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Artículos Científicos

Efectos físicos de la iluminación en medios impresos para la lectura en discapacidad visual

Physical Effects of Lighting in Print Media for Reading in Visual Disability

Efeitos físicos da iluminação na mídia impressa para leitura em deficiência visual

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Resumen

Si bien se han realizado esfuerzos enfocados a las mejoras de los productos de lectura en términos de comprensión, retención, memoria, velocidad de lectura, entre otros, y su eficacia en asociación con determinados usos ortotipográficos, se ha estudiado poco la incidencia de la iluminación ambiental sobre el soporte papel, material en el que se conllevan los escritos y su efectividad o limitación en el rendimiento y la permanencia en el lector, sobre todo en personas con discapacidad visual. En esta investigación se estudió el nivel de luminosidad de los sustratos para textos impresos con la finalidad de optimizar el proceso de lectura en espacios universitarios. Se seleccionaron tres muestras de papel de uso común y se midió su nivel de luminosidad a través de luxómetro en ambiente natural y artificial. Se compararon las medias de la luminosidad del papel cuché con las del tipo prensa por la mañana (p = 0.005) y por la tarde (p = 0.002) y se observó una diferencia significativa a favor del primero; y una diferencia

también significativa al mediodía a favor del *offset* (p = 0.002) al comparar sus medias de luminosidad con las del tipo prensa (cuyo índice fue menor en todos los casos). Los resultados exponen el nivel de luminosidad de estos sustratos y su conocimiento supone mejoras en términos de bienestar para el usuario en condiciones de uso temporal o permanente del objeto en atención a su índice de reflectancia.

Palabras clave: ambiente natural-artificial, luminancia, reflexión, sustratos.

Abstract

Efforts have been made to improve reading products in terms of comprehension, retention, memory, reading speed, among others, and their effectiveness in association with certain orthotypographic uses, but little has been studied the incidence of ambient lighting on paper, material in which the writings are involved and their effectiveness and/or limitation in performance and permanence in readers, especially in people with visual disability. This investigation studied the level of luminosity of substrates for printed texts in order to optimize the reading process in university spaces. Three samples of common use paper were selected, and their level of luminosity was measured through a lux meter in a natural and artificial environment. The averages of brightness of the coated paper were compared with those of press type in the morning (p = 0.005) and in the afternoon (p = 0.002) and a significant difference was observed in favor of the first; and a significant difference also at noon in favor of offset (p = 0.002) when comparing its brightness averages with those of the press type (whose index was lower in all cases). The results expose the level of luminosity of these substrates and their knowledge implies improvements in terms of well-being for the user in conditions of temporary or permanent use of the object according to its reflectance index.

Keywords: natural-artificial environment, luminance, reflection, substrates.

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Resumo

Esforços foram feitos para melhorar os produtos de leitura em termos de compreensão, retenção, memória, velocidade de leitura, entre outros, e sua eficácia em associação com certos usos ortográficos, mas a incidência da iluminação ambiente não foi estudada. no suporte de papel, material no qual os escritos são realizados e sua eficácia e / ou limitação no desempenho e permanência na leitura, especialmente em pessoas com deficiência visual. Nesta investigação, estudou-se o nível de luminosidade dos substratos dos textos impressos, a fim de otimizar o processo de leitura no espaço universitário. Três amostras de papel de uso comum foram selecionadas, e seu nível de luminosidade foi medido através de um luxímetro em um ambiente natural e artificial. As médias do brilho do papel *couché* foram comparadas com as do tipo prensa pela manhã (p = 0,005) e à tarde (p = 0,002) e observou-se uma diferença significativa a favor do primeiro; e uma diferença significativa também ao meio-dia em favor do deslocamento (p = 0,002) ao comparar suas médias de luminosidade com as do tipo prensa (cujo índice foi menor em todos os casos). Os resultados expõem o nível de luminosidade desses substratos e seu conhecimento implica melhorias em termos de bem-estar para o usuário em condições de uso temporário ou permanente do objeto, de acordo com seu índice de refletância.

Palavras-chave: ambiente natural-artificial, luminância, reflexão, substrates.

