

Seguimiento al análisis de las edificaciones de uso escolar: su evaluación e impacto en la educación primaria y secundaria

Follow-up to the analysis of buildings for school use: their evaluation and impact on primary and secondary education

Acompanhamento da análise de edificações para uso escolar: sua avaliação e impacto no ensino fundamental e médio

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Resumen

El objetivo del presente artículo consistió en dar seguimiento a la metodología aplicada por Pacheco (2021) para conocer la situación en que se encontraba la infraestructura de instituciones educativas del nivel preescolar, aunque en esta ocasión se eligió a 17 planteles de educación básica ubicados en la zona centro del país (Ciudad de México, Hidalgo, Querétaro y Tlaxcala). Para ello, se realizó un estudio de carácter cuantitativo, así como cualitativo con soporte fotográfico, levantamiento físico de datos específicos de cada plantel, así como análisis de los indicadores de la Secretaría de Educación Pública (SEP). Las preguntas que orientaron este estudio fueron las siguientes: 1) ¿el número de profesores disponibles es suficiente para brindar una educación de calidad a toda la población estudiantil?, 2) ¿la infraestructura física de las escuelas es apta para la edad de sus usuarios?, 3) ¿los espacios físicos usados para las actividades académicas cumplen con los requerimientos básicos para desarrollarlas con eficacia?, y 4) ¿los planteles educativos cuentan con las condiciones de infraestructura adecuadas para operar de manera segura en medio de la actual situación generada por la pandemia de covid-19? Los resultados demuestran las carencias generales de los planteles examinados en cuanto a ventilación, iluminación, mobiliario y recursos hidrosanitarios. En conclusión, se puede indicar que este escenario, en medio de la actual

emergencia generada por la covid-19, dificulta el regreso a clases presenciales, pues los planteles necesitan cumplir con un mínimo de condiciones de bioseguridad para llevar a cabo con éxito el proceso educativo.

Palabras clave: ambiente educacional, cumplimiento normativo, edificaciones de uso escolar, educación primaria y secundaria, relación alumno-profesor.

Abstract

The objective of this article consisted of following up on the methodology applied by Pacheco (2021) to know the situation in which the infrastructure of educational institutions of the preschool level was found, although on this occasion 17 elementary schools located in the central area of the country (Mexico City, Hidalgo, Querétaro and Tlaxcala). For this, a quantitative study was carried out, as well as a qualitative one with photographic support, physical survey of specific data of each campus, as well as analysis of the indicators of the Ministry of Public Education (SEP). The questions that guided this study were the following: 1) Is the number of teachers available enough to provide a quality education to the entire student population? 2) Is the physical infrastructure of the schools suitable for the age of its users? 3) Do the physical spaces used for academic activities meet the basic requirements to develop them effectively? And 4) Do educational establishments have adequate infrastructure conditions to operate safely in the midst of the current situation generated by the covid-19 pandemic? The results show the general deficiencies of the schools examined in terms of ventilation, lighting, furniture and hydrosanitary resources. In conclusion, it can be indicated that this scenario, in the midst of the current emergency generated by covid-19, makes it difficult to return to face-to-face classes, since the schools need to comply with a minimum of biosafety conditions to carry out the process successfully educational.

Keywords: educational environment, regulatory compliance, buildings for school uses, primary and secondary education, student-teacher relationship.

Resumo

O objetivo deste artigo foi dar seguimento à metodologia aplicada por Pacheco (2021) para conhecer a situação da infraestrutura das instituições educacionais de nível pré-escolar, embora nesta ocasião 17 escolas primárias localizadas na zona central do país (México City, Hidalgo, Querétaro e Tlaxcala). Para isso, foi realizado um estudo quantitativo, além de um qualitativo com suporte fotográfico, levantamento físico de dados específicos de cada campus, bem como análise dos indicadores do Ministério da Educação Pública (SEP). As questões que nortearam este estudo foram as seguintes: 1) O número de professores disponíveis é suficiente para oferecer uma educação de qualidade a toda a população discente? 2) A infraestrutura física das escolas é adequada à idade de seus usuários?, 3) Os espaços físicos utilizados para as atividades acadêmicas atendem aos requisitos básicos para desenvolvê-las com eficácia? E 4) Os estabelecimentos de ensino possuem condições de infraestrutura adequadas para operar com segurança em meio à situação atual gerada pela pandemia covid-19? Os resultados mostram as deficiências gerais das escolas examinadas em termos de ventilação, iluminação, mobiliário e recursos hidrosanitários. Concluindo, pode-se apontar que esse cenário, em meio à atual emergência gerada pelo covid-19, dificulta o retorno às aulas presenciais, uma vez que as escolas precisam atender a um mínimo de condições de biossegurança para realizar o processo com sucesso.

Palavras-chave: ambiente educacional, conformidade regulatória, edificações para uso escolar, ensino fundamental e médio, relação professor-aluno.

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Introduction

In Mexico, the national educational system is made up of the following levels: basic, upper secondary and higher, in the schooled, non-schooled and mixed modalities, while the basic type education is made up of the preschool, primary, as well as secondary levels. (Secretariat of Public Education [SEP], 2019). Primary education is compulsory and universal, since it is a constitutional right, and it is offered in three services: general, indigenous and community, in the following modalities: general, telesecundaria, technical, federal, mixed. This level of education lasts for three years, and students are usually between 12 and 16 years of age.

Now, since everything that adolescents learn takes place in educational establishments, the physical educational infrastructure (INFE) must be considered as an essential element to promote the integral development of schoolchildren in a quality environment. In other words, the INFE is a

transcendental pedagogical element, because if its conditions are appropriate, environments full of stimuli can be created for students.

Therefore, it is essential to verify that the INFE complies with the regulations with the appropriate structure, distribution of its areas, quality of materials (according to educational level), facilities, location, security, etc., in order to determine if the property is suitable to carry out the pedagogical process. Due to this, studies on buildings for school use have been increasingly oriented to understand how the physical spaces that students use favor or prevent learning, hence they contribute to improving the architectural design, planning, quality of facilities, ventilation, lighting, etc. (Blackmore *et al.*, 2011; Blanco, 2009, Campana *et al.*, 2014; Cheryan *et al.*, 2014; Duarte *et al.*, 2011; Duarte *et al.*, 2017, Murillo, 2003; Murillo y Román, 2011).

Objective

Because the protagonists of the educational process are students, teachers, administrative staff and parents, it is necessary that all have a minimum in terms of security levels, adequate facilities and basic services to develop the training task. Therefore, the purpose of this study was to provide elements regarding regulatory compliance, maintenance and rehabilitation of educational spaces, thereby continuing the research carried out by Pacheco (2021). For this analysis, the following questions were raised:

1. Is the number of teachers available enough to provide a quality education to the entire student population?
2. Is the physical infrastructure of the schools suitable for the age of its users?
3. Do the physical spaces used for academic activities meet the basic requirements to develop them effectively?
4. Do the educational establishments have the adequate infrastructure conditions to operate safely in the midst of the current situation generated by the covid-19 pandemic?

Material and method

A quantitative study was carried out, as well as a qualitative one with photographic support, physical survey of specific data of each campus for its later study, as well as analysis of the indicators of the Ministry of Public Education (SEP). Likewise, the investigation had a multidisciplinary nature when studying regulatory compliance, since knowledge in civic matters, architectural studies, constructive certainty, hydro-sanitary and electrical installations, as well as

legal notions were required. In addition, it was necessary to apply mandatory regulations, as well as voluntary observance, laws and construction regulations according to the municipality where the evaluated campus was located.

