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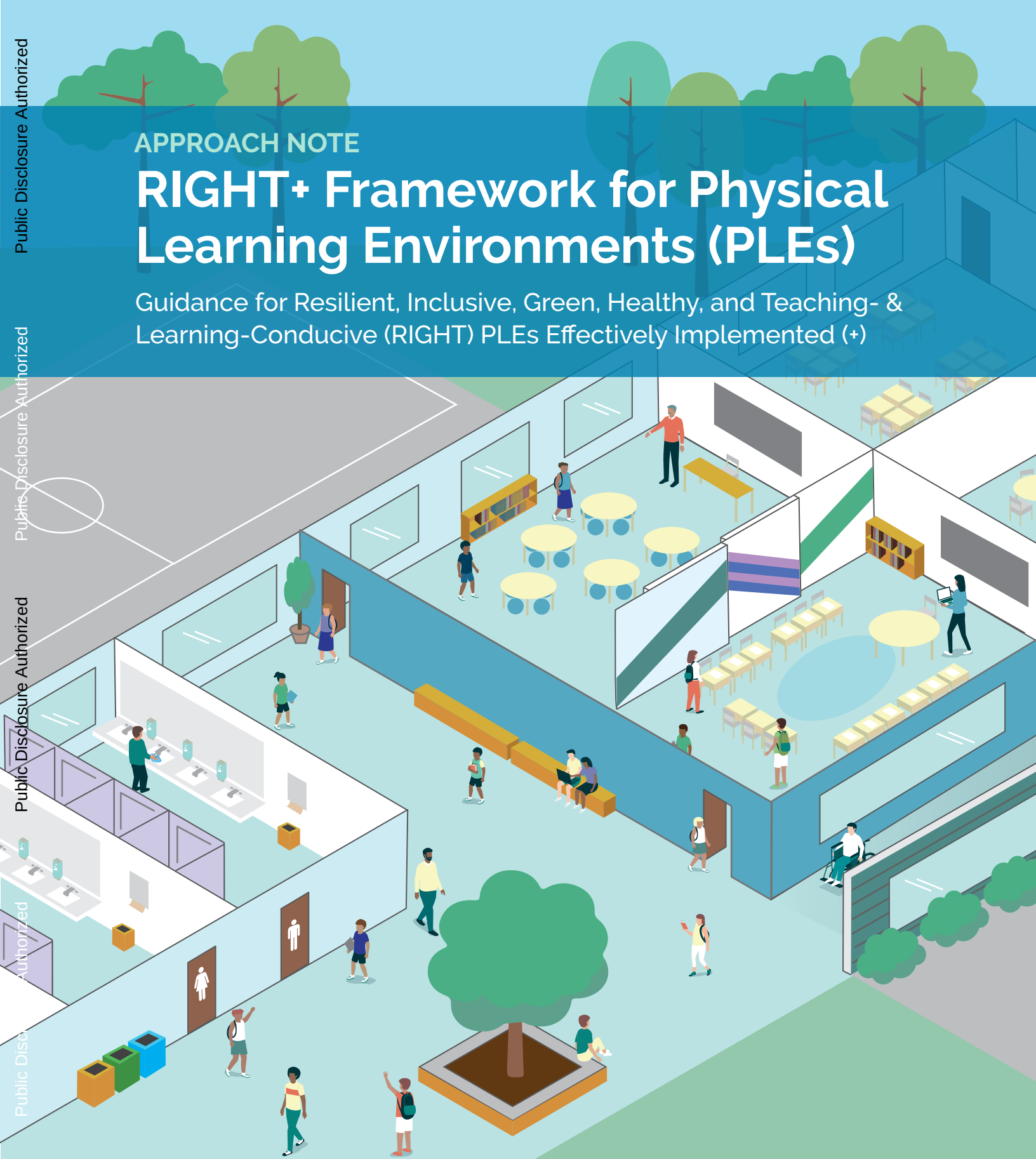
APPROACH NOTE

RIGHT+ Framework for Physical Learning Environments (PLEs)

Guidance for Resilient, Inclusive, Green, Healthy, and Teaching- & Learning-Conducive (RIGHT) PLEs Effectively Implemented (+)



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APPROACH NOTE

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Guidance for Resilient, Inclusive, Green, Healthy, and Teaching- & Learning-Conducive (RIGHT) PLEs Effectively Implemented (+)

PLE Thematic Group—Education Global Practice
Safer Schools Thematic Area—Global Facility for Disaster Reduction and Recovery

March 2025

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ABBREVIATIONS AND ACRONYMS

CO	Carbon monoxide
COVID-19	Coronavirus disease 19
EIMS	Education infrastructure management system
EMIS	Education management information system
FCV	Fragility, conflict, and violence
FY	Fiscal year
GHG	Greenhouse gas
GP	Global Practice
GPSS	Global Program for Safer Schools
GRID	Green, Resilient and Inclusive Development
HVAC	Heating, ventilation, and air conditioning
ICT	Information and communications technology
IEQ	Indoor environmental quality
LIC	Low-income country
LMIC	Low- and middle-income country
MHH	Menstrual health and hygiene
O&M	Operation and maintenance
OECD	Organisation for Economic Co-operation and Development
PLE	Physical learning environment
RIGHT+	Resilient, Inclusive, Green, Healthy, Teaching- & Learning-Conducive (+Effective Implementation)
SEND	Special educational needs and disabilities
USD	United States dollars
UNESCO	United Nations Education, Scientific and Cultural Organization
WASH	Water, sanitation, and hygiene
WBG	World Bank Group
WHO	World Health Organization

EXECUTIVE SUMMARY

In the context of the global learning crisis, climate change, and increasing disasters, Physical Learning Environments (PLEs) can play an important role in increasing education outcomes globally, especially in the most vulnerable populations. For this framework, PLEs comprise the physical elements of the learning environment at three different levels: spaces; the school as a whole; and the network of education facilities.

In low- and middle-income countries (LMICs), PLEs face common challenges that result in the exclusion of vulnerable populations, hinder students' learning outcomes, and threaten students' and teachers' health and well-being. The main issues relate to insufficient supply of places in schools, poor physical conditions, and lack of safety. Furthermore, the design of the PLEs is often conceived to support only traditional pedagogical practices, limiting the effectiveness of the teaching-learning process. As a crosscutting challenge, the management of the education infrastructure is critical.

As part of the World Bank investments, PLE-related activities represent roughly 50 percent of its resources invested in education projects (over USD 14 billion) over the past decade (World Bank 2025). Despite this increasing pressure, World Bank Group (WBG) task teams working on PLEs may face challenges in accessing comprehensive guidance and support. Moreover, the production and dissemination of analytical work showing the linkages between PLEs and education outcomes is limited, and task teams require more guidance on operationalizing successful PLE strategies during the project cycle.

PLE-related activities represent roughly 50 percent of its resources invested in education projects (over USD 14 billion) over the past decade

In response, the Resilient, Inclusive, Green, Healthy, and Teaching- & Learning-Conducive (RIGHT+) framework was prepared on existing evidence, experience from WBG engagement, and institutional strategies to provide guidance to task teams. It encompasses a set of strategies and characteristics that are not a linear work path but rather an organizational scheme that can be used as an umbrella guide to ensure high-quality learning environments through:

(1) R | Build **resilient** PLEs that protect the safety of all users while ensuring education continuity, characterized by risk-informed location, building code compliance, and disaster risk mitigation plans.

(2) I | Promote **inclusive** PLEs that enable all students to have access to learning, featuring accessible spaces, gender-friendly facilities, and adequate capacity to accommodate diverse student needs.

(3) G | Ensure **green** PLEs that reduce negative environmental impacts, marked by energy efficiency, water efficiency, waste management, and sustainable construction materials.

(4) H | Create **healthy** PLEs that protect and nurture students' and teachers' health and well-being, providing adequate basic provisions, good indoor environmental quality, and well-maintained buildings.

(5) T | Foster effective **teaching- & learning-conducive** PLEs, characterized by spaces that are of adequate capacity and flexibility to fit with chosen pedagogies, providing sufficient furniture, ICT infrastructure and equipment, while ensuring the spaces optimize the level of stimulation and choice afforded to all users.

(6) + | Achieve **effective implementation** through solutions that extend to the whole-life infrastructure investment cycle, by improving the management process at multiple levels through capacity building, stakeholder engagement and feedback, all informed by comprehensive, up-to-date educational infrastructure data systems.

To guide the practice, the RIGHT+ proposes six factors, with characteristics summarized in the table below. Each concept and the attribute of each characteristic is developed in the section 4 of the document.

Characteristics of RIGHT+ PLEs

Factor	Characteristics
Resilient	Risk-informed location
	Building code compliance
	Disaster risk mitigation
	Resilient recovery
Inclusive	Access to schools
	Gender-sensitive
	Accessible infrastructure
Green	Energy efficiency
	Water efficiency
	Waste management
	Sustainable construction
Healthy	Adequate basic services
	Indoor environmental quality
	Effective maintenance
Teaching- & learning-conducive	Adequate capacity
	Optimal spatial experience
	Fit with pedagogy
	Equipped for learning
+ Effective implementation	Infrastructure management cycle
	Management improvement processes
	Educational infrastructure data

The intended use of this framework is not to be a one-fit-all solution that must be fully implemented using a top-bottom approach. Instead, its objective is to provide education practitioners with an organizational scheme to assess the PLE's situation and to propose solutions for the rehabilitation of existing PLEs or construction of new ones. The proposed six strategies, characteristics, and attributes are intended to be used to interpret PLE needs and guide the appropriate design of interventions. To maximize impact, it emphasizes taking advantage of the entry points and building on existing demands, expanding them to maximize impact, creating synergies among factors, and prioritizing interventions based on context and needs. The framework is flexible and serves as a reference for local solutions, allowing communities to diagnose and design their own proposals with local solutions.