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Introduction

Although efforts have been made to improve reading products in terms of comprehension, retention, memory, reading speed, among others, and their effectiveness has been studied in association with certain orthographic uses, little has been investigated regarding the incidence of ambient lighting on the paper support, material in which the writings are involved and their effectiveness or limitation in performance and permanence in the reader, especially in people with visual impairment. The development of these daily tasks must be performed under the necessary optimal conditions, and maintaining comfort in natural or artificial lighting during the process is essential.

According to the Royal Spanish Academy [RAE] (2019), disability, in general terms, refers to a “physical, sensory or psychic decrease that totally or partially incapacitates a person for work or for other ordinary tasks of life”; while the visual disability in particular refers to the limitations that affect acuity and the visual field (National Council for Educational Development [Conafe], 2010, p. 1). Two groups of visual impairment are known: a distant one and a nearby one, with different degrees of physiological complexity, attending to the various causes that cause them. To date, systems have been designed that allow them educational inclusion and access to culture.

The World Health Organization [WHO] (2018) notes that 1.3 billion people live with some form of visual impairment. In Mexico, the National Institute of Statistics and Geography [Inegi] (2018) takes up some WHO concepts regarding visual impairments. For example, "it includes descriptions that refer to total loss of vision, visual weakness (people who only see shadows or lumps), and other limitations" (p. 13). In some of these cases the use of lenses does not compensate for the condition of one or both eyes, another reason why the definition of visual impairment is not usually so easy to encircle.

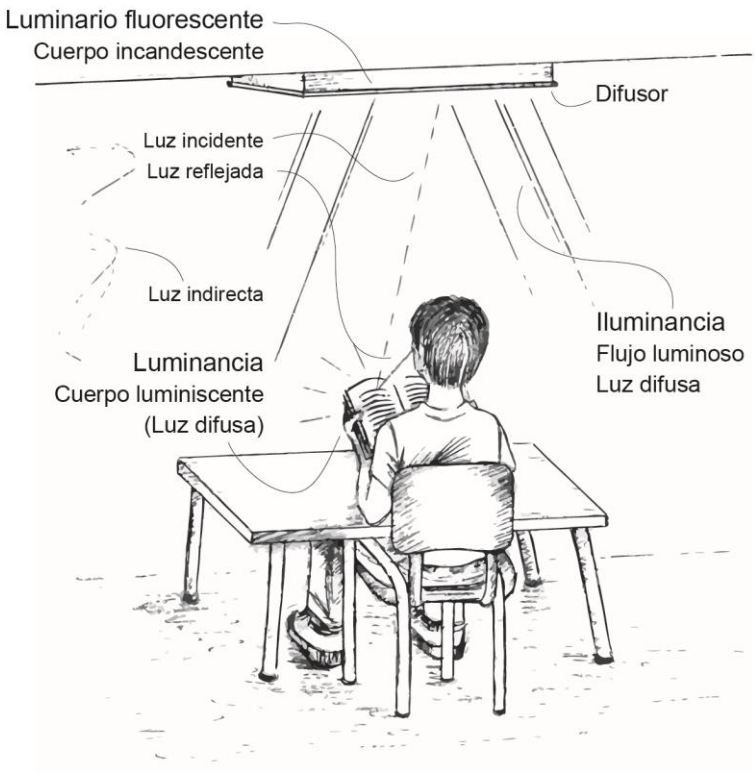
In addition to total blindness, for which the braille system is considered the best method of literacy, myopia, astigmatism, farsightedness or strabismus, to name but a few, are other types of disabilities that to a lesser or greater degree could show difficulties in the reading process. In these terms, Quintana (2015, p. 16) suggests lighting according to people with visual limitations in work areas, since the natural or artificial lighting prevailing in the readers' environmental space makes possible the visual perception of an object when configuring it in its figure and its background.

The human eye, as Bueche (1988, p. 598) says, is an electromagnetic radiation detector, since it is sensitive to a small area of the spectrum (380 nm to 780 nm), where the light energy received by the eyeballs stimulates to the photoreceptor cells (cones and rods) of the retina, which direct it towards the optic nerve, where the electrical signal that is then led to the visual cortex of the occipital lobe transits, which finally translates the nerve impulse. It is important to note that natural and artificial light have a level of incidence and reflection on objects in everyday spaces, and that there is the unit to measure the luminous flux is the so-called lux (Physics Dictionary, 1998, p. 309).