Being a continuation of the work of Pacheco (2021), the following phases were used in order to obtain the replicability of the methodology:

Phase I

Collection of data on buildings for school use. This was done based on the format of the technical information card (CIT) of the Institute of Physical Educational Infrastructure (INIFED, 2019), and covered the following aspects:

- A. General information about the educational building.
- B. Location, environment and identification of threats.
- C. Basic requirements of the property where the campus is located.
- D. Verification that it has the following services: potable water, sanitary-storm drainage, electricity, gas installation, information and communication technology.
- E. Accessibility.

Phase II

Calculation of the indicator of the Ministry of Public Education (SEP) (2019) that linked the number of students and teachers in buildings for school use. The elementary and imperative conditions that schools must comply with were identified, as established by the Organization for Economic Cooperation and Development (OECD): accessibility, sustainable environment and social collaboration. Likewise, images were presented that supported and validated the analyzed evidence.

Phase III

The following regulations applied to both primary and secondary schools were used:

- a) NMX-R-021-SCFI-2013. Requirements. Schools —quality of the educational physical infrastructure (Norma Mexicana, 2013).
- b) NOM 001 SEDE 2012 Electrical Installations (DOF, 2014).
- c) NMX-R-084-SCFI-2015. Data collection for the diagnosis of the educational physical infrastructure (Norma Mexicana, 2015a).

- d) NMX-R-024-SCFI-2015. Schools — supervision of physical educational infrastructure works (Norma Mexicana, 2015b).
- e) NMX-R-90-SCFI-2016. Elements for accessibility to the spaces of the educational physical infrastructure (Norma Mexicana, 2016).
- f) NMX-R-083-SCFI-2019. Schools —design-manufacture of furniture for the physical educational infrastructure— criteria and requirements (Norma Mexicana, 2019).
- g) Standards and specifications for studies, projects, construction and facilities (INIFED, 2014).
- h) Complementary technical standards to the Construction Regulations of Mexico City (Official Gazette of Mexico City, 2017).
- i) Technical Standards of the Construction Law of the State of Tlaxcala (Mexican Standard, 2018).
- j) Construction Regulations for the Federal District (Official Gazette of D. F., 2004).
- k) Hidalgo Construction Regulations.
- l) Construction Regulations of Querétaro.

Data

A representative sample of the central area of the country of 17 basic education schools, located in the states of Mexico City (CDM), Hidalgo (HGO), Querétaro (QRO) and Tlaxcala (TLAX) was considered. Next, table 1 shows the characteristics of the schools analyzed:

Tabla 1. Características básicas de las escuelas analizadas.

Nivel educativo	Clave de centro de trabajo	Ubicación
Primaria	P-15EPRO6XXX	Ciudad de México
Primaria	P-15EPR21XXX	Ciudad de México
Primaria	P-09PPR14XXX	Ciudad de México
Primaria	P-09DPR15XXX	Ciudad de México
Primaria	P-09DPR28XXX	Ciudad de México
Primaria	P-15EPR48XXX	Ciudad de México
Primaria	P-09DPR16XXX	Hidalgo
Primaria	P-15DPR16XXX	Querétaro
Primaria	P-22DPR08XXX	Querétaro
Primaria	P-22DPR45XXX	Querétaro
Primaria	P- 29DPR04XXX	Tlaxcala
Secundaria	S-09DES00XXX	Ciudad de México
Secundaria	S-09DES00XXX	Ciudad de México
Secundaria	S-09DES00XXX	Ciudad de México
Secundaria	S-09DES00XXX	Ciudad de México
Secundaria	S-09DES00XXX	Ciudad de México
Secundaria	S-09DES00XXX	Ciudad de México

Nota: Elaboración propia con fines didácticos

Field tools and analysis

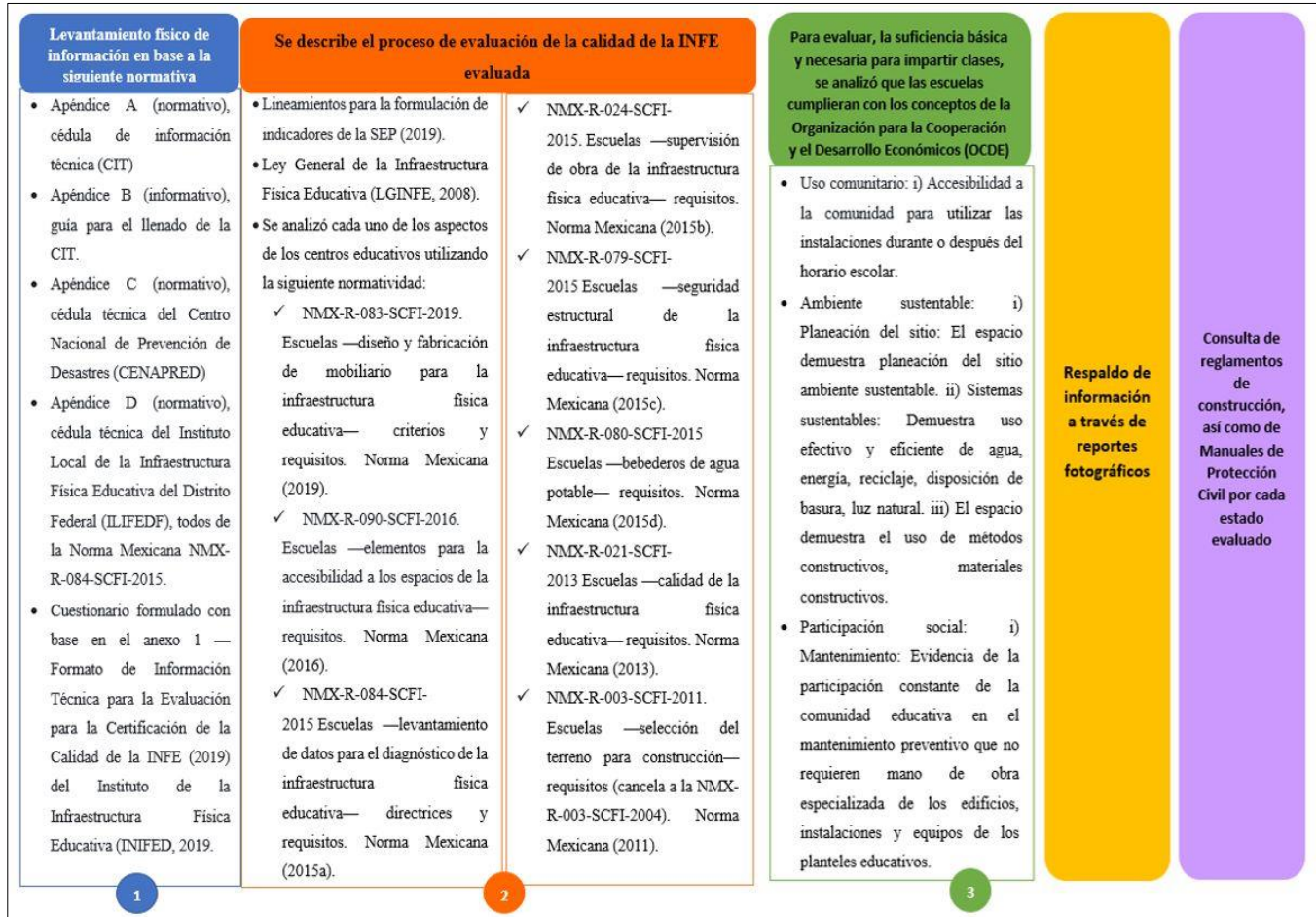
- A. The current state of the INFE of public primary and secondary schools in the central area of Mexico City was reviewed. This choice was made to carry out the comparison, as well as its regulatory compliance.
- B. All the information collection sheets of the school buildings were digitally captured based on the format of the technical information card (CIT) of the Institute of Educational Physical Infrastructure (INIFED) (2019).
- C. The sufficiency criteria we used for the present analysis were the following:
 - i. Campus created for educational use. Here the age of the property was taken into account and if it had been built as an educational building or if it was an adaptation of a house, room, warehouse or adapted land without minimum compliance with the regulations.

