

<https://doi.org/10.23913/ride.v11i22.940>

Artículos científicos

Evaluación del impacto de la infraestructura física educativa en la educación

Evaluation of the impact of the Physical Educational Infrastructure in education

Avaliação do impacto da infraestrutura física educacional na educação

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Resumen

Esta investigación tuvo como objetivo evaluar las condiciones y el estado actual de la infraestructura física educativa (INFE) y su efecto en la educación a nivel preescolar. Para ello, se concretó un estudio de caso en el que se incluyeron los jardines de niños públicos ubicados en la región central de la República mexicana. Las preguntas formuladas fueron las siguientes: ¿qué relación existe entre la INFE y la educación que en su interior se imparte?, ¿cuánto impacta el estado actual de la INFE en la eficacia de la educación? y ¿qué papel desempeña el cumplimiento normativo de la INFE en dicha relación e impacto en la educación? El estudio desarrollado fue de tipo mixto, ya que se utilizaron técnicas cuantitativas, cualitativas y de carácter multidisciplinario. Los instrumentos utilizados fueron la selección de la muestra representativa a través de un proceso aleatorio, la observación no participativa, el levantamiento físico de datos, el soporte fotográfico y el análisis de cumplimiento normativo con base en lo que señalan la Ley General de Educación (LGE, 2019), los reglamentos de construcciones de cada uno de los estados evaluados, las normas oficiales mexicanas de tipo obligatorio y de observancia voluntaria, así como los lineamientos de la Secretaría de Educación Pública (SEP, 1921), Manuales de Protección



Civil e informes de la Organización para la Organización para la Cooperación y el Desarrollo Económicos (OCDE, 1961). Los resultados indican que el estado físico y el emplazamiento de los centros educativos inciden directamente en el desempeño de los estudiantes, por lo que se debe gestionar la adecuada supervisión por parte de las autoridades y de los mismos usuarios (docentes, administrativos y personal), quienes deben identificar los riesgos y las condiciones en las que se prestan los servicios de educación a nivel de preescolar en México. Asimismo, se debe fomentar la mejora continua de la calidad de la INFE para consolidar el derecho a la educación de todos los niños y las niñas de este país.

Palabras clave: Infraestructura Física Educativa, impacto, nivel de enseñanza y plantel educativo.

Abstract

This research aimed to evaluate the conditions and current state of the educational physical infrastructure (INFE) and its effect on education at the preschool level. For this, a case study was carried out that included public kindergartens located in the central region of the Mexican Republic. The questions asked were the following: what is the relationship between INFE and the education that is taught within it? How much does the current state of INFE impact on the effectiveness of education? And what role does INFE regulatory compliance play in this relationship and impact on education? The study developed was of a mixed type, since quantitative, qualitative and multidisciplinary techniques were used. The instruments used were the selection of the representative sample through a random process, non-participatory observation, physical data collection, photographic support and analysis of regulatory compliance based on what the General Education Law (LGE, 2019), the construction regulations of each of the evaluated states, the official Mexican standards of mandatory and voluntary observance, as well as the guidelines of the Ministry of Public Education (SEP, 1921), Civil Protection Manuals and reports from the Organization for Economic Cooperation and Development (OECD, 1961). The results indicate that the physical condition and location of educational centers have a direct impact on student performance, so the adequate supervision by the authorities and the users themselves (teachers, administrators and staff), who must identify the risks and conditions in which education services are provided at the preschool level in Mexico. Likewise, the continuous

improvement of the quality of the INFE should be promoted to consolidate the right to education of all boys and girls in this country.

Keywords: Physical Educational Infrastructure, impact, teaching level and Educational Campus.

Resumo

Esta pesquisa teve como objetivo avaliar as condições e o estado atual da infraestrutura física educacional (INFE) e seus efeitos na educação em nível pré-escolar. Para isso, foi realizado um estudo de caso que incluiu creches públicas localizadas na região central da República Mexicana. As perguntas feitas foram as seguintes: qual a relação existente entre o INFE e a educação que é ministrada nele? Quanto o estado atual do INFE impacta na eficácia da educação? E que papel a conformidade regulatória do INFE desempenha nessa relação e impacto na educação? O estudo desenvolvido foi do tipo misto, uma vez que foram utilizadas técnicas quantitativas, qualitativas e multidisciplinares. Os instrumentos utilizados foram a seleção da amostra representativa por meio de processo aleatório, observação não participativa, coleta de dados físicos, suporte fotográfico e análise do cumprimento regulatório com base no que dispõe a Lei Geral de Educação (LGE, 2019), o regulamento de construção de cada um dos estados avaliados, as normas mexicanas oficiais de observância obrigatória e voluntária, bem como as diretrizes do Ministério da Educação Pública (SEP, 1921), Manuais de Proteção Civil e relatórios da Organização para a Organização para a Cooperação Econômica e Desenvolvimento (OCDE, 1961). Os resultados indicam que a condição física e a localização dos centros educacionais têm impacto direto no desempenho dos alunos, por isso a adequada supervisão por parte das autoridades e dos próprios usuários (professores, administradores e funcionários), quem deve identificar o riscos e condições em que os serviços de educação são prestados no nível pré-escolar no México. Da mesma forma, deve-se promover a melhoria contínua da qualidade do INFE para consolidar o direito à educação de todos os meninos e meninas deste país.