The incidence of light, following Prado and Ávila (2009, p. 56), is the amount of illuminance or illumination that falls from a source (incandescent body - with its own light -) with a particular level depending on its intensity, quality and power (luminaries,

lamps, spotlights, etc.); Reflection or brilliance is the light that, upon impact (on a luminescent body - without its own light) - is dispersed in the environment directly (towards the work plane as desk lamps), indirect or diffuse (subtle and not direct) . Halliday and Resnick (1985, p. 401) describe a diffuse reflection just on objects such as paper (see figure 1).

Figura 1. Relaciones de iluminación en un espacio de trabajo (salón de clases)



Fuente: Elaborado por Cano Celestino.

The physical conditions of the materials may not show significant difficulties in a first eye contact. However, according to Mondelo, Torada and Barrau (2000, p. 121), in the permanence and in communion with the space they could generate other sensations. In particular experience, has prolonged reading been limited with the use of any substrate used for that purpose? What level of incidence and reflectance do the substrates of the three main editorial media have in particular contexts and under specific lighting? Which of them shows a higher degree of luminance? Which ones would be more recommended for use in prolonged reading? Why attend to these observations?

The objective of this research is to study the level of luminosity of the substrates for printed texts, with the understanding that digital texts have not supplanted paper

texts and that in our day users' reading preferences are concomitant (Cow and Hernández, 2006, p. 124), in order to optimize its use in the reading process. The above under the hypothesis that the papers that reflect a greater amount of luminance are the type of cutlery, given the nature of its smooth surface tending to bright, so they would be the least suitable for use in long-term editorial media, as they facilitate glare, eye fatigue and poor reader performance.

Methods

In the research design, the environmental factor, the object factor and the user factor were considered. In the environmental factor, natural and artificial lighting (consisting of four luminaires with two bulbs each - Supra model, 32 watts, T8 -) inside the university classroom (classroom of 7.9 mx 6.4 m) belonging to the Faculty was measured of the Habitat of the Autonomous University of San Luis Potosí. At first, the level of natural light was recorded with open blinds and without artificial light emission (Figure 2, paragraph a); and in a second moment, artificial light was evaluated, with closed blinds and without natural light emission (figure 2, paragraph b).

Figura 2. Proceso de aplicación de la prueba: aula con iluminancia natural (a), aula con iluminancia artificial (b) y registro al contacto con usuario (c)

(a) (b) (c)

Fuente: Elaborado por Cano Celestino.

Within a wide variety of types of paper in the industry, in the object factor we considered the substrates type offset, cutlery and press with grammage less than 150 g / m2, as they are widely used materials in the three main print media , namely, the book, the magazine and the press. (It should be noted that these types of paper have common names that may vary by region or country depending on their particular characteristics). In addition, a horizontal tabloid format (28 cm x 43 cm) folded in half (21.5 cm x 28 cm) was used as a reading object for each one and without textual printing to record the

brightness index of the light source on the substrate, as well as to measure its reflectance index in contact with the user. The dependent variables (natural-artificial lighting, ceilings, walls and walls) and the independent variables (offset type substrates, cutlery and press) were analyzed.

At 10:00 hours three measurements were taken to record the level of illuminance in the classroom with natural light and open blinds; The average was then acquired to represent the level of natural lighting. Then, three measurements were taken for offset paper, first with a luxmeter on the object, and after that the average was obtained to represent the level of light incidence; Then three more measurements were taken with a lux meter in front of the object and the mean was also recorded to represent the light reflection index before the substrate. The same measurements were then taken to obtain the corresponding means of the ambient light and the object with artificial light and closed blinds.

At 14:00 hours the process carried out in the morning was repeated to obtain the means of the ambient light level, incidence level and reflection of the offset paper. In the same way we proceeded with the coated paper and with the press paper in both temporalities. The measurements were made under the conditions cited during the summer of 2018 for a period of 20 days. In order to obtain the degree of luminosity of the substrates, a luxmeter (Sper Scientific 840020) was used on contact with the object and simulating the optimal reading activity 30 cm away from the human eye. In the user factor, the reader was asked to wear white clothes during the application of the study to control the level of illuminance on the object in the environment (figure 2, paragraph c).