- ii. Facilities that meet the minimum requirements for use, requested by the OECD.
 - iii. Number of schools that have evidence of an architectural project and general planning based on demand or executive project.
 - iv. If there is the minimum necessary furniture or equipment according to the level analyzed.
 - v. If the campus has the basic services necessary to provide its service.
 - vi. The electrical and plumbing installations are the minimum necessary and adequate for the level.
 - vii. If it is located in a safe area (near gas stations, rapid transport routes, hillsides, garbage dumps, markets, high voltage lines, etc.).
 - viii. The common administrative areas have ventilation and lighting according to the regulations required by the level analyzed.
- D. A bibliographic review was carried out to develop a mapping of the main regulations (mandatory and voluntary compliance) applicable to INFE in various areas (environment, civil protection, facilities, etc.) in Mexico in order to identify if they serve the needs of primary and secondary schools.

Procedure

The study was structured based on the stages applied in Pacheco's research (2021), see figure 1, which indicates the explanation of the study phases.

Figura 1. Explicación de las etapas del estudio.



Fuente: Elaboración propia con fines didácticos

Results

A relevant aspect that was detected when analyzing the schools of these educational levels was that some of the designs had the influence of the work carried out between 1932 and 1934 by the painter and architect Juan O'Gorman (Pérez, 2011), characterized by building schools with modular spaces (in series) so that the classrooms had the maximum amount of natural light and ventilation. The main objective was to build schools to address the deficit that existed at that time (DOF, 2019) see figures 2 and 3, which show the primary and secondary schools influenced by the work of Juan O'Gorman.

Figura 2. Escuela primaria influenciada en la obra de Juan O’Gorman. Ubicada en Ciudad de México, muestra claros amplios en sus fachadas para el adecuado aprovechamiento de la luz y la ventilación (Xochimilco Tlalpan).



Fuente: Nancy Pacheco (2018) tomada con fines didácticos

Figura 3. Escuela secundaria influenciada en la obra de Juan O’Gorman. Ubicada en Ciudad de México, cuenta con amplios ventanales para la adecuada ventilación, así como aprovechamiento de la luz natural (Azcapotzalco).



Fuente: Nancy Pacheco (2018) tomada con fines didácticos

However, due to the actions undertaken since 2012 by the Ministry of Public Education (eg, the Educational Reform, the General Education Law [LGE], [2019], the updating of study plans and programs, as well as as well as educational materials and methods), these infrastructures do not satisfy the basic needs of the students.

In this sense, the results obtained present serious deficiencies, since there are no longer large windows to take advantage of natural light and ventilation. Instead, fences have now been erected due to insecurity, obstructed with artificial elements from the environment, or removed to expand other adjoining areas required by the large number of students. In addition, some of these windows border garbage cans, house walls, expressways, gas stations or vandalism areas; see (figures 4 and 5).

Figura 4. Escuela secundaria ubicada en Ciudad de México, en la localidad de Tláhuac. Obsérvese que se desaprovecha la luz y la ventilación debido a las rejas agregadas por inseguridad o por estar ubicada frente a vías rápidas de transporte.



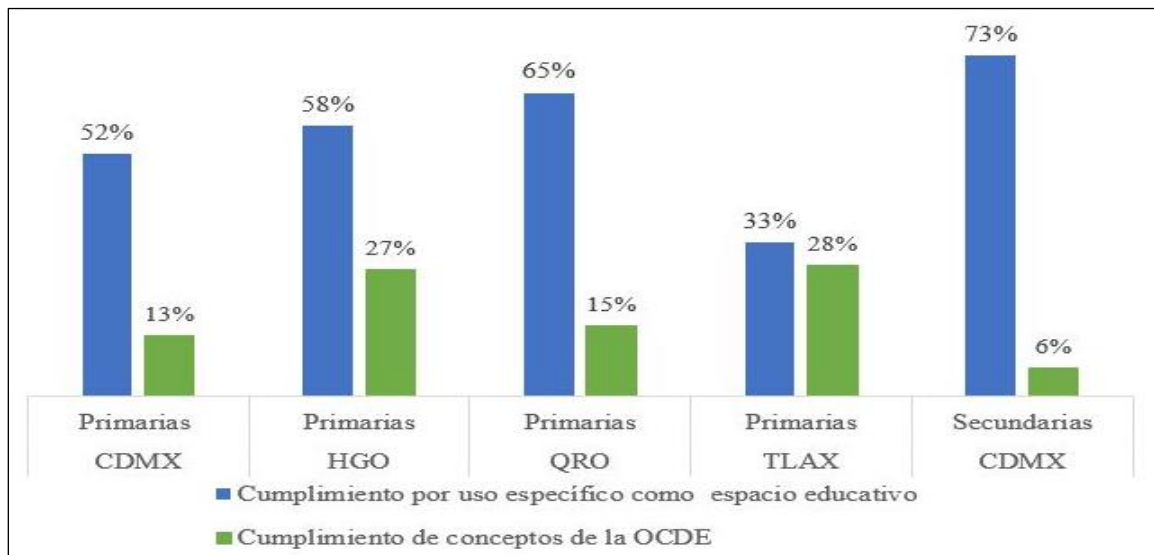
Fuente: Nancy Pacheco (2019) tomada con fines didácticos

Figura 5. Escuela primaria ubicada en Ciudad de México, localidad de Azcapotzalco. Véase el acceso obstruido por el comercio ambulante, lo que representa un riesgo para el alumnado.



Fuente: Nancy Pacheco (2019) tomada con fines didácticos

Figura 6. Acato normativo de las INFE como espacio educativo y de los conceptos de la OCDE.