Palavras-chave: Infraestrutura Física Educacional, impacto, nível de ensino e estabelecimento educacional.

Fecha Recepción: Noviembre 2020

Fecha Aceptación: Mayo 2021

Introduction

The learning acquired at the preschool (or kindergarten) level has great significance for the human being, since it is the stage where the initial knowledge of formal education is acquired. In addition to this, at this educational level the toddler has their first contact with the space called "school", which must have the appropriate infrastructure to promote their physical and cognitive development. Therefore, this study has attempted to evaluate the state of certain educational establishments, as well as their location and their main problems (Ministry of Public Education (SEP, 2008).

According to a study carried out by the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2016), as well as data from the Second Regional Comparative and Explanatory Study (SERCE, 2008) it can be stated that the Physical conditions of schools have “an important effect on student performance and can contribute significantly to reducing the learning gap associated with social inequality” (p. 493). Likewise, a large part of the investigations carried out in recent years on school quality and efficiency have explored the relationship that exists between the physical conditions of schools and student learning.

Similarly, the National Institute for the Evaluation of Education (INEE, 2018) has presented evidence on how school infrastructure impacts student well-being and learning. However, in a study carried out by the Inter-American Development Bank cited by Duarte, Gargiulo and Moreno (2011) it is pointed out that the conditions of educational infrastructure in Latin American countries and access to basic services of electricity, water, sewerage and telephones in schools are highly deficient.

In the international context, Jadille (2016) shows the impact of the design of educational spaces on learning, while Campana, Velasco, Aguirre and Guerrero (2014) explain that the educational infrastructure is a transcendental element for the performance of schoolchildren, since it fulfills a motivational and functional role; that is, it produces a better attitude in students towards learning and facilitates the teaching process. Blincoc (2005), on the other hand, presents an investigation regarding the age and condition of Texas secondary schools and their influence on student performance. Bullock (2007), on the other hand, mentions the relationship between the physical conditions of schools and the performance of students at the middle school level in the state of Virginia.

Likewise, Boese and Shaw (2005) point out that the state of New York's school facilities has an impact on the health and performance of schoolchildren, hence they advocate for healthy schools for students. Picus, Marion, Calvo, and Glenn (2005) teach the link between student achievement and the quality of educational facilities. Higgins, Hall, Wall, Woolner and McCaughey (2005) refer to the campaigns of those involved in the leadership, design, planning, resourcing and management of British schools, while Branham (2004) states that the quality of school infrastructure has a significant effect on school attendance and dropout rates.

Due to all of the above, the information presented in this article on the conditions in which educational establishments are found at the preschool level, specifically in the central region of the Mexican Republic, is relevant. For this, issues related to the number of students and teachers in the classrooms, furniture and equipment, maintenance, municipal services, facilities (electrical and hydro-sanitary), the environment and security, among others.

In this sense, the questions asked were the following:

- What is the relationship between INFE and the education that is imparted within it?
- How much does the current state of INFE impact the effectiveness of education?
- What role does INFE regulatory compliance play in this relationship and impact on education?

Methodological framework

The present investigation was mixed, since both quantitative and qualitative techniques were used with a multidisciplinary support. The quantitative approach was used when making the representation of a concrete and specific reality known, while the qualitative paradigm was used when collecting information based on observation (photographic support). Likewise, it was a multidisciplinary investigation because to carry out the analysis of regulatory compliance, knowledge of civil engineering, analysis of architectural spaces, structural safety and basic principles of law were used.

Data

Population: Located in the central region of the Mexican Republic.

Sample: The study was carried out in 18 preschool educational institutions located in Mexico City (CDMX), the state of Mexico (EDO MÉX), Hidalgo (HGO), Querétaro (QRO), Morelos (MOR) and Tlaxcala (TLAX).



Glossary of terms and / or abbreviations

DOF: Official Gazette of the Federation.

CCT: (Work Center Code): It is the entry key to the catalog of work centers (schools) authorized by the SEP; In addition, it is the element of relationship with all the systems of the SEP or the educational authorities in the states.

Federal entity or state: Territorially delimited unit that together with other entities make up a nation.

INEE: National Institute for the Evaluation of Education. Its main task is to evaluate the quality, performance and results of the national educational system (SEN) in basic and upper secondary education, in accordance with article 3 of the Political Constitution of the United Mexican States (CPEUM, 1917).

Institute or INIFED: National Institute of Educational Physical Infrastructure. It issues standards and technical specifications, participates in the development of Mexican standards, and prepares operational guides for the administration of resources for educational infrastructure.

INFE or Physical Educational Infrastructure: Furniture and real estate destined for education imparted by the State and individuals, with authorization or with recognition of official validity of studies, within the framework of the national educational system, in terms of the General Education Law (DOF, 2019b), as well as the services and facilities necessary for its correct operation.

NOM: Official Mexican Standard of mandatory use.

NMX: Regulations of voluntary observance; however, if they are mentioned as part of a NOM, their observance becomes mandatory.

Campus: Educational center where students are taught.