Finally, from the recorded data, box graphs were obtained to identify the extreme values and once recognized they were eliminated. With the final data, a one-way analysis of variance (Anova) was used to compare the means of luminosity in natural and artificial environments, type of paper, time and degree of incidence and reflection. A 95% confidence level was used to evaluate the null hypothesis.

Results

A difference in the means of the records of the reflection of the substrates in natural and artificial environment was found. The descriptive result of the measurements made can be seen in table 1.

Tabla 1. Resultado descriptivo de las medias de luminosidad según tipo de sustrato, donde *1*: offset; *2*: cuché, y *3*: prensa.

		N	Media	Desviación típica	Intervalo de confianza para la media al 95 %		Mínimo	Máximo
					Límite inferior	Límite superior		
Media de la incidencia de la luz sobre el objeto en ambiente natural (10:00 horas)	1	18	217.12	51.25	191.64	242.61	132.00	325.00
	2	19	195.73	69.80	162.09	229.38	67.66	335.66
	3	20	219.56	75.12	184.40	254.724	93.00	369.33
	Total	57	210.85	66.29	193.26	228.44	67.66	369.33
Media de la incidencia de la luz sobre el objeto en ambiente artificial (10:00 horas)	1	20	364.81	56.26	338.48	391.14	266.00	439.66
	2	20	350.60	50.65	326.89	374.30	258.66	422.33
	3	20	347.86	45.49	326.57	369.16	258.66	423.33
	Total	60	354.42	50.68	341.33	367.51	258.66	439.66
Media de la	1	2	95.13	36.26	78.15	112.10	56.00	187.6

reflectancia		0						6
de la luz	2	19	91.38	28.93	77.43	105.33	30.33	143.33
sobre el	3	19	80.33	25.34	68.11	92.55	41.33	131.66
objeto en ambiente natural (10:00 horas)	Total	58	89.05	30.75	80.97	97.14	30.33	187.66
Media de la	1	19	155.71	19.16	146.48	164.95	132.00	188.33
reflectancia	2	20	161.03	19.03	152.12	169.94	132.00	197.33
de la luz sobre el objeto en ambiente artificial (10:00 horas)	3	20	141.78	17.32	133.67	149.89	119.00	180.33
	Total	59	152.79	19.97	147.59	158.00	119.00	197.33
Media de la	1	20	154.41	46.43	132.68	176.14	43.66	220.66
iluminación	2	20	154.41	46.43	132.68	176.14	43.66	220.66
en ambiente natural (10:00 horas)	3	20	154.41	46.43	132.68	176.14	43.66	220.66
	Total	60	154.41	45.64	142.62	166.20	43.66	220.66
Media de la	1	2	456.9	42.17	437.2	476.68	365.6	522.6

iluminación		0	5		1		6	6
en ambiente artificial (10:00 horas)	2	20	456.95	42.17	437.21	476.68	365.66	522.66
	3	20	456.95	42.17	437.21	476.68	365.66	522.66
	Total	60	456.95	41.45	446.24	467.65	365.66	522.66
Media de la incidencia de la luz sobre el objeto en ambiente natural (14:00 horas)	1	20	88.81	26.82	76.25	101.36	44.00	154.00
	2	20	89.90	25.33	78.04	101.76	57.33	136.66
	3	20	91.41	25.43	79.50	103.31	57.33	138.33
	Total	60	90.04	25.45	83.46	96.61	44.00	154.00
Media de la incidencia de la luz sobre el objeto en ambiente artificial (14:00 horas)	1	15	416.13	29.94	399.55	432.71	360.00	467.00
	2	20	382.43	67.28	350.94	413.92	241.66	510.00
	3	18	384.07	43.31	362.53	405.61	299.66	466.33
	Total	53	392.52	52.28	378.11	406.93	241.66	510.00
Media de la	1	2	50.14	12.91	44.09	56.18	30.00	76.46