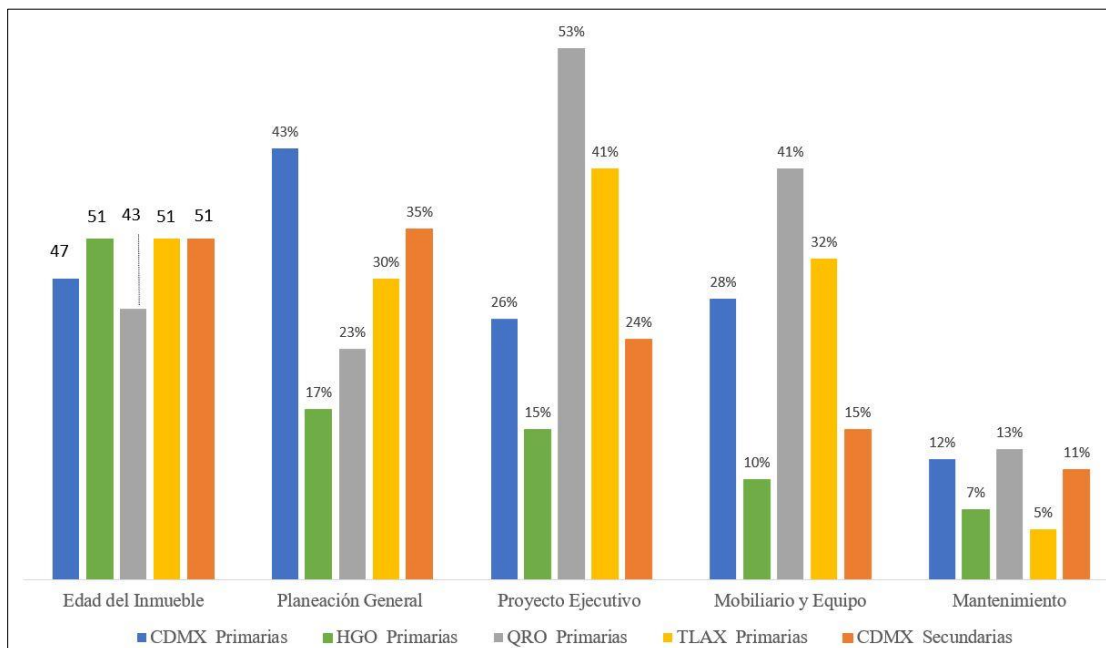


Fuente: Elaboración propia con fines didácticos

Figure 6 presents the percentage of compliance as an educational space of the evaluated schools. Note (in blue) that secondary schools in Mexico City, as well as elementary schools in the state of Querétaro meet 73% and 65%, respectively. This shows that there are several spaces used for other purposes not related to general planning (adaptation of areas). However, regarding compliance with the basic concepts required by the OECD (in green), note that all the INFE evaluated are below 33%.

Figure 7 shows the status of the evaluated INFE regarding the property age variable. It is observed that most of the buildings are more than half a century old, which means that they were built to serve educational needs of other times. Another noteworthy point is that there is no evidence that the structures have been planned as educational spaces. Likewise, it was found that no institution has the appropriate furniture and that maintenance is precarious.

Figura 7. Evaluación de la INFE.



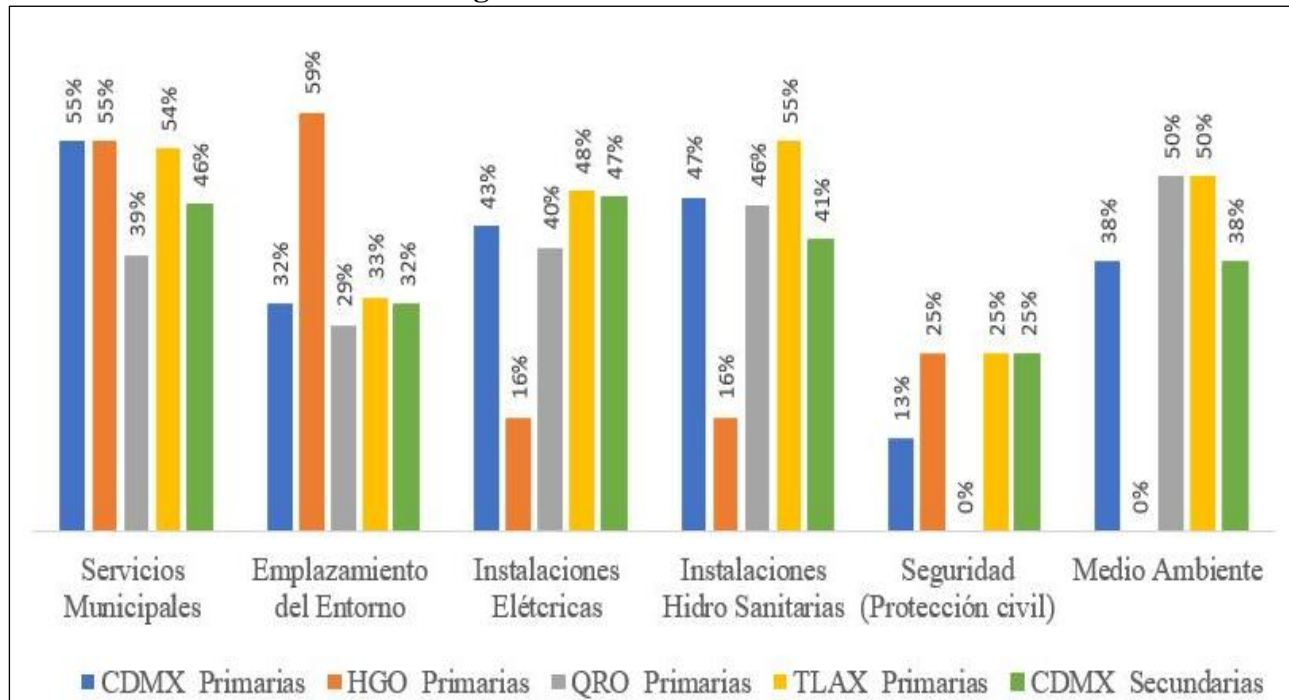
Fuente: Elaboración propia con fines didácticos

Based on the information collected in the three phases of the analysis, figure 8 reflects the real conditions in which the educational buildings were located, that is, scarce municipal services (55% as the maximum degree of regulatory performance) and deficient electrical installations (48 % maximum in classrooms, laboratories and bathrooms).

Regarding possible environmental threats to the building (within a radius of less than 10 km), the following figures were found: 35% express roads, 23% truck stops (excessive movement of goods and people), 12% vandalism areas (markets and street vendors), 20% near clandestine garbage dumps and 10% near gas stations.

Likewise, the results obtained in terms of hydrosanitary conditions were worrying. In this sense, it is possible to point out the lack of drinking water in the students' drinking fountains (the few buildings that had them), as well as the lack of sanitary furniture to equip the bathrooms.

Figura 8. Estado de la INFE.



Fuente: Elaboración propia con fines didácticos

Based on the above, it can be emphasized in a general way that the INFE in which the students receive their classes does not comply with the established regulations.

Now, and to give continuity to the study carried out by Pacheco (2021) on the effectiveness and efficiency of the INFE in preschool education, in the following paragraphs a comparison is presented in the criteria indicated, although now including at the primary and secondary level of the same study area. Based on this purpose, the following question was formulated: is the number of available teachers sufficient to provide a quality education to the entire student population? For this, the analysis of the sample was carried out in comparison with the fulfillment of what was established by the SEP on the student-teacher indicator (see table 2 and figure 9).