SEN: National Educational System. It is the organized set of educational services and actions regulated by the State that enable the exercise of the right to education.

SEP: Secretariat of Public Education. It is one of the State secretariats in charge of the administration, regulation and promotion of education. Its function is to design, execute and coordinate public policies on education in Mexico.

Next, table 1 shows the CCT (work center code) of the evaluated schools.

Tabla 1. CCT analizados

Entidad federativa	CDMX	EDO MÉX	HGO	QRO	MOR	TLAX
CCT	09DJN04 XX	9DJN014X X	13DJN0983 XX	22DJN012 XX	17DJN042 XX	29EJN007 XX
	09DJN02 XX	15EJN325 XX	09DJN0747 XX	22DJN025 XX	17DJN006 XX	29EJN001 XX
	09DJN01 XX	15EJN417 XX	09DJN052X X	22PJN006 XX	17DJN064 XX	29DJN007 XX

CCT: Clave de centro de trabajo: Es la llave de entrada al catálogo de centros de trabajo (escuelas) autorizados por la Secretaría de Educación Pública (SEP).
Entidad federativa o Estado: Unidad delimitada territorialmente que en unión de otras entidades conforman a una nación.

Fuente: Elaboración propia

Process

This study was structured in two stages, which are explained below:

Stage I

In this we proceeded to the physical survey of the information by states. This was done based on a quantitative checklist, which served to guide the field observation carried out in each of the educational establishments. This list was made up of the following appendices:

- Appendix A (normative), technical information card (CIT)
- Appendix B (informative), guide for filling out the technical information card,
- Appendix C (normative), technical certificate of the National Center for Disaster Prevention (CENAPRED)
- Appendix D (normative), technical certificate of the Local Institute of Physical Educational Infrastructure of the Federal District (ILIFEDF), all of the Mexican Standard NMX-R-084-SCFI-2015: Schools - data collection for the diagnosis of infrastructure educational physics— guidelines and requirements.

Likewise, a questionnaire formulated based on Annex 1 - Technical Information Format for the Evaluation for the Quality Certification of the INFE (2019) of the Institute of Physical Educational Infrastructure (INIFED, 2019) was carried out, which includes the aspects to be evaluated during the visit, such as INFE essential (it has minimum premises for curricular activities and basic facilities), INFE functional (covers with the aspects of the essential type and equipment according to pedagogical and technological advances) and INFE sustainable (meets functional aspects and incorporates environmental conservation programs), as well as type of educational spaces, safety equipment and risk analysis.

Stage II

In this stage, the process of evaluating the quality of the evaluated INFE is described:

1. The guidelines for the formulation of indicators of the SEP (2019) were used.
2. General Law of Educational Physical Infrastructure (LGINFE, 2008).
3. Each aspect of the educational centers was analyzed using the following regulations:
 - NMX-R-083-SCFI-2019. Schools —design and manufacture of furniture for the physical educational infrastructure— criteria and requirements. Mexican Standard (2019).
 - NMX-R-090-SCFI-2016. Schools —elements for accessibility to the spaces of the educational physical infrastructure— requirements. Mexican Standard (2016).
 - NMX-R-084-SCFI-2015 Schools - data collection for the diagnosis of the educational physical infrastructure - guidelines and requirements. Mexican Standard (2015a).
 - NMX-R-024-SCFI-2015. Schools - supervision of work of the educational physical infrastructure - requirements. Mexican Standard (2015b).
 - NMX-R-079-SCFI-2015 Schools —structural security of the educational physical infrastructure— requirements. Mexican Standard (2015c).
 - NMX-R-080-SCFI-2015 Schools - drinking water fountains - requirements. Mexican Standard (2015d).
 - NMX-R-021-SCFI-2013 Schools —quality of the educational physical infrastructure— requirements. Mexican Standard (2013).

- NMX-R-003-SCFI-2011. Schools — selection of land for construction — requirements (cancels NMX-R-003-SCFI-2004). Mexican Standard (2011).
4. Regarding the basic and necessary sufficiency to teach classes, it was analyzed that the schools comply with the concepts of the Organization for Economic Cooperation and Development (OECD), which are the following:
 - Community use: i) Accessibility to the community to use the facilities during or after school hours.
 - Sustainable environment: i) Site planning: The space demonstrates sustainable environment site planning. ii) Sustainable systems: Demonstrates effective and efficient use of water, energy, recycling, garbage disposal, natural light. iii) The space demonstrates the use of construction methods, construction materials.
 - Social participation: i) Maintenance: Evidence of the constant participation of the educational community in preventive maintenance that does not require specialized labor of the buildings, facilities and equipment of the educational establishments.
 5. The information was supported through photographic reports.
 6. Construction and Civil Protection regulations were consulted for each evaluated state.