To successfully implement the RIGHT+ framework, task teams will need to use a comprehensive approach to PLEs that prioritizes the learning process, expands solutions to address the broader context, scales interventions to benefit all education infrastructure, and relies on data-driven decision making, all complemented with capacity-building processes. By adopting this approach, task teams can promote PLEs that truly support learning and development for all, with the potential to make a lasting impact on the education sector.

1. Introduction

In the context of the global learning crisis, education systems all over the world need to maximize the return on their education investments, including in physical learning environments (PLEs). The most recent estimates suggest that nearly two-thirds of all 10-year-olds globally cannot read and understand a simple story (World Bank 2022). Known as "the third teacher" (Malaguzzi 1993; Shmis et al. 2019), PLEs can be a powerful input to improve education outputs and results, ultimately increasing education outcomes.

In addition, climate change and increasing frequency of natural disasters threaten education outcomes globally, especially in the most vulnerable populations (Porter 2021; Daza Obando et al. 2023). All countries need to incorporate new strategies to reduce the vulnerability of their education systems and increase their contribution to climate change mitigation (Chankrajang and Muttarak 2017). Of all education investments, PLEs have among the highest potential to help education systems mitigate and adapt to climate change (Ambasz, Holla, and Sabarwal 2022).

Of all education investments, PLEs have among the highest potential to help education systems mitigate and adapt to climate change

PLEs, especially in low- and middle-income countries (LMICs), face common challenges that result in the exclusion of vulnerable populations, hinder students' learning outcomes, and threaten students' and teachers' health and well-being. The main issues are related to an insufficient supply of places in schools, poor physical conditions, and a lack of safety, which expose students to the risk of infectious disease, injury, or even death in case of disasters. Furthermore, PLEs' designs often support only traditional pedagogical practices, limiting the effectiveness of the teaching-learning process and, ultimately, affecting learning outcomes.

PLE-related activities represent one of the largest and most demanded investments in the World Bank Group's (WBG) portfolio of education projects. Since 2013, 30 projects that include PLE related investments were approved annually by the Education Global Practice of the World Bank (World Bank 2025). This represents roughly 50 percent of its resources invested in education projects (over USD 14 billion) over the past decade. And this number continues to grow, especially in Sub-Saharan Africa, South Asia, and Latin America and the Caribbean.

Despite this growth in investment, WBG task teams and counterparts may face challenges accessing comprehensive guidance and support to maximize the impact of PLE investments. While global evidence showing the impact of PLEs on education outcomes is growing, analytical work showing the linkages between them is still limited. Task teams and education practitioners need more guidance on operationalizing successful PLE strategies, as do the experts assigned to support them during the project cycle.

In response, the *Resilient, Inclusive, Green, Healthy, and Teaching- & Learning-conducive (RIGHT+)* framework was prepared to provide strategic and operational guidance to task teams to comprehensively address the above challenges, thereby maximizing the impact of WBG investments in PLEs. The framework was prepared on the basis of existing evidence, experience from WBG engagement worldwide and key institutional strategies, such as the Green, Resilient, and Inclusive Development (GRID). It builds on knowledge on the impact of PLEs on learning, such as presented in the WBG's 2019 international review of published evidence (World Bank 2019), as well as on effective strategies from various countries that have overcome one or more PLE challenges.

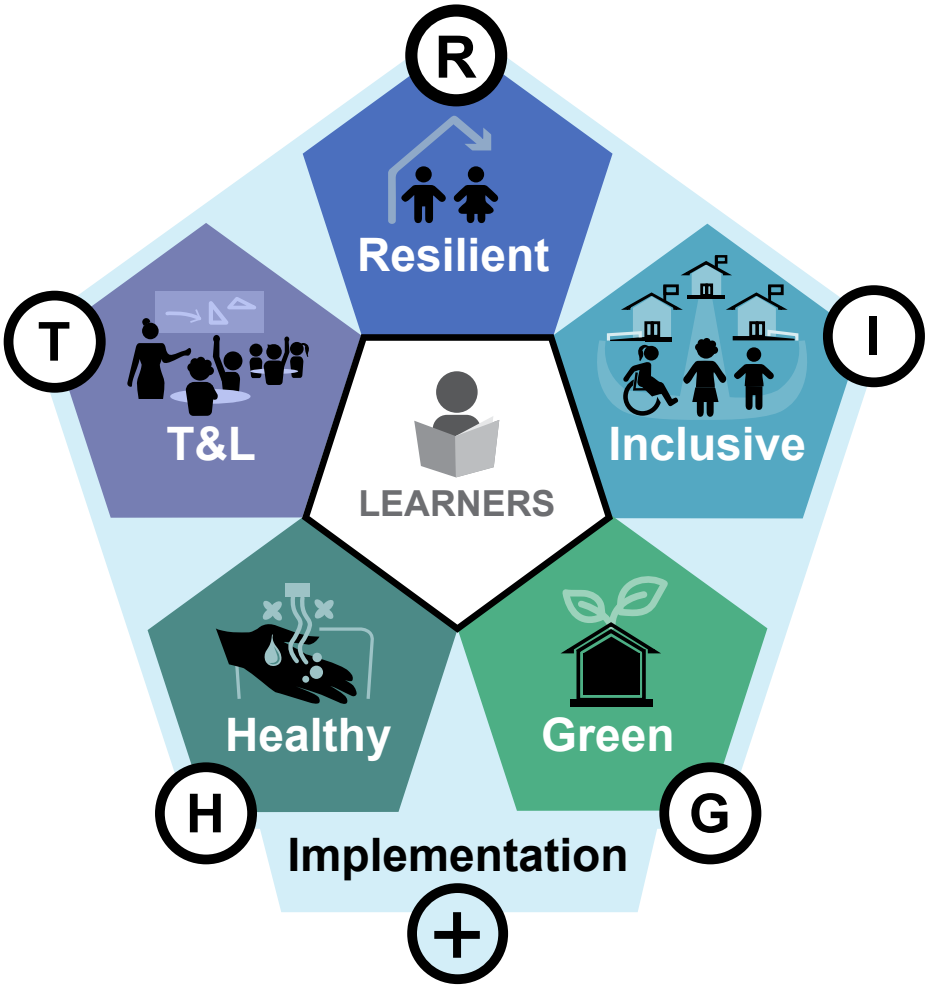
The framework was prepared on the basis of existing evidence, experience from WBG engagement worldwide and key institutional strategies

2. Objective

The primary objective of the RIGHT+ framework is to ensure that WBG interventions effectively support LMICs to increase learning outcomes for all students while simultaneously contributing to climate change mitigation and adaptation.

To achieve this, the framework´s practical purpose is to guide WBG task teams and counterparts in promoting resilient, inclusive, green, healthy, and teaching- & learning-conducive (RIGHT) PLEs that are effectively implemented (+) at scale (Figure 1).

Figure 1. The RIGHT+ PLE Framework: 6 Factors



The main audience is task team leaders, team members, and extended teams (working in operations or on analytical work) involved in investments in PLEs from any Global Practice (GP). Any development or partner institution outside the WBG working on PLE investments can also use the framework.

The principles and recommendations predominantly focus on the planning, designing, rehabilitation and construction, and operation and maintenance of PLEs offering basic education services within public education systems in LMICs, as these represent the largest needs and gaps in education access and quality. It is anticipated that the material will be more widely relevant, however. Box 1 describes the elements of PLEs.

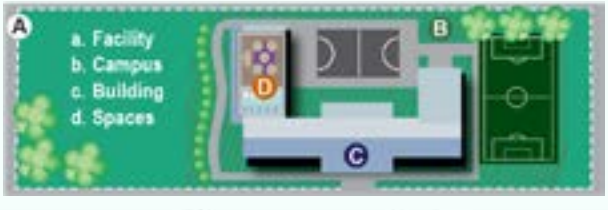
Any development or partner institution outside the WBG working on PLE investments can also use the framework

Box 1. Elements of Physical Learning Environments (PLEs)

PLEs comprise physical elements at three different levels:

(1) **Spaces**, such as classrooms and other teaching and learning areas, in which students, teachers, content, equipment, and technologies interact.

(2) The **school as a whole,** including buildings, amenities, outdoor and indoor spaces, furniture, equipment, and other similar physical elements.



(3) The **network of education facilities** that collectively provide education services in a certain territory.