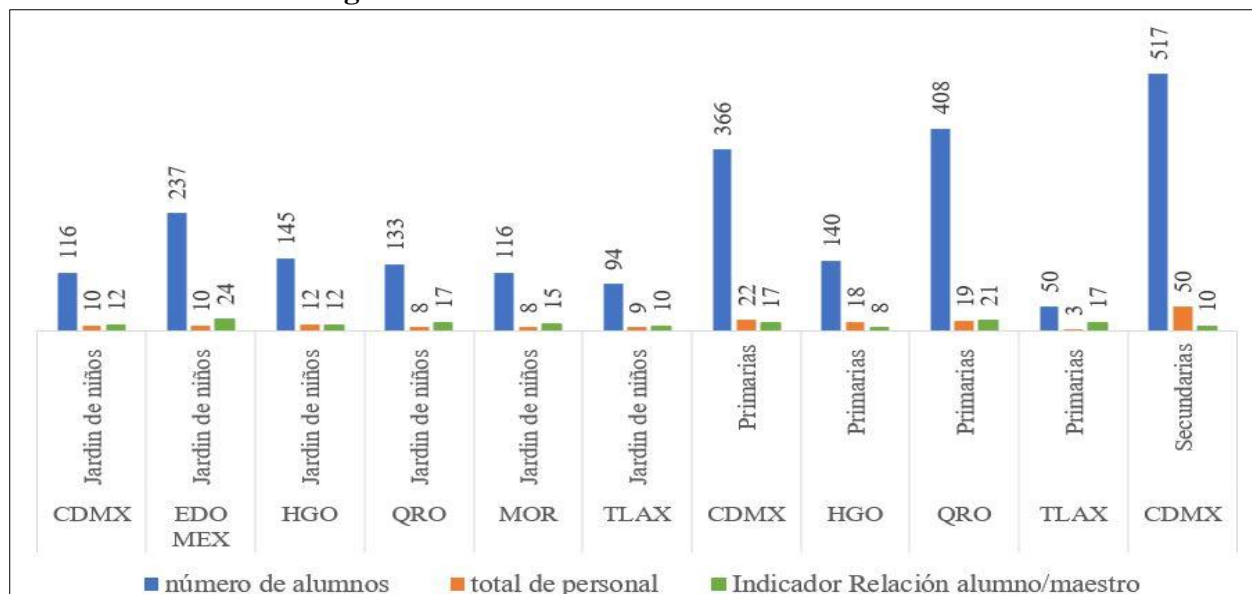
Tabla 2. Suficiencia de alumnos/profesores.

Procedimiento aplicado a nivel preescolar	Semejanzas	
	Primaria	Secundaria
Indicador de la SEP relación alumno/maestro, esto se puede calcular con la ecuación 1.	Se logró aplicar y obtener el valor de dicho indicador para estos dos niveles educativos	
Discrepancias		
Las diferencias se presentan en la figura 9. En ella se incluyó el nivel jardín de niños para resaltar las diferencias encontradas en los niveles evaluados. De los seis estados examinados, solo Hidalgo cumple el mínimo necesario tanto en jardín de niños como en primaria, seguido por la Ciudad de México en secundaria.		

Fuente: Elaboración propia con fines didácticos

$$Relación\ alumno/maestro = \frac{Matricula\ Total}{Total\ de\ profesores} \quad ecuación\ (1)$$

Figura 9. Relación número de alumnos/docentes.



Fuente: Elaboración propia con fines didácticos

This indicator helps us to understand the amount of human resources (teachers) available in each INFE evaluated, which could serve as a reference to evaluate said criterion at the national level. Specifically, it can be said that in the central area of Mexico City there are more students in the classrooms than teachers, which is more critical at the basic level (see figure 10). This, of course, affects the teaching-learning process since at this level more hours of attention and dedication to the student are necessary, which cannot be carried out due to the lack of teachers.

Figura 10. Primaria ubicada en la Ciudad de México, municipio de Magdalena Contreras. Se evidencia la demanda de alumnos, así como la carencia de docentes en los niveles básicos de educación.



Fuente: Nancy Pacheco (2019) tomada con fines didácticos

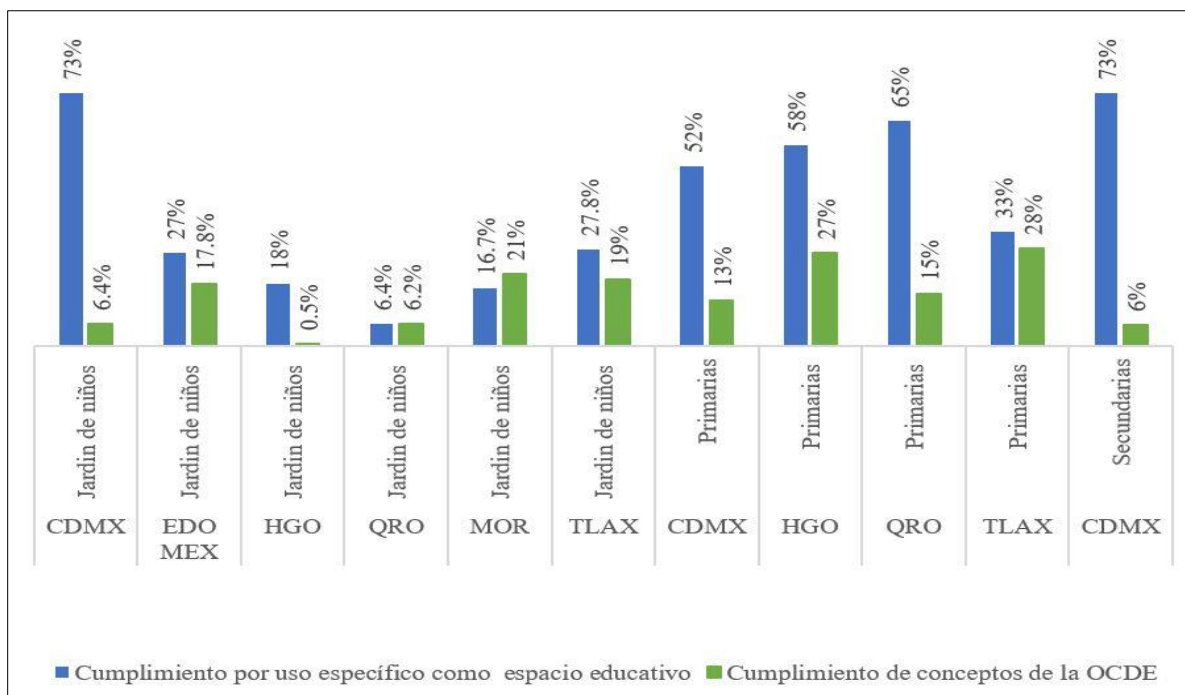
To answer the question, is the physical infrastructure of schools suitable for the age of its users? The analysis was carried out based on the requirements indicated by the OECD and on the information compiled by the applicable regulations, see (table 3 and figures 11 and 12).

Tabla 3. Condiciones de la INFE de acuerdo con la edad del educando.

Procedimiento aplicado a nivel preescolar	Semejanzas	
	Primaria	Secundaria
Evaluación del cumplimiento normativo del inmueble como espacio educativo, así como de la observancia de los conceptos señalados por la OCDE.	Se logró aplicar la metodología y obtener el porcentaje de cumplimiento para ambos niveles educativos.	
Discrepancias		
Las discrepancias se muestran en las figuras 11 y 12. En ellas se incluyó el nivel jardín de niños para resaltar las diferencias encontradas en los niveles evaluados. Véase que la Ciudad de México cumple con 73 % en cuanto a uso específico para espacio educativo tanto a nivel jardín de niños como a nivel secundaria, pero existen carencias de cumplimiento para el nivel de primaria. Se destaca que ningún estado evaluado cumplió el mínimo necesario de los conceptos solicitados por la OCDE.		