For the analysis of evidence of impairment on learning, some of the following factors were considered (Table 2):

Tabla 2. Factores que impactan en el aprendizaje

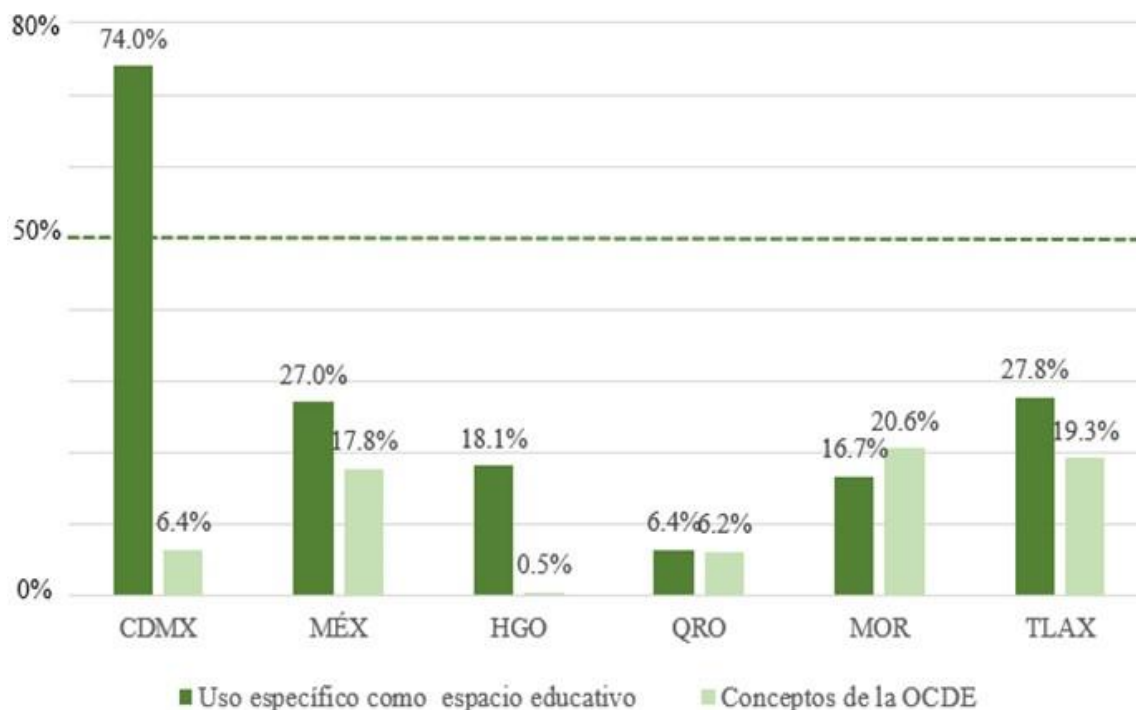
Factor	Variables consideradas
Pedagógicos	Número de alumnos por maestro. Métodos y materiales didácticos utilizados. Tiempo dedicado por los profesores a la preparación de sus clases. Mobiliario y equipo. Condiciones del inmueble. Edad del inmueble. Mantenimiento de las instalaciones. Instalaciones. Servicios municipales.
Psicológicos	Trastornos o desórdenes de interiorización. Sobre control o ansiedad/retraimiento. Conductas como ansiedad, timidez, retraimiento y depresión de la percepción. Memoria y conceptualización que dificultan el aprendizaje.
Factor	Variables consideradas
Sociológicos	Características familiares y socioeconómicas de los estudiantes. Nivel de escolaridad. Calidad del medio ambiente que rodea al estudiante. Seguridad (protección civil).
Fisiológicos	Hormonales Problemas de salud (deficiencias en los órganos de los sentidos) Desnutrición y problemas de peso y salud.

Fuente: Elaboración propia con base en Durón y Oropeza (1999), Jenkins y Oatley (1998) y Mahoney (1997)

Results

Based on the data obtained in stages I and II of the study, Figure 1 shows that Mexico City is the only entity in which, on average, 74% of the specific use of the property is met as an educational building, although only with 6.4% according to the concepts of the OECD, which refer to the basic and necessary sufficiency of the property to be able to teach classes. That is, no property evaluated in the other entities achieved compliance and only in the state of Morelos was the highest value obtained with 20.6%. It should be noted that the LGE establishes (in its article 99) that furniture and real estate must meet the requirements of "quality, safety, functionality, timeliness, equity, sustainability, resilience, relevance, integrity, accessibility, inclusiveness and hygiene." For this reason, for its evaluation in this area, three priority dimensions were defined, which each school must fulfill as an essential part of the right to education: basic services on campus, sufficient and accessible school spaces, and basic safety and hygiene conditions. However, as can be seen in figure 1, its compliance was null and no plant evaluated in this rubric reached the average mean.

Figura 1. Porcentaje de cumplimiento normativo del inmueble como espacio educativo según los conceptos que señala la OCDE



Fuente: Elaboración propia

Table 3 reveals the data obtained in percentages of the schools evaluated by states.

Tabla 3. Evaluación de la INFE

Entidad	Edad del inmueble (años)	Planeación general	Proyecto ejecutivo	Mobiliario y equipo	Mantenimiento
CDMX	45	25.6	12.8	15.5	5.11
EDO MÉX	48	23.0	19.4	37.5	10.4
HGO	44	10.1	8.6	1.73	1.6
QRO	50	14.1	19.4	18.8	1.2
MOR	45	23.8	54.1	46.0	2.2
TLAX	43	31.0	51.7	59.8	2.2

Fuente: Elaboración propia

The table above shows that the school infrastructure lacks compliance in specific basic areas, which are detailed below:

The general planning of school buildings, which must take into consideration, among other aspects, school demand, installed capacity, area of influence, consolidation, the new building, repair, the modality of the different educational levels and the selection of terrain. This has a significant impact on the education of students, since they do not have an INFE initially planned for this purpose.