The RIGHT+ approach provides qualities to guide practical action in PLE projects keeping the focus on the "learners" and learning progress. The key qualities recommended to design the RIGHT+ PLEs were selected according to:

The RIGHT+ approach provides qualities to guide practical action in PLE projects keeping the focus on the "learners" and learning progress

(1) Evidence on the impact of PLEs on learning, such as that presented in the WBG's 2019 report "The Impact of School Infrastructure on Learning: A Synthesis of the Evidence."[1]

(2) The WBG's strategic institutional priorities, such as the Green, Resilient and Inclusive Development (GRID).

(3) Principles and good practice examples from various countries that have shown effective strategies to overcome one or more of the identified challenges.

(4) Knowledge and experience reported by task teams working on projects with PLE interventions.

The framework aims to help education practitioners working on PLEs. It does not provide a linear work path or a one-size-fits all, but rather an organizational scheme that can be adapted to any context to maximize the impact of PLE investments.

Therefore, the intended uses are for:

- **Assessing the context needs and design accordingly:** the six strategies, characteristics, and attributes (Table 1) can be used to interpret PLE needs and to design appropriate interventions at any level, from an individual project to an education infrastructure network.
- **Enhancing existing or new PLEs:** the RIGHT+ is not only intended to guide the design and construction of new infrastructure. Given that the pressing needs in LMICS are maintaining and improving the existing infrastructure, the RIGHT characteristics, and attributes can be used as design principles to guide the rehabilitation of existing infrastructure to progressively enhance their contribution to learning outcomes.
- **Building on the existing demands and expanding them to maximize impact:** The framework is not designed as a one-size-fits-all package to be implemented all at once; rather, it serves as a guide to gradually enhance PLE interventions. Projects can be triggered by different initial events, such as a reaction to a natural disaster, a demand increase, or a change in a school's design. In these scenarios,

1 This report from Barret et al. provided a "rainbow" summary diagram that was adapted to be operationalized for the challenges typically facing LMICs.

the framework stresses that to gain maximum impact from any investment, actions should not be limited to the immediate response but incorporate as many RIGHT+ factors as possible.

- **Creating synergies among factors:** The importance of the RIGHT+ is not on its individual characteristics but on the aggregation of factors. As PLE interventions are multidimensional, the framework can be used to ensure that the characteristics are closely interconnected in the physicality of the solutions being developed for either existing or new PLEs.
- **Prioritizing interventions:** The framework doesn't provide a prioritization mechanism. Depending on the context and needs, each PLE intervention will prioritize solutions to respond to certain challenges. In each context, for example, measures to ensure student's health and safety can be the priority, while in others, the challenge is to find green solutions to save energy. In any case, the proposal is to maximize the investment, considering as many of the factors as possible.
- **Serving as a reference for local solutions:** The RIGHT+ is not intended to guide a top-bottom approach with pre-defined solutions for countries and communities. The framework is intended to open the spectrum of challenges and solutions to help communities diagnose and design its own proposal with local solutions.

3. Challenges Faced by the World Bank Current Portfolio of PLEs

Developing countries face diverse and multifaceted challenges in their PLEs. While some regions such as East Africa need to expand PLEs due to increasing demographic trends, others, such as Central Asia, need to consolidate the school network to adapt to decreasing demand, albeit in many cities excess demand still exists. Similarly, in the Pacific Islands, PLEs are affected by natural disasters, while South Sudan struggles to continue education services amid conflict and instability.

The common challenges faced by PLEs, especially in LMICs, can provide a framework to assess, identify, prepare, and address successful and comprehensive interventions in existing and new PLEs. The common challenges encompass issues related to resilience, inclusivity, environmental sustainability (or green), health, and the ability to foster teaching- and learning-conducive environments, as described next. And addressing these challenges requires more than just identifying the issues: effective implementation is crucial for ensuring the success of each factor within the RIGHT+ framework (hence the + in the name).

PLEs are often vulnerable to natural hazards, putting students and teachers at risk and affecting the continuity of education service delivery. Many schools in LMICs lack hazard-resistant designs, and new schools are often built without consideration of potential exposure to natural hazards. Due to poor building regulations, construction quality, or underinvestment in PLE maintenance (World Bank 2021b), 1 million school buildings globally are vulnerable to natural hazard damage, and an average of 2,500 school children are at risk of being killed by a collapsing school in an earthquake each year. At the same time, the education sector worldwide experiences significant financial losses due to school damages, with global estimates indicating losses of USD 3 billion and USD 4 billion annually due to earthquakes and tropical cyclones, respectively (World Bank 2021b). Natural disasters severely impact children's schooling, learning, and overall well-being. This impact is particularly devastating in LMICs, where the cumulative impact of natural hazards exacerbates the challenges governments face in managing and financing a growing stock of school facilities while ensuring quality education and service continuity. Human-induced events—such as those in fragility, conflict, and violence (FCV) settings—can threaten PLEs by making them targets of violence, exposing children to risk and

1 million school buildings globally are vulnerable to natural hazard damage, and an average of 2,500 school children are at risk of being killed by a collapsing school in an earthquake each year

reducing their availability. For example, Burkina Faso alone accounts for half of the school closures recorded in Central and West Africa, with more than 6,100 schools closed due to conflict-related insecurities as of July 2023 (UNHCR Africa 2023).

PLEs are often insufficient to receive or are inaccessible to all students or they lack the conditions to ensure the participation of vulnerable groups, including girls and those with disabilities. Scarce or no access to PLEs due to limited government resources to strategically plan and invest in school infrastructure is a barrier to basic education for all. In Uganda, over 55 percent of lower-secondary school children walk more than 30 minutes to reach school (Bashir et al. 2018). PLEs frequently suffer from overcrowding and poor maintenance, and require prolonged travel, disproportionately impacting disadvantaged students, including girls. In Angola, nearly 20 percent of classrooms, accommodating approximately 1.12 million students, operate in the open air, under trees (World Bank 2021a). Likewise, PLEs often lack regulations regarding physical accessibility—such as at entry points, corridors, and sanitary facilities—that meet the needs of students and teachers with disabilities (Alasuutari et al. 2020). Physical conditions such as inadequate lighting or shared-gender water, sanitation, and hygiene (WASH) facilities can contribute to a general feeling of insecurity and danger at school, significantly affecting girls' attendance and learning opportunities. In India, for instance, 25 percent of girls do not attend classes during menstruation due to a lack of adequate WASH infrastructure at school (van Eijk et al. 2016).

In Uganda, over 55 percent of lower-secondary school children walk more than 30 minutes to reach school

The construction practices, materials, and designs employed for PLEs often have detrimental environmental effects. PLEs in LMICs often lack an energy- or water-efficient design or rely on nonrenewable energy sources, contributing to increased greenhouse gas (GHG) emissions and environmental harm. For example, in South Africa, the use of fluorescent lights in schools makes lighting (a basic necessity) the major contributor to energy usage, accounting for as much as 31 percent of the daily in-term usage for affluent schools and 40 percent for poor schools, compared to 14–25 percent in developed countries (Samuels, Grobbelaar, and Booysen 2020). The use of unsustainable or nonrecyclable materials like concrete and plastic generates high levels of embodied carbon emissions, waste that is often improperly disposed of, leading to soil, air, and water pollution. Moreover, PLE operations—such as inefficient electricity usage or excessive transportation to commute to/from schools—can contribute to increased carbon monoxide (CO) emissions.

PLEs in LMICs often lack an energy- or water-efficient design or rely on nonrenewable energy sources, contributing to increased greenhouse gas (GHG) emissions and environmental harm

PLEs in LMICs are often characterized by poor indoor environmental quality (IEQ), low access to quality WASH, and overcrowding, putting students and teachers at risk of disease and even death (United Nations Children's Fund (UNICEF) and World Health Organization 2018). These can limit students' participation in education (Trinies et al. 2016), impacting their learning. For instance, a study in Ethiopia that measured the effect of high temperatures on test scores found that each additional day with temperatures above 33ºC reduces the standardized total test score of students by 0.009 standard deviations (Srivastava, Tafere, and Behrer 2024). Access to adequate WASH services has been linked to better health and increased attendance rates for girls. Worldwide, 19 percent of schools have no drinking water service, keeping nearly 570 million children from accessing clean water at school. Over 620 million children (in 23 percent of schools) have no sanitation service at their school. Thirty-six percent of schools serving nearly 900 million children have no basic hygiene services (United Nations Children's Fund (UNICEF) and World Health Organization 2018). And health and safety challenges exacerbated in past years by shocks such as the COVID-19 pandemic will continue to mount as the effects of climate change worsen.

A study in Ethiopia that measured the effect of high temperatures on test scores found that each additional day with temperatures above 33ºC reduces the standardized total test score of students by 0.009 standard deviations

PLEs are often designed to support traditional pedagogical practices and to simply provide enough "seats" for students in a given location, but not as spaces actively conducive to teaching and learning. The design of the existing PLE inventory was prepared decades—or even centuries—ago, often following architectural trends that may no longer be conducive to modern educational practices. As a result, it is common for classrooms to be cramped, to provide an anonymous experience, and to lack good-quality furniture, and information and communications technology (ICT) infrastructure. This type of provision can lack flexibility in space usage, making it challenging to adapt to effective and evolving teaching methods and technologies. Traditional school layouts, with rows of desks facing the front of the classroom, may struggle to cater to diverse learning styles and collaborative learning. For example, a study in Russia (Shmis, Ustinova, and Chugunov 2020) shows that most of its schools have traditional learning environments: 79 percent of teachers never or hardly ever rearrange tables, chairs, or other elements of the space prior to the start of a lesson. The lack of appropriate and sufficient furniture, equipment, and technology hampers teachers' ability to employ interactive and experiential learning approaches that can enhance student engagement and comprehension.