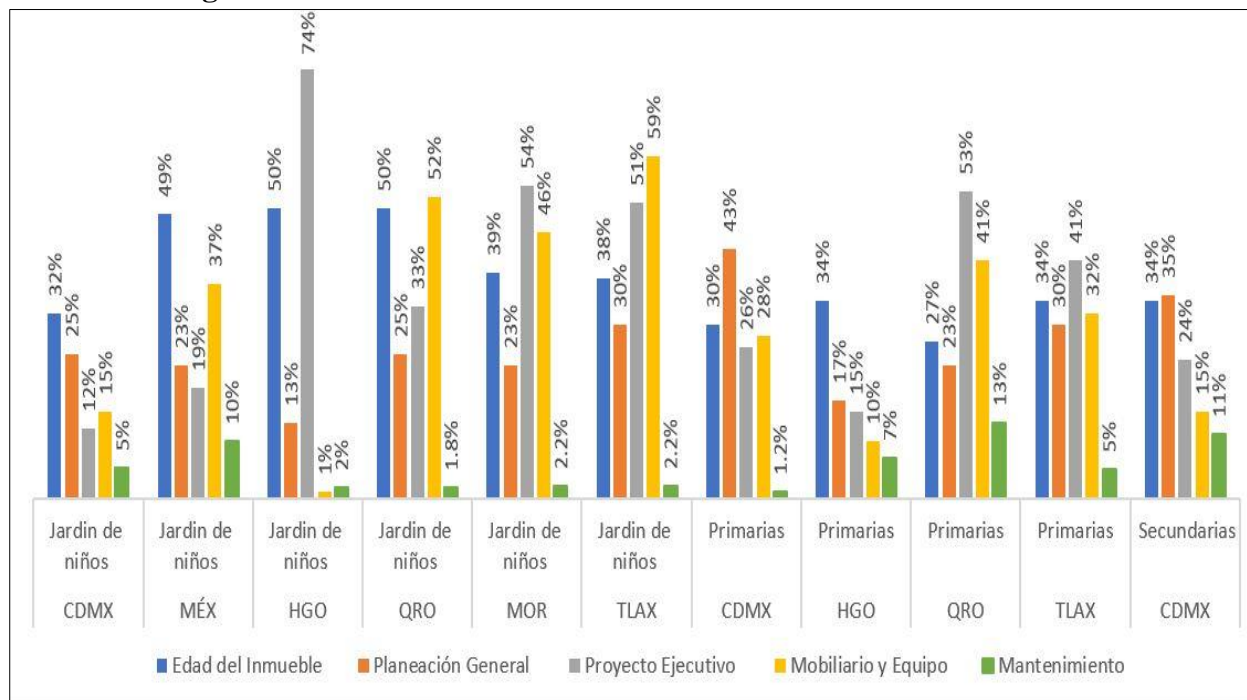
Fuente: Elaboración propia con fines didácticos

Figura 11. Porcentaje de cumplimiento de los conceptos de la OCDE, así como de uso escolar.



Fuente: Elaboración propia con fines didácticos

Figura 12. Resultado de las condiciones de los edificios de uso escolar.



Fuente: Elaboración propia con fines didácticos

The results show that none of the properties examined had a general planning, which directly affects student learning. In general, the state of Hidalgo presented the best levels in this area in kindergarten, followed by the state of Querétaro and Tlaxcala (both at the primary level). Regarding basic furniture, no campus reached 60% minimum compliance.

Figura 13. Estado actual del mobiliario de las escuelas evaluadas tanto a nivel primaria como secundaria en los estados de Hidalgo (c), Ciudad de México (d, e, f) y Tlaxcala (g, h).



Fuente: Nancy Pacheco (2018) tomada con fines didácticos

Figure 13 showed - in image (c) - backless chairs that can cause accidents and make it impossible to carry out activities properly; In the image (d) it can be seen that the chairs are larger than the students - out of the norm for the level and without maintenance (e) and (h) -. Also, without light in basic areas (such as workshops) and without adequate equipment for laboratories (g).

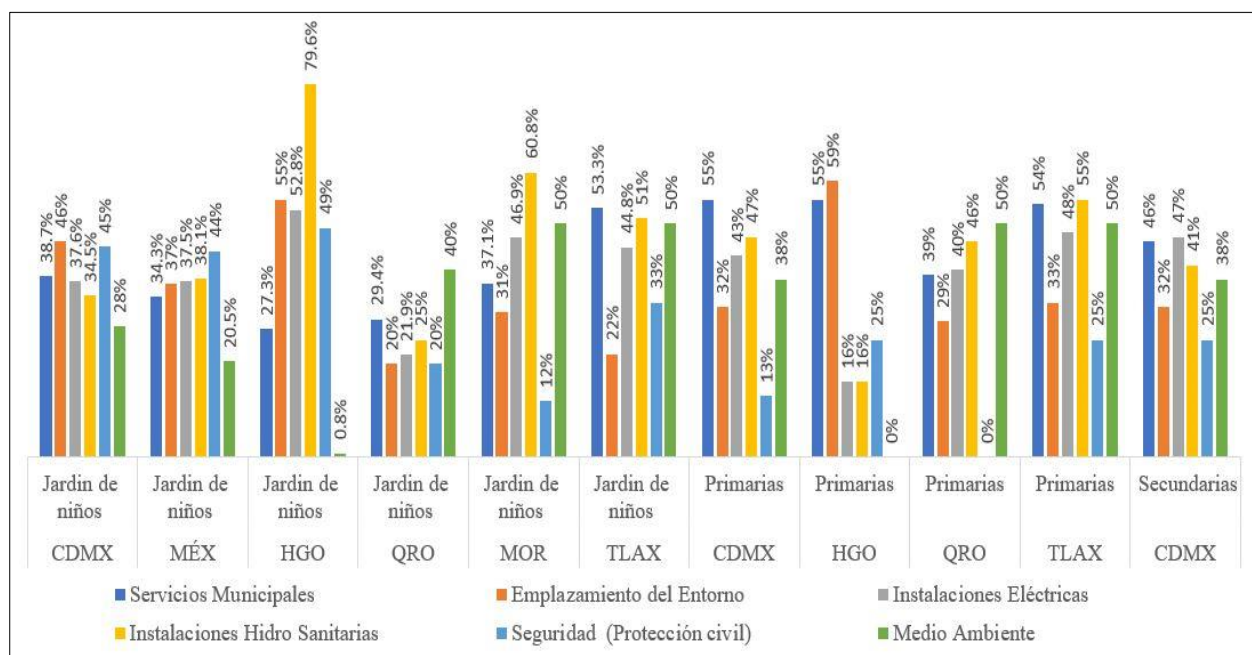
For the question, do the physical spaces used for academic activities meet the basic requirements to develop them effectively? The comparison of table 4 and figure 14 is presented.

Tabla 4. Estado real de la INFE

Procedimiento aplicado a nivel preescolar	Semejanzas	
	Primaria	Secundaria
Metodología aplicada para comprobar el estado real de la INFE evaluada.	Se logró aplicar la metodología y obtener el porcentaje de cumplimiento para ambos niveles educativos.	
Discrepancias		
Las diferencias se presentan en la figura 13, que quedaron sustentadas con la evidencia fotográfica de las figuras 13, 15, 16, y 17, las cuales revelaron el impacto negativo en el aprendizaje escolar de cerca de 2524 estudiantes de nivel preescolar, así como de 1481 tanto de primaria como de secundaria.		