As for the executive project of the schools, this must be the representation or graphic expression of the solution to the requirements provided by the area in charge of the educational planning of the SEP and, where appropriate, it will consist of the following plans: plant of the whole o master plan, general plans of the buildings, facades and general cuts, modification plans and of all the facilities. However, the results indicate that only the states of Morelos and Tlaxcala reached 54.1% and 51.6% of regulatory compliance, respectively, which led us to ask ourselves the following question: was the campus originally designed for this purpose or was it adapted? since none presented any evidence about their planning, design, etc. In addition to this, there were some cases where various interventions were made to the facilities without having any project or record of it.

This has an impact on student learning because they spend many hours in a place that does not have the basic conditions for this purpose. In support of the aforementioned, figures 2 and 3 are shown.

Figura 2. Evidencia de construcciones con diseño habitacional que funcionan como planteles educativos (jardín de niños)



Fuente: Fotografía de Nancy Pacheco. (a) Estado de Tlaxcala de Xicoténcatl (2018), (b) Estado de Querétaro, municipio Arroyo Seco (2018) y (c) Ciudad de México, municipio Miguel Hidalgo (2018).

Figura 3. Evidencia de construcciones de espacios exteriores inadecuados para operar como escuelas, con cuartos construidos como anexos y fuera de la norma, así como inadecuada planeación de las aulas y de acceso a ellas



Fuente: Fotografía de Nancy Pacheco. (d) Estado de Hidalgo Pachuca del Soto (2019), (e) Estado de Morelos, municipio de Cuautla (2019) y (f) Estado de México, municipio de Valle de Cahalco (2019)

Likewise, with regard to furniture and equipment as a didactic means for the teaching-learning process, this requires particular characteristics determined by the educational level, the use (quality, materials, durability, etc.), the pedagogical and ergonomic requirements, as well as by the type and characteristics of the furnished space, since it is considered that the

school furniture will be used by hundreds of students over a long period. For this reason, their quality must be sought so that they have an adequate duration and are safe. Likewise, in the evaluation it was considered that the furniture should be chosen according to the age of the students, the size of the classrooms and the number of students, since it is important that the children are in an environment adapted to their body measurements (ergometry and disabilities) (figure 4).

Figura 4. Mobiliario fuera de la norma para el nivel escolar, con material frágil, nulo mantenimiento y cantidad de mobiliario inadecuado



Fuente: Fotografía de Nancy Pacheco. (g) Estado de Hidalgo, municipio de Atapexco (2019), (h) Ciudad de México, municipio de Xochimilco (2019), (i) Estado de México, municipio de Ecatepec (2019)

From the results obtained, it is highlighted that of the 18 schools evaluated, only the state of Tlaxcala presented the highest value, with 59.8% degree of regulatory compliance. In fact, the main problems in this area were the following: inadequate furniture for the educational level, low-quality and insufficient furniture required and not suitable for people with different abilities, which hinders the optimal development of the teaching work.

Regarding maintenance, the results showed that no campus complied with regulations and that the highest values were achieved, on average, in the State of Mexico and in Mexico City with 10.4% and 5.11%, respectively. These figures are worrying because the maintenance of the facilities and the materials used is essential to avoid accidents (figure 5).

Figura 5. Áreas de casas adaptadas para funcionar como espacios educativos, carentes de cumplimiento normativo en iluminación, ventilación, mobiliario y áreas comunes para impartir clases a nivel de educación preescolar



Fuente: Fotografía de Nancy Pacheco. (j) Estado de Querétaro, municipio de Tolimán (2018), (k) Estado de Morelos, municipio de Yautepec (2019), (l) Estado de Tlaxcala, municipio Zacatelco (2019), (m) Estado de Hidalgo, Tolcayuca (2018).

As initially noted, the INFE was analyzed taking into account some factors that may affect the normal development of the teaching-learning process, which are shown in Table 4.

Tabla 4. Estado de la INFE

Entidad	Servicios municipales	Situación del entorno	Insta. eléctricas	Insta. hidrosanitarias	Edad del inmueble (años)	Seguridad (protección civil)	Medio ambiente
CDMX	38.7	46.5	37.6	34.5	40	45.0	28.0
EDO MÉX	34.3	34.7	37.5	38.1	37	44.1	20.5
HGO	27.3	55.1	52.8	79.6	41	49.7	0.81
QRO	29.4	20.2	21.9	25.0	50	20.1	40.5
MOR	37.1	31.9	46.9	60.8	39	12.5	50.1
TLAX	53.3	22.2	44.8	51.3	38	33.3	50.0

Fuente: Elaboración propia

The values show a worrying reality, since a maximum compliance value was observed on average of 53.3% only in the state of Tlaxcala regarding the basic municipal services with which a school needs to operate. This reality affects school processes directly and violates human rights due to the precarious conditions in which students receive their education.