Traditional school layouts, with rows of desks facing the front of the classroom, may struggle to cater to diverse learning styles and collaborative learning

PLEs investments are not informed by evidence and are often inadequately managed, leading to the previously mentioned challenges. While spending in education infrastructure is low in most LMICs, this is not the only reason for the described challenges. Inefficient

use of existing resources also limits PLEs' effectiveness, just as in higher-income countries (European Commission 2022). Institutions managing the PLE inventory in LMICs often lack the normative, human, and technical resources to ensure effective implementation. Education systems usually do not have basic data, such as PLEs' location and status, impeding infrastructure managers from effectively planning and monitoring the state and needs of the school infrastructure network. Teams working in education infrastructure typically have insufficient capacity for comprehensive planning, design, implementation, and, especially, evaluation. Instead, interventions are dealt with case-by-case on a needs basis, without a comprehensive strategy to address PLE investments optimally, at scale.

A recent study of educational infrastructure investments across the 27 European Union countries found that none of them achieve a comprehensive approach to PLE management due to challenges with data, stakeholder engagement, and use of feedback (European Commission 2022).

4. Framework to Build Resilient, Inclusive, Green, Healthy, and Teaching- & Learning-Conducive (RIGHT) PLEs That Are Effectively Implemented (+)

The RIGHT+ framework is grounded in and builds on previous WBG work. The factors in the next section are not provided as extra things to do, but as a practical way in which a comprehensive range of policy imperatives can be addressed. As is appropriate for PLEs, the suggested attributes are integrated by a strong educational focus on the needs of learners. Table 1 summarizes the main characteristics to be considered in each factor of the RIGHT+ framework.

Table 1. Characteristics and Recommended Attributes of RIGHT+ PLEs

Factors	Characteristics	Recommended attributes
Resilient	Risk-informed location	Availability of information about a school facility's **exposure to natural hazards**
	Building code compliance	**Level of compliance with the building code** and related regulation over the infrastructure lifecycle
	Disaster risk mitigation	**Disaster risk mitigation or climate change adaptation plans** in place
	Resilient recovery	**Performance of recovered school infrastructure** will be better in the event of future natural hazards
Inclusive	Access to schools	**School access by any transport mode** using a reasonable travel distance
	Gender-sensitive	Quantity and quality of **WASH facilities, segregated by gender**
		Presence of **gender-sensitive design considerations**
		Provision of **cleaning and menstrual hygiene** supplies
	Accessible infrastructure	Presence of adequate **ramps or elevators**
		Quantity and quality of **disability-compliant toilets/lavatories/urinals**
		Presence of **assistive technology and disability signage**
		Provision of **special transport for students with disabilities**
Green	Energy efficiency	Optimization of existing and future **embodied energy**
		Operational **energy consumption**
		Use of alternative **renewable energy and passive approaches**
		Use of **sustainable transportation modes**
	Water efficiency	**Water harvesting, consumption, and saving**
	Waste management	Disposal of **construction waste**
		Presence of **waste disposal system**
	Sustainable construction	Use, type, and source of **sustainable construction materials**
		Passive design approach, community-based approach, and use of technologies appropriate to the area

Factors	Characteristics	Recommended attributes
Healthy	Adequate basic services	Sufficient **provision of water**
		Adequate connection to **functioning sewage systems**
		Sufficient provision and quality of **water, sanitation, and hygiene (WASH) facilities**
		Availability of **electrical supply**
	Indoor environmental quality	Provision of good **indoor air quality**
		Provision of adequate **natural and artificial lighting**
		Provision of comfortable **temperature and humidity levels**
		Provision of acceptable **acoustic performance** in the classroom
		Access to **green spaces**
	Effective maintenance	**Good maintenance** in main building elements against deterioration
		Finishes and decorations are kept in good condition
Teaching & learning-conducive	Adequate capacity	Provision of **sufficient space for learning**
	Optimal spatial experience	Creation of a moderate level of **ambient stimulation** in terms of visual complexity and color
		Opportunity for students to feel **ownership** through choice and personalization of the learning space
	Fit with pedagogy	Availability of **flexible spaces** that can support diverse teaching and learning activities
		Schools as a whole support a range of learning activities
	Equipped for learning	Provision of a good quantity and quality of **furniture**
		Availability of **ICT infrastructure and equipment**
+ Effective implementation	Infrastructure management cycle	**Policy, institutional, and regulatory frameworks** in place
		Investment planning strategies in place
		Planning, design, and implementation informed by investment planning strategies
		Operation and maintenance protocols and financing
	Management improvement processes	Multilevel **stakeholder** integration
		Capacity building among staff and infrastructure managers
		Multilevel feedback from users and administrators
	Educational infrastructure data	Educational infrastructure data integrated, updated, and well-maintained in the **Education Management Information System (EMIS)**
		Data analytics for project design, management, implementation, and monitoring and evaluation

To ensure effective PLEs, the RIGHT+ framework represents a continuation of the evidence compiled in the cross-GP work that started with the *Global Guidance for Supporting and Sustaining Safe Schools*.[2] The framework is part of efforts that reflect cross-collaboration from different GP teams—such as Education; Urban, Disaster Risk Management, Resilience, and Land; and Water—to develop technical notes and tools to guide and operationalize PLE investments. The framework is connected with the *Roadmap for Safer and Resilient Schools 2.0 (RSRS)* and the *Global Library of School Infrastructure (GLOSI)*, which build on GPSS tools, data, and accumulated experience from past and ongoing engagements in about 37 countries, while also supporting green, inclusive, and learning-conducive environments.

The framework is part of efforts that reflect cross-collaboration from different GP teams—such as Education; Urban, Disaster Risk Management, Resilience, and Land; and Water

The framework complements other technical guidance notes that aim to contribute to World Bank objectives responding to the effects of climate change and COVID-19. In particular, the framework incorporates the vision of the document *Saving Lives and Livelihoods while Supporting Green, Resilient, and Inclusive Development (GRID)*. Along the same lines, the framework builds on the Education GP's *Guide for Learning Recovery and Acceleration* to address COVID-19 learning losses and build forward better. The framework assumes the vision of the *Climate Change Action Plan 2021–2025*, which states the new World Bank strategies aligned with the Paris Agreement. Likewise, the framework takes into account the relevant guidance and examples from the note *Maximizing Climate Co-Benefits in Education Operations*, which positions PLEs as one of the investments in education with the highest potential to increase climate co-benefits.

2 The framework also builds on the previous analytical work done by Barrett et al (2019): https://openknowledge.worldbank.org/handle/10986/30920

This work draws most recently from the analysis and recommendations stated in the technical guidance note "*The Role of the Physical Learning Environment for Supporting Safe Schools*." The technical guidance note is part of the larger *Safe Schools Practices* guidance package that includes the "*Global Guidance for Supporting and Sustaining Safe Schools Approach Note*." The framework also builds on guidelines developed by other development partners, such as the "*Constructing Education*", prepared by the Council of Europe Bank—CoEB.

Despite the multiple instruments available and efforts from different GPs, task teams and education practitioners working on PLEs receive limited guidance and support on how to maximize the impact of PLE investments. The production and dissemination of analytical work showing the linkages between PLEs and education outcomes is still limited and disconnected. Moreover, there is little guidance to task teams educational practitioners on operationalizing successful PLE strategies and expert support during the project cycle: from project identification, preparation, and implementation to project completion.

In response to this need for practical action, the RIGHT+ framework tries to transform the content into concrete recommendations for task teams to strengthen the PLE project cycle and enhance the impact of the Bank's investments in PLEs.

The RIGHT+ framework builds on six strategies to ensure effective PLEs:

(1) R | Build **resilient** PLEs that protect the safety of all users while ensuring education continuity, characterized by risk-informed location, building code compliance, and disaster risk mitigation plans.

(2) I | Promote **inclusive** PLEs that enable all students to have access to learning, featuring accessible spaces, gender-friendly facilities, and adequate capacity to accommodate diverse student needs.

(3) G | Ensure **green** PLEs that reduce negative environmental impacts, marked by energy efficiency, water efficiency, waste management, and sustainable construction materials.

(4) H | Create **healthy** PLEs that protect and nurture students' and teachers' health and well-being, providing adequate basic provisions, good indoor environmental quality, and well-maintained buildings.

(5) T | Foster effective **teaching- & learning-conducive** PLEs, characterized by spaces that are of adequate capacity and flexibility to fit with chosen pedagogies,

providing sufficient furniture, ICT infrastructure and equipment, while ensuring the spaces optimize the level of stimulation and choice afforded to all users.

(6) + | Achieve **effective implementation** through solutions that extend to the whole-life infrastructure investment cycle, by improving the management process at multiple levels through capacity building, stakeholder engagement and feedback, all informed by comprehensive, up-to-date educational infrastructure data systems.

This framework is an umbrella guide for building RIGHT PLEs (existing and new ones) that are effectively implemented (+) to ensure high-quality learning environments and guarantee sustainable education infrastructure investments. It encompasses the factors and their associated characteristics (Table 1) as elaborated in Section 5.