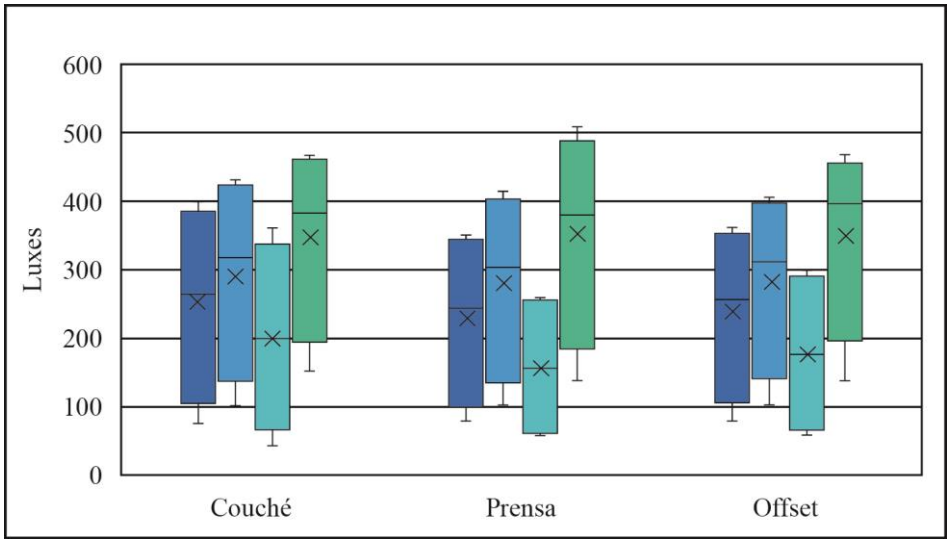
reflectancia		0						
de la luz	2	20	52.60	11.40	47.26	57.94	32.00	73.33
sobre el								
objeto en	3	20	46.42	12.42	40.61	52.24	30.00	73.63
ambiente								
natural	Total	60	49.72	12.32	46.54	52.90	30.00	76.46
(14:00								
horas)								
Media de la	1	20	166.68	19.81	157.41	175.95	121.66	210.66
reflectancia								
de la luz	2	20	165.78	18.61	157.07	174.49	126.00	198.00
sobre el								
objeto en	3	19	146.00	11.67	140.37	151.62	122.00	170.66
ambiente								
artificial	Total	59	159.71	19.37	154.66	164.76	121.66	210.66
(14:00								
horas)								
Media de la	1	16	62.53	7.98	58.28	66.79	45.16	72.00
iluminación								
en	2	16	62.53	7.98	58.28	66.79	45.16	72.00
ambiente								
natural	3	16	62.53	7.9	58.28	66.79	45.16	72.00
(14:00								
horas)	Total	48	62.53	7.8	60.26	64.80	45.16	72.00
Media de la	1	1	471.5	32.57	455.8	487.24	413.3	535.0

iluminación		9	4		4		3	0
en ambiente artificial (14:00 horas)	2	19	471.54	32.57	455.84	487.24	413.33	535.00
	3	19	471.54	32.57	455.84	487.24	413.33	535.00
	Total	57	471.54	31.98	463.05	480.03	413.33	535.00

Fuente: Elaborado por Cano Celestino.

Offset paper showed an average of the highest incidence level with respect to coated paper and press paper in an artificial environment (364.81 lux, 10:00 hours and 416.13 lux, 14:00 hours) (Figure 3). At both times, the average of the coated paper registered a lower level of incidence of luminosity than offset paper in natural environment (195.73 lux, 10:00 hours) and the press in artificial environment (382.43 lux, 14:00 hours). Finally, the average of the press paper obtained a greater degree of incidence with respect to the cutlery and offset, more appreciable in the morning and at noon in a natural environment (219.56 lux and 91.41 lux). There was no significant difference in the mean level of incidence of light on the object in any of the cases.