Likewise, regarding the result of the situation of the environment (geographical environment) where the evaluated buildings are located, only the state of Hidalgo presents on average a maximum value of 55.1% compliance. In this regard, it is worth underlining that this environmental factor is of vital importance for the development of the education of the students, since in the surroundings of the schools evidence of risk or contamination areas was found (eg, gas stations, markets, garbage dumps, high voltage lines, rapid primary roads and bus terminals within a kilometer) (figure 6).

Figura 6. Planteles educativos que colindan en sus espacios exteriores con vías primarias sin protección ni señalización alguna (para los menores que transitan diariamente), así como con basureros a cielo abierto perjudiciales para la salud (transmisión de enfermedades infecciosas)



Fuente: Fotografía de Nancy Pacheco. (n) Estado de Tlaxcala, municipio de Apizaco (2019), (ñ) Estado de Hidalgo, municipio de Chilcuautla (2019)

It was also verified, regarding safety and the environment, that in the evaluated schools the highest value was presented on average by the state of Tlaxcala with 50% (environment), while in security it was the state of Hidalgo with 49.7 %. In summary, it can be said that the schools showed failures in terms of railings, dimensions of stairs and ramps, as well as problems in walls, ceilings and floors due to humidity, cracks, among others. In fact, most schools have never fumigated and 11.5% of them have never carried out deep maintenance (figure 7). Likewise, regarding the conditions of both electrical and plumbing facilities, only the state of Hidalgo presents the highest values with 52.8% and 79.6%, respectively.

Figura 7. Áreas interiores de las casas adaptadas como planteles educativos que colindan con otras casas usadas como bodegas, cocinas, etc.



Fuente: Fotografía de Nancy Pacheco. (o) Estado de México, municipio de Atizapán Zaragoza (2019), (p) Ciudad de México, municipio Azcapotzalco (2019), (q) Estado de Hidalgo, municipio de Lerma y (r) Estado de Querétaro, municipio de Huimilpan

In summary, it can be ensured that the evaluated schools present many deficiencies in terms of infrastructure, furniture and security in general (Figures 8 and 9).

Figura 8. Instalaciones hidrosanitarias en mal estado y ambiente carente de higiene



Fuente: Fotografía de Nancy Pacheco. (s) Estado de Querétaro, municipio de Tolimán (2019), (t) Ciudad de México, municipio Azcapotzalco (2019), (u) Estado de México, municipio de Coacalco de Berriozábal

Figura 9. Nulo mantenimiento eléctrico en las instalaciones



Fuente: Fotografía de Nancy Pacheco. (v) Estado de Querétaro, municipio de Huilmán (2019), (w) Ciudad de México, municipio Tláhuac (2019), (x) Estado de México, municipio de Acolman, (y) Estado de Tlaxcala municipio de Ixtenco

Discussion

Regarding the first silver question in this work (what relationship exists between the INFE and the education that is imparted within it?), In the case of the preschool level, it can be indicated the correct spatial distribution provides a better organization of the materials, as well as a physical environment rich in stimuli and possibilities for action. Likewise, the relationship between the number of students and teachers is very important at this level, since schoolchildren demand more attention and care. In this regard, it is worth mentioning that to obtain the relationship between students and teachers, the formulation of SEP indicators was used, that is, that attention is the result of dividing the total enrollment at the beginning of courses by the total number of teachers compared to the group. This can be calculated with equation 1.

$$\textit{Relación alumno/maestro} = \frac{\textit{Matricula total}}{\textit{Total de profesores existentes}} \dots\dots\dots\textit{ecuación (1)}$$

Table 5 shows the results of the values of the student / teacher ratio indicator in the central zone of the Mexican Republic.

Tabla 5. Indicador de relación alumno/maestro

Entidad federativa	CCT	Alumnos	Maestro	Indicador relación alumno/maestro
CDMX	09DJN04XX	173	12	17
	09DJN02XX	80	9	11
	09DJN01XX	96	8	16
EDO MEX	9DJN014XX	164	6	27
	15EJN32XX	436	18	27
	15EJN41XX	109	5	36
HGO	13DJN09XX	173	14	14
	09DJN07XX	80	8	10
	09DJN05XX	183	13	14
QRO	22DJN01XX	173	10	22
	22DJN02XX	48	3	16
	22PJN006XX	179	12	15
MOR	17DJN042XX	95	7	19
	17DJN006XX	181	12	18
	17DJN064XX	72	4	36
TLAX	29EJN007XX	40	5	13
	29EJN001XX	113	12	11
	29DJN007XX	129	9	18

NOTA: * Del total del personal que atiende a los alumnos, no se especifica cuántos son docentes, administrativos o personal de limpieza, ni cuántos están por horas ni quiénes permanentemente. Por ello, el valor del indicador se realizó considerando que el total del personal es docente menos dos personas: una administrativa y otra de limpieza.

CCT: (clave de centro de trabajo): Es la llave de entrada al catálogo de centros de trabajo (escuelas) autorizados por la SEP, así como el elemento de relación con todos los sistemas de la SEP o de las autoridades educativas en los estados.

Entidad federativa o Estado: Unidad delimitada territorialmente que en unión de otras entidades conforman a una nación.