5. Strategies and Principles: Putting the RIGHT+ Factors to Work

5.1. Build Resilient PLEs

What is a resilient PLE?

A PLE is considered resilient when: (1) its performance meets an acceptable predefined level regarding the likelihood of severe harm to its users, damages, and economic losses caused by natural or human-induced hazard events (such as climate-related hazards, earthquakes, and pandemics)[3] and (2) the educational system is capable of restoring the services delivered by the PLE after a hazard event within an acceptable timeframe to limit educational losses to an acceptable predefined level.

By meeting the first condition, the PLE is considered *safe* regarding disaster risk; by meeting the second condition, the education system, and therefore its school infrastructure network ,are considered *resilient*. Safety and resilience are interrelated concepts. Resilience cannot be achieved without reducing risk (increasing safety), and safety alone is not enough to effectively recover a system after a disaster. Safety is a site-specific condition, while resilience relates to the education system's recovery capacity.

Consequently, a school could be considered resilient when it incorporates key attributes of safety and resilience. Three safety-related attributes at the PLE level are proposed: risk-informed location, building code compliance, and disaster risk mitigation. Resilient recovery is an additional attribute to capture resilience-related features.[4]

3 While recognizing the need to address risk from human-induced physical hazard events, this note focuses primarily on natural hazards due to the global scale of the problem.

4 Disaster risk financing, emergency preparedness and response, and service continuity programs are also aspects related to resilience. However, these aspects relate to the education system as-a-whole rather than solely the school infrastructure network; therefore, they are not discussed in this note.

Box 2. Definition and Classification of Hazard Events

A ***hazard*** is the potential occurrence of a natural event or a human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (adapted from IPCC 2021).

Natural hazards range from large-scale and rapid-onset events (earthquakes and tsunamis, for example) to slow onset events that may take years to develop (for example, droughts and sea level rise). They can be classified as geological hazards—such as volcanic activity, earthquakes, and landslides—and hydro-meteorological or climate-related hazards—such as flood, hurricanes, droughts, tropical storms, windstorms, and wildfires (adapted from IPCC 2021).

Human-induced physical hazard events can be classified in two broad categories: technological and social. The former refers to adverse events triggered by the failure or disruption of built structures, objects, and systems due to a technical malfunction or involuntary human error (for example, failure of a gas pipeline, a dam failure, or transportation accidents). The latter refers to adverse and disruptive events resulting from social dynamics at different scales, ranging, for example, from violence within schools to violent conflict, wars, massive displacement, and social unrest (own elaboration, Global Program for Safer Schools 2024).

Why are resilient PLEs essential for education?

Overall, there is significant evidence that exposure to natural hazard events during school age has a significant and adverse impact on the accumulation of human capital, as far as education outcomes are concerned, including school enrollment, attendance, completion of grade levels, and learning. A recent study (Jing et al. 2024), conducted in thirteen low- and middle-income countries exposed to tropical cyclones between 1954–2010, found a 7.9 percent reduction in school enrollment for children aged 5 or 6 exposed to Category 1 storms, and up to a 28.3 percent reduction for those exposed to Category 4+ storms. Moreover, the study observed that the loss of school enrollment was up to three times more pronounced among girls than boys. Disruptions in primary school enrollment subsequently led to reductions in primary school completion, secondary enrollment, and total years of schooling.

Natural hazard impacts on education outcomes include school enrollment, attendance, completion of grade levels, and learning

In Chile, following the 2010 earthquake, affected children performed lower on average in language and literacy tests, with a 0.19 standard deviation decrease in letter-word identification and a 0.22 standard deviation in text comprehension compared to non-affected children (Gomez & Yoshikawa 2017). Moreover, Shidiqi et al. (2023) reported that students affected by the 2006 Yogyakarta earthquake in Java Island, Indonesia, during their school years experienced a reduction of 0.74 years in schooling and were 11.6

percent less likely to complete primary school than those in non-affected areas. This study also concluded that damage to educational infrastructure is a relevant channel through which natural disasters harm human capital formation. Similarly, Jing et al. (2024) observed that physical damage to schools or disruptions in school access (e.g., road damage) due to severe storms, and the absence of adequate recovery, could lead to reduced enrollment in the 1–2 years following the exposure.

Far from being considered rare and extreme, the frequency and intensity of natural hazard events are increasing worldwide due to climate change. However, the impacts from these events are largely driven by the vulnerability of social, demographic, cultural, and economic systems, as well as the built environment. As reported by Prentice et al. (2024) countries where children face the highest risk of exposure to climate-related hazards—primarily located in sub-Saharan Africa, South Asia, and the Pacific—are also the countries with the lowest levels of education attainment. This situation places populations in these regions at a further disadvantage in terms of education.

The inability of accessing schools for any reasons described above also hurt the student outcomes. As we learned from the COVID-19 disruptions, less schooling leads to less learning and lack of access to schools disproportionally affects vulnerable students and girls in particular. At present, several international studies showed the negative impact of COVID-19-induced school closures (Gajderowicz et al. 2024; Iqbal et al. 2023; Jakubowski et al. 2024). The earlier estimates of the World Bank showed a global impact of USD 10.6 trillion over 45 years of working life of individuals (Psacharopoulos et al. 2020) As COVID-19 demonstrated, school closures and the inability of students to attend schools over an extended time could dramatically hurt individual and country-level economic outcomes. Such school closures are happening today due to the impacts of war (Russian invasion of Ukraine, conflict in Gaza, etc.), climate change (Sabarwal et al. 2024), and natural disasters mentioned above. Ensuring the resilience of schools in low and middle-income countries will enhance these countries' performance and ensure sustainable economic development.

As we learned from the COVID-19 disruptions, less schooling leads to less learning and lack of access to schools disproportionally affects vulnerable students and girls in particular

How to build resilient PLEs? What are the key characteristics of resilient PLEs?

Risk-informed location

The geographical location of school facilities is a defining attribute of their exposure to natural hazards. School managers must be aware and understand this exposure when deciding on the location of a new school or its relocation. Knowledge about the likelihood

of natural hazards affecting the school and connected lifeline infrastructure,[5] including an understanding of their potential frequency and intensity, is the starting point for managing disaster risk. In several countries, it is common for school facilities to be exposed to multiple hazards, which requires a multi-hazard disaster risk management approach.

The main sources of information to assess this attribute are typically hazard maps and historical disaster data,[6] supplemented by site-specific hazard assessments when more detailed data are needed. This information is essential for making risk-informed decisions and raising awareness among the school community, school infrastructure managers, and other stakeholders about the potential consequences of probable natural hazard events on the school's occupants, facilities, and the school's ability to deliver educational services.

When selecting the location for new school facilities, a risk-informed decision aims to minimize the school's exposure to natural hazards. This does not imply that the chosen site is entirely free from natural hazards; rather, it means that effective risk mitigation measures can be realistically implemented to reduce the risk to acceptable levels within the available technical and financial capacities.

When selecting the location for new school facilities, a risk-informed decision aims to minimize the school's exposure to natural hazards

For existing school facilities, the objective of a risk-informed approach is to guide the development of a comprehensive mitigation plan, as outlined below under *Disaster risk mitigation*. In cases where mitigation measures are neither technically nor financially feasible, school relocation may need to be considered.

5 It refers to roads, water, energy and communication grids which schools requires to operate.
6 Usually, this information is produced and managed by other institutions rather than the Education sector. In absence of it, basic information (topography, river maps, etc.) can help for a preliminary screening.

Box 3. Case Study: GeoRisk—The Philippines

GeoRisk Philippines is a multiagency initiative led by the Philippines Institute of Volcanology and Seismology and funded by the Department of Science and Technology. The platform provides information about hazards, the exposure of lifeline infrastructure[7] (including schools), and associated risks. Through GeoRisk, the Department of Education not only has access to data on schools' exposure to natural hazards but also to tools that can predict the potential number of schools located in the path of an active typhoon, among other applications. This data was instrumental in preparing the World Bank's Infrastructure for Safer and Resilient Schools project, which will support the repair, rehabilitation, retrofitting, reconstruction, and construction of classrooms in 1,282 school facilities in the country.

Additional information: GeoRisk Philippines.

Building code compliance

A resilient school **must comply with building codes** and related regulation throughout its entire infrastructure lifecycle. From a safety standpoint, building codes are official documents, typically with legally binding provisions, that reflect society's expectations regarding the safety, quality, and performance of buildings. They regulate the level of risk societies are willing to accept, considering the local social, economic, and cultural context. Ideally, code provisions should take into account the actual technical and financial capacities that countries can realistically mobilize for large scale implementation.[8] Consequently, different countries may have distinct interpretations of safety (or performance expectations), even for buildings that technically perform similarly under comparable risk settings. While safety is not an absolute condition and depends on various factors, some of which are not covered by building codes (e.g., community preparedness), code compliance is an essential mechanism for communities to manage risk. The performance of a school facility that fails to comply with or operates outside the scope of building codes cannot be considered safe.[9]

The performance of a school facility that fails to comply with or operates outside the scope of building codes cannot be considered safe

7 Public infrastructure and utilities, including transportation infrastructure, oil and gas pipelines, electrical power and communication infrastructure, and water supply and sewage infrastructure.