Fuente: Elaboración propia con fines didácticos

Figura 14. Representación de la situación en las que se hallaron los planteles evaluados.



Fuente: Elaboración propia con fines didácticos

In general, it can be indicated that students who attend basic education face serious problems not only due to the deficiencies of the facilities in their schools, but also due to the deficiencies or even the lack of availability of the basic infrastructure services necessary for the operation. daily. It was also found that the amount of drinking water with which the schools are supplied is insufficient, coupled with the fact that the cisterns have not received the necessary minimum maintenance. In fact, the water tanks do not have lids, so, in some cases, they are filled

directly from the general faucet of the property, that is, without going through filters. All this negatively affects learning and generates absenteeism from both students and teachers.

Likewise, in terms of electrical installations, only 48% are covered at the primary level in the state of Tlaxcala and 47% at the secondary level in Mexico City. In summary, the classrooms do not have electricity due to intermittent failures in the zones, lack of adequate equipment, etc.

On the other hand, regarding sanitary facilities, 55% was obtained as the maximum value at the primary level. The main problems detected in this criterion were the lack of connection to the municipal network, the null maintenance of the network, the shortage or lack of bathroom furniture, the lack of maintenance of the drinking fountains, etc.

Regarding the environment of the buildings, unsafe and unhealthy areas were found due to factors such as the following: proximity to gas stations, markets, hotels, factories, high voltage lines, bus terminals, primary roads with constant traffic, etc. For this reason, it is essential that the agencies in charge of educational evaluation address these problems and guide schools so that they can offer better spaces for teaching.

Figure 15 shows that several of the educational establishments analyzed are residential houses with adapted areas. For example, image (i) shows the improvised electrical installations above the students' desks; Image (j) shows the area adapted without ventilation and without adequate light to carry out academic activities; Image (k) shows that the areas (classrooms) were expanded due to excess school demand, although without taking into account adequate regulatory compliance; Image (l) reflects that classes continue to be taught even when extensions of the areas are being carried out at the same time; the image (m) shows that many of the residential houses are operating as a school closing down areas of daily use, which is incorrect and unsafe for the performance of the students; Image (n) shows how they improvise and adapt the furniture for recreation areas; the image (ñ) shows the improvised roof, which is unsafe and outside the regulations; the image (o) shows the null maintenance; and the image (p) shows the lack of lighting in the basic areas where the classes are taught.

Figura 15. Condiciones de los espacios educativos para impartir clases tanto a nivel de educación primaria como secundaria. Imágenes (i), (l) y (m) de Hidalgo; imágenes (j), (ñ), (o) y (p) de la Ciudad de México; imágenes (k) y (n) de Tlaxcala.



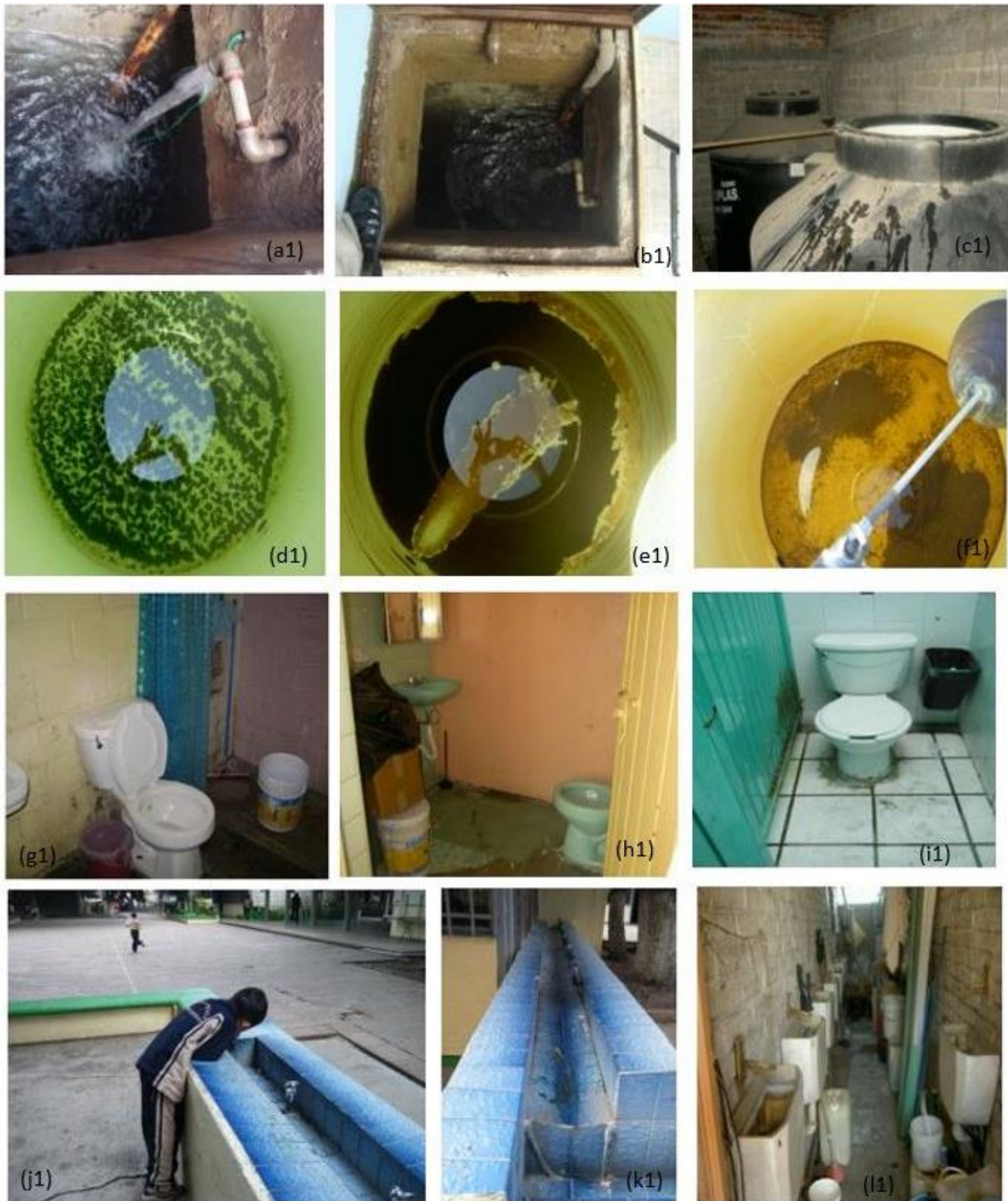
Fuente: Nancy Pacheco (2018) tomada con fines didácticos

Figura 16. Evidencia del estado físico de las INFE evaluadas en los niveles primaria y secundaria. Imágenes (q), (t), (u) de Hidalgo; imágenes (r), (w), (x), (y) de la Ciudad de México, y (s), (v) de Tlaxcala.



Fuente: Nancy Pacheco (2018) tomada con fines didácticos

Figura 17. Instalaciones hidrosanitarias en mal estado y ambiente carente de higiene tanto en educación primaria como en secundaria. Imágenes (a1), (d1), (e1), (g1) de Hidalgo; imágenes (b1), (h1), (l1) de la Ciudad de México; e imágenes (c1), (f1), (i1), (j1), (k1) de Tlaxcala.