Fuente: Elaboración propia

In the above figures, there is a marked difference between the number of students and teachers. In fact, the highest magnitudes of the indicator were registered in the State of Mexico and in the state of Morelos. Likewise, the results of the statistical analysis showed

that in the case of Mexico City there has been a need to improve and privilege an adequate relationship between the number of students per teacher, which has been reflected over the last decades, according to the censuses developed between 1970 and 2017 by the National Institute of Statistics and Geography (Inegi) (2013). In other words, this ratio at the preschool level dropped from 38 to 21 students per teacher in a period of 47 years (Table 6).

Tabla 6. Relación alumnos-maestros (2018-2019)

Entidad	Preescolar	Primaria
	Núm. alumnos/maestro	Núm. alumnos/maestros
Ciudad de México	20	26
Estado de México	22	27
Hidalgo	19	21
Morelos	21	25
Tlaxcala	22	25

Fuente: Elaboración propia con datos del INEGI (2013)

From the results presented, it is understandable that having small groups is favored, since in the sections with more students, more time is usually spent in maintaining discipline than in the development of teaching and learning activities. Likewise, other variables should be highlighted, such as teacher preparation, student behavior in the group (according to educational level) and the presence of support personnel (interns, prefects, assistants, etc.) for parallel assignments.

Likewise, an aspect that is interesting to assess in the context of this indicator is that of the physical infrastructure of school facilities and its use as educational property because it constitutes an element that can condition the educational objectives set. For this reason, it is essential that the educational physical infrastructure (INFE) complies with certain basic regulations, although the findings obtained in this work contradict this principle (see Figures 1, 2 and 3).

On the other hand, and regarding the second question asked (how much does the current state of INFE impact on the effectiveness of education?), The results shown in tables 2 and 3, as well as in figures 4, 5, 6, 7, 8 and 9 reveal the negative impact that these conditions

could be generating in the 2,524 students who were studying in the institutions of the six states of the central region of the Mexican Republic that made up the corpus of this research. The above contradicts some of the basic principles of the teaching-learning process, which are described below:

1. *Impact that falls on the teacher and student*

- a) Given that the INFE has a motivational effect on the learning process, by having a suitable and pleasant environment, students and teachers perform better.
- b) The teacher must ensure that the student learns in circumstances that bring him closer to her reality, within the framework of her own culture. For this reason, it is essential to inform the authorities of the conditions in which the INFE is found to ensure the integrity and health of the students, teachers and the people who work in it.
- c) The absence of teachers (or not having the minimum number of them) translates into delays in learning and lower academic performance.

2. *Manifestation of oral language*

- a) Stress, exhaustion and voice and vision pathologies are some of the problems that teachers suffer more frequently as a result of noise, poor lighting and inadequate ventilation of the INFE, which directly affects the learning of the students.
- b) Noise harms students' school performance because it hinders their attention and learning processes.
- c) Emotional stability can be affected by the insecurity of the surroundings, the environment, the furniture used and the facilities in general.

3. *Listen and express yourself*

- a) The unsafe environment can affect the creativity of the student, as well as their means of artistic and cultural expression.

4. *Mathematical thinking*

- a) Development processes and lived experiences can be affected by an unhealthy and insecure environment.
- b) Out-of-standard furniture, equipment and facilities may affect the development of activities where objects of various sizes must be recognized.

c) Their judgments can be genuinely quantitative and expressed in various ways in everyday situations, although diminished by the resources they have (unsanitary facilities, lack of furniture, etc.).

5. *Conservation of the environment*

a) The lack of water and electricity, as well as unhealthy and out-of-standard buildings, can harm the students' conception regarding the care of plants and animals in their environment.

b) A harmful and unsafe environment can instill the unfavorable effects of human action on the environment.

6. *Communicates the sensations and feelings produced by the sounds of his environment and what he hears*

a) Being surrounded by dual-use spaces (warehouses, kitchens, gas stations, etc.), the student can get used to an environment that is not related to a space designed for teaching and learning.

Finally, to answer the third question posed (what role does INFE regulatory compliance play in said relationship of impact on education?), It was shown that the nexus between INFE and education transcends its walls, since it also implies all its structure, which influences student performance. In this regard, regulations are of vital importance to order coexistence and guide the behaviors of all individuals. Table 7 shows the degree of regulatory compliance obtained from this study and how this affects the learning of the students.

Tabla 7. Marco normativo de la INFE

Documento	Artículos o numerales	Cumplimiento
Constitución Política de los Estados Unidos Mexicanos.	Artículo 3, párrafo 3	El derecho se ve mermado, ya que las evidencias encontradas demuestran falta de responsabilidad del Estado.
Ley General de Educación	Artículo 1 y 2	Se comprobó carencia de su cumplimiento, lo cual repercute en el aprendizaje de los estudiantes. En la norma se establece que se debe