8 In general, developed countries set higher standards as they can afford to, while developing countries struggle to adopt, update, and enforce building codes. Thus, the same school building type built in different countries may be considered officially "safe" within each country even though the expected performance may differ.

9 In the absence of building codes, international standards can be used as reference while addressing this gap should become a priority action for education administrators.

Building code compliance should be maintained throughout the entire lifecycle of a school infrastructure project, not just during the initial design and construction phases. The performance of materials, systems, and equipment can change over time, depending on the effectiveness of operational practices and maintenance. Adequate maintenance procedures are essential to ensure the school performs as expected throughout its economic life.

Poor building code compliance is a major source of vulnerability for modern school buildings in developing countries, and the challenge is even greater for older infrastructure. As building codes evolve, infrastructure managers must upgrade a large number of facilities, a significant technical and financial undertaking that complicates compliance even in developed countries. The engineering community has made progress in designing retrofits for common school building types, though, in some cases, replacing old buildings is more cost-efficient. When conventional retrofits are not financially viable, phased interventions that progressively improve performance can be a feasible alternative (Box 4).

Assessing code compliance of existing school buildings typically involves analyzing their construction year to identify the applicable code version at that time and comparing it with the current code to identify design gaps and vulnerabilities. In countries with low code compliance, additional information, such as the construction owner, may be necessary to better understand code compliance.

As building codes evolve, infrastructure managers must upgrade a large number of facilities, a significant technical and financial undertaking that complicates compliance even in developed countries

Box 4. Case Study: Incremental Seismic Rehabilitation and Retrofitting of School Buildings—Peru

In 2016—via supreme decree- N° 003-2016-VIVIENDA—the Ministry of Housing, Construction, and Sanitation introduced the concept of incremental seismic rehabilitation and retrofitting—that is, building modifications that reduce seismic risk by improving seismic performance and that are implemented progressively when applicable, often in conjunction with other repair, or rehabilitation improvement activities. The criteria recommended to guide the structural design is the "Engineering Guideline for Incremental Seismic Rehabilitation", FEMA P-420, Risk Management Series, USA, 2009 and the FEMA's manual intended to assist school administration personnel responsible for the funding and operation of existing school facilities to comply with seismic building code provisions. Given the change in code, the Ministry of education introduced the incremental retrofitting program as part of a seismic risk reduction strategy for public school buildings in Peru in the National Plan for Educational Infrastructure (2015–2025).

Additional information:

- Seismic Risk Reduction Strategy for Public School Buildings in Peru
- Engineering Guideline for Incremental Seismic Rehabilitation
- Incremental Seismic Rehabilitation of School Buildings

Disaster risk mitigation[10]

To mitigate the impacts of hazard events on schools, the broader system to which the school belongs must have essential disaster risk management functions in place. Examples of these functions are early warning systems or accessibility from the school to essential services like hospitals. The strategy to address existing risk factors and establish these functions is typically devised in the form of a **disaster risk mitigation plan** (when related to climate-related hazards, this plan is referred to as a **climate change adaptation plan**).

The plan should address two equally significant aspects: (1) reducing risk in existing school infrastructure; and (2) incorporating risk management criteria into the planning, design, and operation of new school infrastructure. Adopting risk-informed approaches during the planning and design stages of new infrastructure is highly cost-effective for reducing risks.

It is essential to understand that, despite proactive measures to reduce the exposure of school infrastructure to natural hazards, certain large-scale phenomena—including earthquakes, heat waves, and various climate-related events—are unavoidable. Moreover, socioeconomic factors often lead to communities accepting the placement of schools in

It is essential to integrate disaster risk mitigation as a standard practice within the framework of school infrastructure management because certain large-scale phenomena are unavoidable

10 For this approach note, climate change adaptation falls under this category.

hazard-prone areas. Therefore, it is essential to integrate disaster risk mitigation as a standard practice within the framework of school infrastructure management.

This characteristic involves verifying the availability and implementation of disaster risk mitigation and/or climate change adaptation plans for school facilities located in hazard-prone areas. If such a plan is not yet available, it should prompt action to develop one.

Box 5. Case Study: Enhancing Resilience in Kyrgyzstan Project (ERIK)—Kyrgyz Republic

Enhancing Resilience in Kyrgyzstan (ERIK) was a USD 20 million lending project approved by the World Bank in 2018 to assist the Kyrgyz government in strengthening its capacity to respond to disasters, including a USD 12 million component to support the Kyrgyz Republic's State Program on Safer Schools and Preschools. The investment will reduce the seismic vulnerability of at least 10 school facilities, benefiting over 6,000 students and teachers. ERIK laid the technical foundation for the program to be scaled up nationwide. Additional financing of USD 55 million was approved by the Bank in April 2020, of which USD 39 million was allocated to increase the safer school component in at least 30 schools. Additionally, this project facilitated the formulation of a national school infrastructure plan that incorporates a risk mitigation plan for the entire public-school portfolio.

Additional information: Enhancing Resilience in Kyrgyzstan (ERIK).

Resilient recovery

Resilient recovery ensures that **disaster-affected school infrastructure performs better during future hazard events** as a result of recovery actions.[11] It refers to the **functional continuity**[12] of the network of schools and the education system's ability to minimize service disruptions. Resilient recovery is guided by the following key principles: prioritizing functional recovery, risk-informed reconstruction planning, integrated efforts toward RIGHT+ PLEs, and the active participation of the school community. Although not the primary focus of this framework, these principles also apply to recovery processes triggered by human-induced physical hazards—particularly in FCV contexts where school communities and infrastructure are affected by conflicts.

Prioritizing functional recovery means that the reconstruction strategy focuses on interventions to restore the basic intended functions of the school facility during the initial

11 Meeting the country's up-to-date, multi-hazard design provisions.
12 Ability of a school infrastructure and education system to provide near-normal services to teachers and learners after a disruptive event.

phase. This level of functionality is below the pre-disaster level but exceeds the minimum required for the school to reopen and operate.[13]

Risk-informed reconstruction planning aims to integrate disaster risk reduction criteria into the design of the reconstruction strategy. This approach may require a multi-hazard vulnerability assessment that goes beyond the specific hazard that caused the disaster, examining future potential risks posed by other hazards. A wide range of intervention options can be considered to reduce risk. A critical aspect is reducing the vulnerability of school buildings in addition to performing repairs and other rehabilitation works. By doing so, the recovered school infrastructure will perform better during future hazard events occur.

A critical aspect is reducing the vulnerability of school buildings in addition to performing repairs and other rehabilitation works

Efforts toward RIGHT+ PLEs can be integrated into post-disaster reconstruction, offering an opportunity to improve the overall quality of the learning environment. By focusing on resilient, inclusive, greener, healthier, and learning-conducive improvements, the concept of resilient recovery can be fully realized. Although timing and budget constraints often discourage decision makers to take this approach, advancements in technology, efficient engineering solutions, and phased implementation processes have shown promising results in overcoming these obstacles.

The **active participation of the school community** should be promoted and facilitated in any resilient recovery process. This participation offers mutual benefits for both the community and reconstruction managers, including a common understanding of the recovery process, increased community awareness of reconstruction efforts and challenges, a shared perspective on resilient recovery, and active collaboration to identify the most suitable reconstruction solutions.

From a resilience perspective, education administrators and school principals should be equipped with crisis management tools such as early warning systems and emergency/contingency/service continuity plans. Early warning systems aim to trigger timely actions in the event of imminent hazards, thereby reducing their impacts. The various plans establish response protocols to manage emergency situations and ensure the continuity of educational services.

13 NIST-FEMA Special Publication FEMA P-2090/NIST SP-1254

This characteristic can be assessed in pre-disaster situations by reviewing existing reconstruction policies and tools that support the integration of risk reduction criteria into reconstruction planning.

Box 6. Case Study: Istanbul Seismic Risk Mitigation and Emergency Preparedness Project (ISMEP)—Türkiye

In 1999, the 7.1-magnitude Marmara earthquake shook northwest Türkiye, killing more than 17,000 people and causing USD 5 billion in damage. The earthquake significantly damaged Istanbul's infrastructure. The Istanbul Seismic Risk Mitigation and Emergency Preparedness Project (ISMEP) was conceived in 2005 to enhance preparedness, strengthen critical infrastructure, and improve institutional and technical capacity for disaster risk management and emergency response. This USD 1.2 billion project includes USD 550 million in World Bank financing. To reduce seismic risk, the project pioneered an innovative approach that combined: risk reduction investments such as the reconstruction of public buildings; broader programs including public awareness campaigns; and investments that strengthen disaster response.

Additional information: Enhancing Seismic Preparedness in Istanbul.

Do you want to learn more about building resilient PLEs?

(1) Refer to the World Bank's Roadmap for Safer and Resilient Schools and the RSRS OCL course for step-by-step guidance on addressing natural hazard risks in school infrastructure at scale. The RSRS is complemented by the Global Baseline for School Infrastructure–GLOSI, a repository of evidence-based knowledge and data about school infrastructure.

(2) Refer to Global Facility for Disaster Reduction and Recovery (GFDRR) and the World Bank's Education Sector Recovery Guidance Note, which provides practical guidance to national governments about key priorities for the education sector following a major disaster or crisis.