Fuente: Nancy Pacheco (2018) tomada con fines didácticos

Figura 18. Carencia total del mantenimiento eléctrico en las instalaciones tanto en educación primaria como en secundaria. Imágenes (m1), (o1), (p1) de Hidalgo, imágenes (n1), (r1), (s1), (t1) de la Ciudad de México, e imágenes (ñ1), (q1) de Tlaxcala.



Fuente: Nancy Pacheco (2018) tomada con fines didácticos

Finally, the results obtained are presented with the following question: do the educational establishments have the adequate infrastructure conditions to operate safely in the midst of the current situation generated by the covid-19 pandemic? In this regard, it can be indicated (as

evidenced in figures 13, 15, 16 and 17) that the institutions do not have the minimum areas required to serve the entire student population. In fact, as demonstrated before, it has become clear that teachers must work with a large number of students. Likewise, regarding the lighting by areas (lux) and the ventilation required per classroom, it can be ensured that regulatory compliance is null (tables 5 and 6).

Tabla 5. Estado real de iluminación de aulas.

Niveles mínimos por cumplir de acuerdo a la normatividad			Cumplimiento de niveles de luxes obtenidos de las INFE evaluadas			
Tipo de edificación	Local	Nivel de luxes	Primaria		Secundaria	
			Local	Nivel de luxes	Local	Nivel de luxes
Atención a educación preescolar	Aulas	250	Aulas	200	Aulas	219
Educación formal básica y media	Aulas y laboratorios	300	Aulas y laboratorios	254	Aulas y laboratorios	260
	Circulaciones	100	Circulaciones	76	circulaciones	80
Ver detalle en las siguientes Normas Oficiales Mexicanas: NOM-001-SEDE-2018, “Instalaciones eléctricas (utilización)”; NOM-007-ENER-2014 “Eficiencia energética para sistemas de alumbrado en edificios no residenciales”; NOM-013-ENER-2013, “Eficiencia energética en sistemas de alumbrado para vialidades y exteriores de edificios”; NOM-025-STPS-2008, “Condiciones de iluminación en los centros de trabajo”.						

Fuente: Elaboración propia con fines didácticos

Tabla 6. Estado real de ventilación en las aulas.

Volúmenes mínimos de aire					
Niveles mínimos por cumplir de acuerdo a la normatividad		Cumplimiento de volúmenes mínimos de aire por aulas obtenidos de las INFE evaluadas			
Volúmenes disponibles por alumno (m ³)	Número de renovaciones por alumno y por hora	Primaria		Secundaria	
		Volúmenes disponibles por alumno (m ³)	Número de renovaciones por alumno y por hora	Volúmenes disponibles por alumno (m ³)	Número de renovaciones por alumno y por hora
3	9	2	7	2	6
5	5	3	3	2	4
7	4	5	3	5	3
9	3	6	2	7	2

La renovación del aire se podrá realizar de forma natural a través de los espacios abiertos en ventanas y/o de forma mecánica por medio de aparatos y accesorios destinados para tal fin. Dependiendo de la localización geográfica, se recomienda proporcionar una ventilación natural cruzada controlada, de por lo menos un tercio (1/3) del área de la ventana o un noveno (1/9) del área local. El porcentaje mínimo de ventilación será de 5 % del área del local.

Fuente: Elaboración propia con fines didácticos

Regarding furniture and equipment, as well as hydraulic and plumbing installations, figures 13, 15, 16 and 17 show the degree of non-compliance. The above shows us that if the basic regulations of the INFE were followed to address this current situation generated by covid-19, some basic measures issued by the World Health Organization could be met, such as an adequate distance (non-compliance by excess population demand), hygiene measures for hands and personnel (non-compliance due to water shortage and insufficient number of bathrooms, sinks and drinking fountains), protection and safety (maximum compliance level of 25% obtained), adequate ventilation and lighting (non-compliance for being located in areas of high insecurity, adjacent to garbage dumps, bus stops and ambulance). All this, as already mentioned, has had an impact and will continue to negatively influence the learning of schoolchildren at all educational levels.

Discussion

As seen in the volume and the date of the literature related to educational infrastructure, it can be said that an interest has arisen in the specific aspects of the INFE design, since it has been perceived that this variable affects the teaching practice and student learning. This statement, in fact, can be organized into a number of key themes described below.

Regarding environmental impacts, Temple (2007) and Higgins et al. (2005) refer to sources that describe the ways in which specific environmental conditions impact student learning, that is, noise, temperature, air quality, ventilation, and lighting (Earthman and Brown, 2004 ; Higgins et al., 2005; Keep, 2002; Lackney and Jacobs, 2004). In addition to this, it should be noted that there is much debate about the importance of specific elements such as color, aesthetics and ergonomic properties of furniture, since the increase in the comfort of teachers and students raises the levels of concentration and development in the tasks performed (Bateman, 2009).

Consistent with this idea, Bullard (2010) and Simont et al. (2007) explain that in various investigations the quality of school buildings is linked to child development at an educational level. This aspect can be divided into two assumptions:

1. The INFE is assigned a stimulating role: that is, it is argued that a more pleasant environment tends to generate feelings of well-being that predetermine both disciples and educators so that they have a better attitude towards teaching and learning .
2. Its use is attributed to the state of INFE since it operates directly facilitating the teaching-learning process (Young, 2003, citado por Campana *et al.*, 2014).

Likewise, Ponce de León and Alarcón (2014) point out that noise affects the psychological development of students, which has a negative effect on the learning process; while Coronel (2017) indicates that INFE has an essential role in stimulating students.

Regarding the functional level, studies such as those of Martínez et al. (2013), Muñoz and Guzmán (2010), Campana et al. (2014), Duarte et al. (2011, 2017) and Del Valle (2001) establish that the INFE impacts students' standardized test results.

Regarding the indirect influence at the motivational level, the works of Blackmore et al. (2011) and Del Valle (2001) show that infrastructure affects learning by encouraging involvement, as well as collaborative teaching work.

In summary, the different studies on INFE have shown that it is a fundamental element, and at the same time complex, for the learning of girls, boys and adolescents, which is why it should be studied in depth. In this sense, this research is highly relevant, since in no other have so many variables been addressed (eg, public services, facilities, basic areas, lighting, ventilation, student /

teacher relationship, etc.), the which were analyzed according to current regulations on educational buildings, and their impact on the current health situation generated by covid-19.

Conclusions

Based on the results obtained in this research, it is possible to detect with greater certainty the aspects that must be taken into consideration for the better functioning of schools and for a correct investment of the resources destined for this purpose, which, in addition, can serve for the prevention of accidents, affectations and desertion of students. In this regard, it should be noted that, in this study, in general, evidence was collected that shows that the manufacture of improvised educational spaces is common (eg, classrooms made with corrugated metal sheets or multipanel).

These types of deficiencies are more significant today due to the pandemic that is being experienced throughout the world, since in order to return to face-to-face classes it is essential that schools meet certain minimum requirements; for example, minimum ventilation required, adequate lighting, optimal dimensions of the classrooms to accommodate large groups of students, provision of potable water for hand washing and disinfection of spaces, etc. In short, the educational physical infrastructure must be in a position to comply with what is stipulated in the Political Constitution of the United States of Mexico and in the General Education Law, which establishes that the State must guarantee compulsory education and quality.

Finally, as future lines of research, it is important that this type of analysis be applied at other educational levels to enrich the data collected. That is, it can include populations from other states of the country and institutions of upper secondary and higher education of public and private centers.

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