		“recibir educación de calidad en condiciones de equidad”.
Ley General de la Infraestructura Física Educativa	Del Artículo 1 al 33	Falta de lineamientos generales de construcción, equipamiento, mantenimiento, rehabilitación, reforzamiento, reconstrucción y habilitación de inmuebles e instalaciones destinados al servicio del sistema educativo nacional.
Reglamentos de construcción por estados	<p>Artículo 69 (CDMX). Artículos 87, 332, 334, 613 (Tlaxcala). Artículo 196 (Puebla). Artículo 274 (Querétaro). Artículo 166 (Morelos) Artículo 88 (Estado de Morelos).</p>	<p>La superficie del terreno deberá estar en relación con el número de alumnos para el que esté destinado el edificio. No pueden ser menos de 5 metros cuadrados por alumno (escaso cumplimiento).</p> <p>Las escuelas públicas o privadas y cualquier otra edificación destinada a la enseñanza deberán contar con el visto bueno de seguridad y operación de un director responsable de obra, lo cual nunca se demostró con evidencia.</p> <p>Falta de local de enfermería y/o consultorio médico. Cada escuela debe contar con un local adecuado para enfermería y equipo de emergencia, así como de rampas en todo desnivel y pasamanos de apoyo en escaleras para alumnos con discapacidad (nula evidencia de ello).</p> <p>Las áreas exteriores de juegos en escuelas de nivel inicial se situarán próximas a sus aulas e incorporarán fosos de arena y zonas pavimentadas (insuficiencia de cumplimiento para casas adaptadas).</p> <p>Equipo de áreas de juego: Columpios, toboganes, carruseles, balancines (equipos basculantes), revestimiento de las superficies de</p>

		<p>áreas de juego absorbentes de impacto (nulo cumplimiento).</p> <p>Los espacios deben ser los adecuados según los requerimientos pedagógicos y ofrecer el máximo de posibilidades de adaptación y flexibilidad al uso del mobiliario, equipo y material educativo necesarios para su desarrollo (nulo cumplimiento).</p>
Programas de protección civil		Se debe contar con un plan de protección civil, alarma sísmica de prevención, cantidad de extintores existentes, cantidad de botiquines de primeros auxilios existentes (con suministros vigentes), señalamientos de prevención, señalamientos de rutas de evacuación, señalamientos de puntos de reunión (insuficiente desempeño).
Documento	Artículos o numerales	Cumplimiento
Normas NOM y NMX	Artículos 220-86 (instalaciones eléctricas).	Accesibilidad. Tanto en zona rural como en zona urbana, el acceso principal al predio y a la escuela debe realizarse a través de vialidades terciarias. De no ser posible, se permite el acceso por vialidades secundarias. Se recomienda una sección mínima de 8 metros de la vía de acceso (evidencia escasa).
		Ubicación: Se encontraron planteles ubicados a una distancia igual o menor a 500 metros del lindero más cercano a los depósitos de basura; otros ubicados a una distancia igual o menor a 50 metros de las estaciones de servicio (gasolineras o gaseras), al igual que los ubicados

		<p>a menos de 50 metros de las líneas de electrificación de alta tensión (nulo desempeño).</p> <p>Servicios públicos: Se debe contar con red municipal de agua potable, red de drenaje sanitario, red de energía eléctrica, servicio de recolección de basura, servicio de transporte público (observancia insuficiente).</p> <p>Instalaciones eléctricas: Se permite hacer el cálculo de la carga de un alimentador o una acometida para escuelas (insuficiente cumplimiento).</p> <p>Servicios sanitarios: Deben tener módulos independientes para alumnas, alumnos, profesores, profesoras y discapacitados (nulo cumplimiento para casas habitacionales adaptadas). Contar con escusados, mingitorios, lavamanos, vertederos y regaderas (nula observancia).</p> <p>Mobiliario: Se recabó información sobre el mobiliario con que se cuenta en el inmueble educativo y sus cantidades, así como sobre el estado general de conservación. Deplorables condiciones de mesas binarias, sillas, sillas para maestro, bancos, sillas con paleta, mesa-bancos, escritorios, pizarrones, estantes, archiveros, basureros, butacas y casilleros.</p>
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Fuente: Elaboración propia

As can be seen, the conditions found in the properties evaluated expose multiple deficiencies, which directly affects the learning of the students.

Conclusions

The findings shown in this research show the lack of basic regulatory compliance in the institutions analyzed at the preschool level, which affects the integral and harmonious development of the child. Specifically, when studying the relationships between school infrastructure and the results obtained, it is observed that the factors that are most highly and significantly associated with learning are its use as an educational space (planning), the presence of teaching support spaces (libraries and common areas), connection to public services of electricity, drinking water, adequate furniture and equipment, as well as bathrooms in condition and with the appropriate number.

This shows that the states of the central region of the Mexican Republic should improve the physical educational infrastructure to eliminate the large existing gaps, which negatively impact schools in the public sector. In this sense, investment should be made in the construction of buildings that meet the minimum requirements to teach classes according to the particularities of each educational level. This means working on the improvement and maintenance of hydraulic, sanitary and electrical installations.

Finally, initiatives must be created to optimize the instruments that guide public policies in the field of educational physical infrastructure. For this, it will be essential to promote more studies at both regional and international comparative levels to strengthen the analysis of the connections between school infrastructure and student learning.

Future lines of research

It is convenient to continue deepening to consolidate this line of research, which could be achieved if inquiries are carried out in private schools and the sample is expanded to include other regions of the Mexican Republic and other educational levels.

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