(3) Read GADRRRES's (Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector) Comprehensive School Safety Framework 2022–2030 on safer learning facilities.

(4) OECD's Climate-resilient Infrastructure highlights emerging good practices and remaining challenges across OECD and G20 countries.

5.2. Promote Inclusive PLEs

What is an inclusive PLE?

A PLE is considered inclusive when it promotes equitable learning opportunities enabling all students to have access to learning.

For example, planning an equitable distribution and adequate supply of classrooms for the existing and projected number of students is needed to ensure access to education for all students, particularly the most disadvantaged living in poor conditions, the vulnerable, those living in remote areas, or indigenous student population that often cannot access schools as other children. An inclusive school must provide gender-sensitive PLEs to reduce the barriers to school attendance—especially for girls—due to lack of safety, inadequate WASH facilities, or lack of gendered classroom or school spaces for learning or recreational activities. Finally, an inclusive school must ensure the physical access, participation, and social interaction of students and staff with disabilities through school design considerations.

Why are inclusive PLEs essential for education?

The challenge of inclusiveness operates at both population and individual level. At the population level, inclusiveness involves ensuring an adequate geographical distribution of schools. When nearby schools are lacking, the likelihood of children attending reduces significantly. Insufficient school places may result in cramped conditions (Irambona and Syomwene 2023), the need for shifts, or reduced school hours. This is all certain to impact negatively on the quantity and quality of education experienced and thus on learning (Maxwell 2016). Access to schools is also influenced by transportation options. Excessive time spent traveling to and from school can drain students' energy and limit their time for resting or completing homework. This constraint can hinder their participation in extracurricular school activities, limiting their overall opportunities for engagement. Moreover, families may be more likely to keep children at home (Kousky 2016). Not surprisingly, a major review of 30 years of literature concluded that building a new school had the clearest positive impact on education (Glewwe et al. 2011), as access was made simpler for what was presumably an underserved population where the school was built. Also, more space per pupil could have become available given the expansion in infrastructure. A subsequent 10-year review of impact evaluations also found good evidence of the impact of school building on improved educational outcomes in South Asia (S. Asim et al. 2017).

A major review of 30 years of literature concluded that building a new school had the clearest positive impact on education, as access was made simpler

At the individual level, one of the most critical challenges is ensuring accessibility for all pupils, especially those with Special Educational Needs and Disabilities (SEND) and female students. Accessibility encompasses various aspects, including physical barriers—such as upper floors accessible only by stairs and lack of navigation tools such as braille signage for blind children. The United Nations (UN) estimates that only around one-half of primary schools worldwide are disability-adapted (Secretary-General 2023). Additionally, accessibility involves addressing more subtle factors, like the availability of appropriate WASH facilities, the lack of which can disproportionately discourage teenage girls from attending school (Bundy et al. 2005). Still less visible are the problems faced by children with various types of learning difficulties. Although needs vary by individual, a very influential aspect of PLEs is the "sensory diet" offered (Wójcik 2023). Is the space too chaotic and congested? Are there places to calm down? Elements like these in a sensory-friendly classroom can make a significant difference to the success of a pupil with SEN (Mostafa 2014).

The cumulative impact of these accessibility issues ultimately leads to an equity concern. From an educational perspective, these challenges result in reduced or limited attendance or less effective time spent in school. It is crucial to address these barriers to ensure that all students, regardless of their individual needs or gender, have equal opportunities to access and benefit from education.

How to promote inclusive PLEs? What are the key characteristics of inclusive PLEs?

Access to schools

PLEs' capacity is critical to ensure that students of a certain community have access to education. Many LMICs have significant demand for education facilities but limited resources to meet it. Adequate school capacity ensures that more students have **school access** to education and can enroll in schools within their communities. This is especially relevant for equitable access to education, benefiting marginalized populations such as girls, children from rural areas, and children with SEND.

Adequate school capacity ensures that more students have school access to education and can enroll in schools within their communities

This characteristic can be considered via the ease of *reaching a school from a location (household) within a reasonable distance using a given travel mode.*[14] At the school level, **school access** refers to the availability of transportation modes (walking, biking, driving,

14 Travel mode can be active or nonactive: active transportation refers to walking and biking, and nonactive to driving and public transportation.

and public transportation) students use to reach school and the type and condition of roads (such as paved, unpaved, or leveled) that provide immediate access to school sites. At the school network level, spatial access is measured by the travel distance from students' homes to existing schools' locations using a specific or combined travel mode. For new construction, locating schools near public transportation or a transport network ensures higher access, while reducing pollution and land development impacts.

For new construction, locating schools near public transportation or a transport network ensures higher access, while reducing pollution and land development impacts

A spatial accessibility network analysis can ensure that all students have a seat in the classroom by examining the network's performance in terms of access, occupancy, capacity, and projected demand of students due to population growth and migration flows. The use of transportation, geographic, and spatial data related to socioeconomic indicators, demographic population trends, and school inventories is a key element for inclusive planning. That information allows efficient planning of the school infrastructure network to guarantee school sites are well distributed and serve the targeted demand in a specific catchment area.

Spatial accessibility for whom is fundamental to identify the user when modeling spatial accessibility networks, as student populations will have various needs and travel behaviors. For example, the cut-off for travel distance to a kindergarten is very different from the cut-off for a high school, as a child aged 2–5 years old has a lower ability and willingness to walk and commute (10–15 min) than a teenager aged 12–15 years old (15–30 min). And the parameters to calibrate spatial accessibility models are different in urban versus rural areas, as the latter's remoteness and lack of transportation networks limit access to schools.

Improving **access to school** can be addressed by: (1) expanding existing schools to provide sufficient classrooms for current and future student populations; (2) prioritizing investment for new construction in sites that increase the levels of accessibility in their catchment areas; (3) locating or reallocating student demand to optimize the school infrastructure network; (4) providing a bus service for the school community to reduce students' travel time; and (5) implementing alternative options to traditional PLEs, such as mobile schools or boarding schools, to increase school access.

Extra space for future extension of the school's footprint should ideally be considered when a new building is being created, or even the provision of foundations fit to support later building of additional building stories, which could be most practical in urban areas. Contraction due to any anticipated demographic shrinkage should be considered and

attention paid to the ease of adapting buildings to alternative uses (community, commercial, etc.). This can be partially addressed by efforts to maximize community benefit in the design. For example, Portugal's generic "double ring" layout allows for a core ring for the school, and a more easily accessible periphery ring for community use in the evenings.[15]

Box 7. Case Study: Accessibility and Optimization Analysis—Colombia

In Colombia, the city of Cali developed a long-term school infrastructure plan in 2018 to manage its school portfolio efficiently and increase the city's supply of classrooms to advance elimination of the two-shift system and allow a full school day for every child. An additional objective of the school construction program was to prioritize the replacement or retrofitting of existing schools identified as highly vulnerable to earthquakes. To ensure an efficient and forward-looking investment, the planning process factored in anticipated population growth and demographic changes in the region and sited new school locations using the results of an optimization of travel routes based on the existing municipal transportation network (Scarinci 2019). To promote an inclusive approach, municipal planners leveraged city staff and school administrators to collect data on the physical characteristics and shortcomings of school facilities and used these to objectively prioritize interventions. Local factors related to security—such as the existence of "invisible boundaries" of gang activity that impacted access to school—were considered in the planning and design of individual schools (100 Resilient Cities 2019). To date, Cali has retrofitted and rebuilt numerous schools, improving learning and safety and moving closer to elimination of the shift system citywide.

Additional information: Improving the Safety and Resilience of School Infrastructure in Cali, Colombia.

Gender-sensitive

The gender-sensitive characteristic of an inclusive school consists of eliminating barriers that contribute to gender disparities in education. School design and construction standards play a role in shaping gender sensitive PLEs. For example, **WASH facilities** must be of sufficient capacity and separated by gender to reflect students' needs. In some countries, construction codes often state that the ratio per student for lavatories/toilets/urinals is the same no matter the gender of the student population. In practice, the needs of female students are different when they use WASH facilities, especially during their menstrual period because their toilet time use increases, resulting in long lines, particularly during recess. Evidently, the regulation reinforces the idea of gender disparities instead of guiding the minimum requirements for a gender-friendly environment.

WASH facilities must be of sufficient capacity and separated by gender to reflect students' needs

15 European Commission (2022). A study on smart, effective, and inclusive investment in education infrastructure: final report. Brussels, Directorate-General for Education, Youth, Sport and Culture.

The overall design of PLEs must include **gender-sensitive design considerations**. The classroom arrangement should promote inclusivity, which, depending on the cultural context, could be by creating nongendered seating arrangements where students can collaborate and interact without feeling restricted by traditional gender norms. Likewise, the design of common areas and social spaces must have flexible settings to promote a better sense of school community and inclusivity. Locker rooms and sports facilities should be designed considering the needs and privacy of all students. For example, individual changing rooms within locker rooms ensure students feel comfortable and safe.

