incorporate physiological indicators (e.g., eye-tracking, biometrics) to better understand cognitive engagement during creative tasks.

Overall, while lighting optimisation enhances certain dimensions of creative performance, it is not sufficient on its own. A comprehensive strategy that aligns environmental quality with pedagogical support is essential for fostering creativity in architectural education.

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