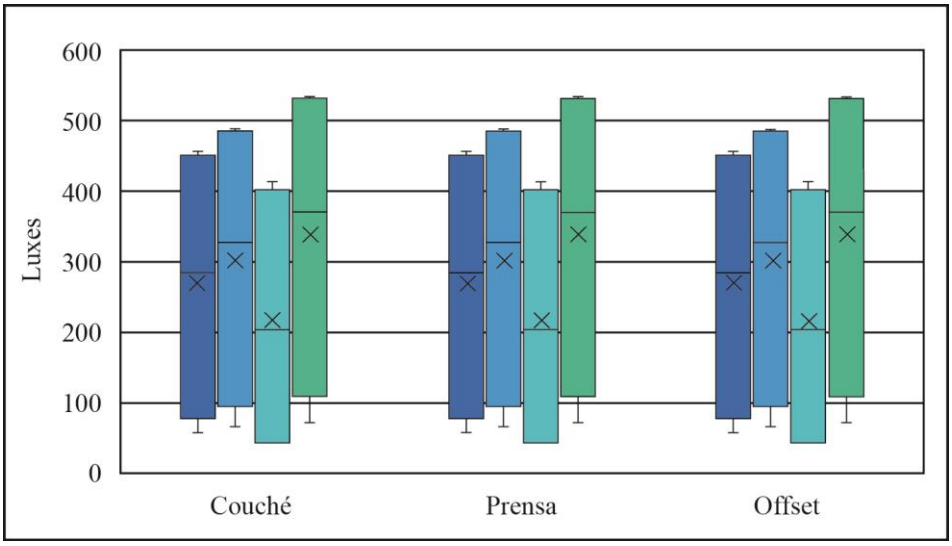
Figura 3. Media de la iluminación sobre el objeto. En las dos primeras cajas se muestra la media de la incidencia de la luz sobre el objeto en ambiente natural y artificial (10:00 horas); en la tercera y cuarta caja se observa la medida realizada en ambiente natural y artificial (14:00 horas)



Fuente: Elaborado por Ramírez Martínez.

On the other hand, with respect to the reflection index (10:00 hours) and with artificial lighting, when comparing the type of substrate type with the press type, a significant difference was obtained ($p = 0.005$), the type showed a greater luminosity (161.03 lux) (figure 4). When the offset type substrate is compared with the press type (141.78 lux), a difference in favor of the offset (155.71 lux) is observed but this difference is not significant ($p = 0.06$). There was also a difference between the reflection index of the offset and the knife in favor of the latter (5.31 lux) but it was not significant, since their differences are close. In all cases, the average of the reflection of the press paper was below the index of the substrates coated and offset.

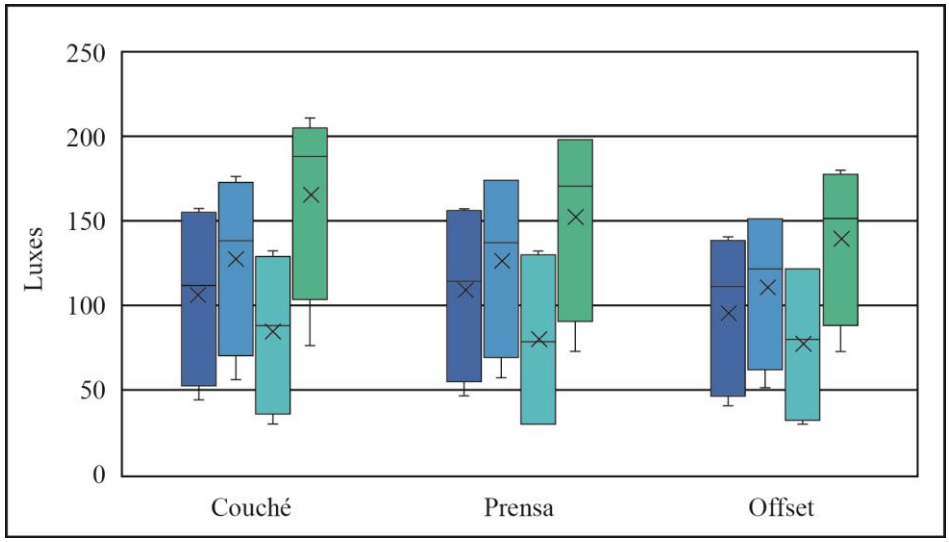
Figura 4. Media de la iluminación. Las dos primeras cajas muestran la media de la iluminación (10:00 horas) en ambiente natural y artificial; mientras la tercera y cuarta caja exponen la medida realizada en los mismos ambientes (14:00 horas)



Fuente: Elaborado por Ramírez Martínez.

At noon (2:00 pm), also in an artificial environment, when comparing the offset type substrate with the press type, a significant difference is observed (p = 0.001): the average of the reflection of the former is higher (166.68 lux) (figure 5). When comparing the coated substrate with the press (146.00 lux), the difference is also significant (p = 0.002); In this case, the average brightness is higher in the type of cutlery (165.78 lux). As in the morning, in this temporary space there is a small difference (0.89 lux) between the brightness of the offset and the knife in favor of that, but it is not significant, since the luminosity of both substrates is similar.

Figura 5. Media de la reflectancia de la luz sobre el objeto. Las dos primeras cajas refieren la media de la reflectancia de la luz sobre el objeto (10:00 horas) en ambiente natural y artificial. La tercera y cuarta caja muestran la medida realizada (14:00 horas) en ambiente natural y artificial



Fuente: Elaborado por Ramírez Martínez.

The average of the illumination in natural and artificial environment predominant in the morning inside the school space was 154.41 lux and 456.95 lux, respectively; in the afternoon, the natural ambient light was 62.53 lux and the artificial light 471.54 lux inside the same space.

Discussion

In educational institutions, lighting conditions are very much in line with the light standardization systems prescribed at international level in order to make tasks in work spaces more efficient. The Mexican Society of Engineering and Lighting [SMII] (1967, pp. 6 and 13) and Fonseca (2002, p. 96) establish a limit of 400 lux as a level of artificial light intensity in spaces such as classrooms. However, Prado and Ávila (2010, p. 18) establish a lighting level of 500 lux to 700 lux in workspaces associated with reading.

Therefore, artificial lighting inside the classroom in which the objects were measured ranged in the range established by regulations, as indicated by the average of the average obtained in this investigation, where a lesser or equal use is suggested for the interior of said spaces However, natural lighting was well below the standard. The variable associated with artificial lighting was controlled and, given that adequate ambient light of this nature was noticed, it would be understood that the values obtained

in the luminance index of the substrates are of regular incidence produced on the same objects under these conditions of reading.

According to Oborne (1987, pp. 232 and 302-303), bodies absorb a percentage of the level of incidence that falls from the light source and then reflect a certain amount of light, always dependent on their own lining, because, although said average of luminosity falls on objects located in the work area, each absorbs a different amount of light according to the quality of its surface. Inside the classroom, the established norm with respect to the predominance of light colors in ceilings, walls and walls was met and there was direct lighting from the fluorescent lighting, but mitigated by the use of diffuser (see figure 1).

In this investigation, a higher average of the level of light reflection in the coated paper and offset paper was recorded. In the first one, an influence of the smooth consistency characterized by its glossy, coated or satin finish is deduced to produce a higher level of reflectance towards the reader during the process and under artificial luminosity inside the school spaces. It is necessary to comment that Willberg and Forssman (2002, p. 32) assume a greater limitation during the reading process in a substrate such as the smooth and shiny surface knuckle which they call harmful due to its similarity with a mirror. That is to say, that the reflection of the light initially diffused in the papers, as Halliday and Resnick (1985, p. 401) comments, on a glossy paper would change to speculate as a mirror does.

It would be understood that those substrates with greater contrast to eye contact with natural or artificial lighting such as the cutlery would demand greater visual effort, fatigue and fatigue than others with opposite characteristics. The SMII (1967, pp. 6 and 13) suggests taking with caution the use of semi-gloss or glossy paper to reduce glare reflected on its surface. Thus, as described by Ernst Neufert (2014, p. 516), the SMII also takes the use of matte type coatings well, since in their opinion they do not reflect light excessively. It would be the case that experience or offset the substrates type offset or press (considered in this study) and whose implications are addressed.

The luminosity of the offset, distinguishable by its smoothness and whiteness without being coated, as Hampshire and Stephenson (2008, p. 245) refer, and widely used for printing texts (Proenza, 1999, p. 312), would produce, According to this research, a level of reflection similar to the knife under artificial lighting in the reading process. That is to say, that not only bright substrates would be unsuitable for prolonged reading, also predominantly white consistency substrates should be used with care. Willberg and

Forssman (2002, p. 32) suggest a broken target (bone, cream, sand), which would be appropriate to mitigate luminance and prevent glare from the substrate.

On the other hand, both in natural and artificial environments, press paper registered a lower degree of luminance. In an artificial environment it was possible to distinguish a lower reflectance level by an average of 20.23 lux (20.68 lux less with respect to offset and 19.78 lux with respect to the knuckle at noon; 13.93 lux less with respect to offset and 19.24 lux with respect to the knuckle by the morning). In view of its level of light reflectance, the temporary press type substrate in daily circulation media would be recommended for prolonged reading under certified standard lighting conditions inside architectural spaces such as schools.

Newspaper, also called newspaper, is a widely used substrate for printing economic and comic books (Proenza, 1999, p. 312). In this regard, care has been suggested associated with the printing of the text and the color contrast on the paper given its high level of absorption (Proenza, 1999, p. 312; Willberg and Forssman, 2002, p. 32). In general, as Ambrose and Harris (2011, p. 11) mention, paper is a fundamental element in the creation of the object and its influence on the perception of it must be studied without forgetting that this support is a container of typographic signs and that Its effectiveness in communicating with the user is a whole.

In this investigation, the substratum type and offset type substrates were papers of greater light intensity, so that the hypothesis initially raised is verified that the type of cutlery papers, given their nature, would be the least indicated for prolonged reading, if he wants to avoid eye fatigue, but a similar luminance produced in the offset type substrate was also found. That is, both substrates should be selected with attention to their use.

The observations described are important to facilitate the task, reduce glare, visual fatigue and prevent the loss of its execution, because, although the paper is not an incandescent body or a highly bright object that can cause blindness, it could minimize the reading process in people with low visual abilities and wearing glasses, as well as in subjects with high visual sensitivity.

Here are some recommendations that should be taken into account in the context of the contextual, objective and user factors described in this investigation:

- Design architectural spaces and integral, functional, usable and aesthetic objects, as Norman (2005, p. 18) refers, always according to the user's physical and mental needs, based on multidisciplinary work.

- Attend to the level of natural and artificial illuminance recommended by regulations according to the tasks to be carried out in the interior and exterior spaces for the benefit of the user.
- Select the substrate in consideration of the temporality of use of the object, whether permanent or temporary, and its level of reflectance, seeking at all times the optimization of the process, minimization of eye fatigue and, therefore, reading retention in terms Editorial design (independent of reading content).
- Take lighting precautions when reading incandescent objects, especially in cases where the reflection rate is greater than the incident value, such as in the use of electronic displays (computer, cell phone, tablets), in low ambient lighting conditions or null (high contrast - darkness) and that lead to poor performance in the task.
- Manage actions for the maintenance of the luminaries that minimize the already inherent limitations corresponding to their nature such as flickering. This to avoid the efforts of accommodation and visual adaptation, low visual acuity, constant changes in photopic-scotopic vision and glare and contrasts.

Finally, the results obtained have been registered under the regular working conditions inside a university center, controlling the possible variables. The suggestions described must be taken with moderation since they respond to very particular object, user and contextual factors (corresponding to an architectural space, reflection index of ceiling, walls and walls, type of substrate, climatic state, time of registration, angle visual, user posture, type of luminaires, location, distance to the work plane, quality, power, conditions of these, etc.).

New studies could include other independent variables: degrees of color, texture, opacity, weight, typographic use and type of reading format in contact with natural or artificial lighting to know its relevance of use.

Conclusions

The study carried out gives an account of the presence of the illuminance on the reading objects and their influence in the reading process inside the university classroom. A higher average of the reflection level of the coated paper and offset paper with respect to the press paper under natural and artificial lighting is appreciated. Therefore, the press paper in general would be considered more optimal for reading based on its lower reflection rate in the lighting standards studied, which would facilitate permanence, performance and optimization in the process. In any case, the use of substrates is suggested in consideration of their temporality of use for the reading of the most sensitive users. Future research could confirm these findings and contribute to actions that show a better integration of readers within education, taking into account their particular condition and their degree of visual limitation in different environments.

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