Locker rooms and sports facilities should be designed considering the needs and privacy of all students

Lastly, appropriate management and maintenance practices ensure equitable PLEs. For example, one measure is enforcing accountability and securing funding for the maintenance of WASH facilities and **menstrual health and hygiene (MHH) services**. Another measure is providing the necessary cleaning and menstrual hygiene supplies and pairing these with training and education. This way, female students can attend school without worrying about equitable access to WASH facilities and MHH services, preventing long-term school repetition or drop-out.

Box 8. Case Study: Girls Empowerment and Learning for All Project—Angola

The Girls Empowerment and Learning for All Project, financed by the World Bank, aims to reduce gender inequalities and female learning poverty in Angola's education system and to make economic growth more inclusive in a country expected to have a 30 percent increase in the school-age population by 2030. In 2022, 34 percent of adolescent girls were out of school, only 15 percent had completed secondary education, and 22 percent had zero schooling. The country has the third-highest adolescent childbearing rate worldwide, and 51 percent of women are illiterate. In addition to providing financial incentives for girls to continue from primary to secondary school and introducing WASH education and school-related gender-based violence risk mitigation services, the project is expanding the supply of secondary-level classrooms and making existing schools more gender-friendly in regional "hot spots" of high child marriage and adolescent childbearing. As part of the project, the Ministry of Education is developing new School Construction Guidelines and model school designs that will apply a "gender lens," especially for WASH services, including ensuring separate, secure latrines, using the guidance provided in the World Bank's WASH in Educational Settings Toolkit. The project will also build WASH facilities in existing schools, 60 percent of which have no functioning toilets. The project is expected to be completed by 2025 to create 135,000 new school seats for girls.

Additional information: Angola - Girls Empowerment and Learning for All Project.

Accessible infrastructure

Providing access to PLEs for students and staff with disabilities is essential to allow their participation in learning and recreational activities and promote social interaction and engagement with the entire school community. New schools can incorporate inclusive spaces in the design and construction phase, while existing schools can adapt or accommodate existing spaces as part of a rehabilitation intervention to transform them into inclusive spaces.

Inclusive architectural design includes access to classrooms, learning spaces, libraries, and recreational spaces located at ground level but also at multiple levels of school buildings. The accessibility design must contemplate elevation and dimension considerations to facilitate the mobility of people with disabilities. **Ramps** with an adequate slope are usually a reasonable accommodation to access PLEs, especially at ground level for existing or new schools. However, in existing schools with no space to build ramps to access the second or third level, an alternative solution is the installation of **elevators**. In addition, the design of WASH facilities for students and staff with disabilities is essential to promote inclusivity. For instance, the space for **disability-compliant toilets/lavatories/urinals** has different dimensions and specifications to provide a comfortable experience for users. Considering these design standards forges inclusivity in school facilities.

Providing **assistive technology** (devices and equipment) for students with SEND helps them to engage in learning and recreational activities. Similarly, implementation of **disability signage** like Braille symbols, assistive listening systems, or sign language interpretation generates awareness and reinforces inclusivity in the school environment. Providing a special transportation service for students with disabilities in the surrounding areas guarantees spatial access to those students who struggle to commute by regular means of transportation. Finally, evidence has shown that implementing those accessibility standards and strategies into new construction in the planning stage has a negligible impact on total construction cost (approximately 1%) (World Health Organization and World Bank 2011).

Providing a special transportation service for students with disabilities in the surrounding areas guarantees spatial access to those students who struggle to commute by regular means of transportation

Box 9. Case Study: Tropical Cyclones Eta and Iota Emergency Recovery Project—Honduras

The World Bank is supporting efforts to construct inclusive and resilient school facilities through the Honduras Tropical Cyclones Eta and Iota Emergency Recovery Project. Many persons with disabilities continue to grapple with exclusion, marginalization, and limited access to essential services, particularly in education. This vulnerability is further exacerbated during disasters, where the lack of preparation and inaccessible facilities lead to the disproportionate exclusion of persons with disabilities.

Through the project, reconstructed schools incorporate universal design principles to ensure infrastructure or services are accessible by all without the need for adaptation. Ramps, railings, and accessible toilets are implemented to guarantee safer and more inclusive PLEs. These benefits extend beyond the educational sphere as many schools double as shelters during disasters, providing safer spaces for all citizens in future emergencies. Success factors in this project include a participatory design process via workshops involving local communities, parents, and teachers to gather their inputs on needs and technical advice from the World Bank and GFDRR.

Additional information:

- Honduras Tropical Cyclones Eta and Iota Emergency Recovery Project
- Building Inclusive and Resilient Schools in Honduras
- Enhancing School Accessibility in Comayagua, Honduras

Do you want to learn more about promoting inclusive PLEs?

(1) The UNESCO International Institute for Educational Planning has a website with policy options for addressing the challenge of school distance.

(2) Refer to the World Bank's Inclusive Education Resource Guide: Ensuring Inclusion and Equity in Education, which includes guidance for inclusive PLE planning and implementation.

(3) UNESCO's 2020 report School Accessibility and Universal Design in School Infrastructure provides a wealth of information on accessibility and universal design in PLEs based on evidence from five countries.

(4) UNICEF India's Making Schools Accessible to Children with Disabilities provides guidance on making school infrastructure accessible for children with disabilities.

(5) See Japan's A Collection of Exemplary Design of School Facilities for Special Needs Education for concrete design examples of disability-friendly PLEs.

(6) UNICEF's Inclusive Education Booklet Collection provides practical guidance on a range of topics related to disability-inclusive education, including Booklet 10, which covers PLEs.

(7) A Landscape Review of ICT for Disability-inclusive Education explains which tools can be introduced to PLEs to improve inclusivity.

(8) UNOPS's Infrastructure for Gender Equality and the Empowerment of Women provides: practical guidance on gender-sensitive and socially inclusive infrastructure, describing the most important considerations for gender mainstreaming and social inclusion; and specific tools and checklists to implement best practices.

(9) The World Bank's Costing a Tech-EnableD Disability Inclusive Education (TEDDIE) Intervention is an instrument comprising a costing tool and an implementation toolkit to help policy makers estimate the cost of procuring, using, and maintaining an intervention that leverages technology to support learners with disabilities.

5.3. Ensure Green PLEs

What is a green PLE?

A PLE is considered green when it reduces negative environmental impacts and avoids exacerbating climate change risks by: (1) minimizing its ecological footprint; (2) optimizing the use of resources; and (3) adapting to climate change. By reducing the negative impacts and maximizing the performance and comfort of school buildings through sustainable design and construction, a green school can improve IEQ and the thermal comfort of PLEs, while enhancing students' learning and promoting teachers' productivity. In the long run, a green school saves money in the operation and maintenance (O&M) of building systems due to the more efficient systems and higher quality of construction.

Why are green PLEs essential for education?

Green schools are rooted in the undeniable need to address the environmental crisis facing the world. While the direct links to learning impacts may not be immediately apparent, they are indeed significant. Green schools are thoughtfully designed to minimize the environmental footprint of PLEs by optimizing the use of resources. This approach can result in favorable indoor environmental conditions, including improved air quality and temperature, that are conducive to learning. Studies on green schools have shown that these healthy conditions positively influence learning outcomes. For example, a comparative study of Toronto schools (Issa et al. 2011) found that student, teacher, and staff absenteeism in green schools improved, together with students' academic performance. Teachers in green schools were in general more satisfied with their classrooms and personal workspaces than teachers in other schools, but less so with acoustics. Picking up this last point, tensions that arise between green design issues (for example, between energy savings and air quality for occupant comfort) need to be carefully addressed (Al horr et al. 2016). That said, opportunities exist to capture synergies: for example, a Danish study (van Mil et al. 2018) found that creating pools of light over worktables increased academic performance in math (concentrated study), led to reduced noise levels, and generated energy savings on lighting of around 68 percent. Another study (Korsavi, Jones, and Fuertes 2022) showed that since children generally feel comfortable at a cooler temperature than adults (but usually do not have control

Studies on green schools have shown that these healthy conditions positively influence learning outcomes

over the temperature), energy waste could be avoided 67 percent of the time during the heating season in naturally ventilated classrooms by reducing the set-point temperature and training school occupants when to operate windows. The key insight is to aim for green *and* learning-conducive solutions simultaneously.

Careful stewardship of resources in green schools can lead to reduced operating costs, freeing up funds for other educational priorities. By reducing the negative environmental impacts of PLEs, green practices contribute to breaking the cycle of challenges stemming from natural crises, thereby mitigating the adverse effects on resilience. More subtly, educational learning about green issues can be facilitated and made real by the physical reality of a green school.

How to ensure green PLEs? What are the key characteristics of green PLEs?

Energy efficiency

The energy efficiency of a PLE is related to: (1) the optimization of existing and future **embodied energy** associated with the materials and construction processes throughout the whole lifecycle of school buildings; (2) the **energy consumed** during the operation of school buildings; (3) the use of alternative **renewable energy and passive approaches**; and (4) the use of **sustainable transportation** modes to go to school.

Several alternatives can be implemented to reduce embodied carbon emissions during the whole life of existing buildings and in the construction processes of new ones. It is important to analyze the **embodied energy** of existing building structures to decide whether to rehabilitate or refurbish them or to demolish them and build new structures. If the latter, low carbon alternatives include choosing lower carbon materials, reusing or recycling materials, using fewer finishing materials, or maximizing structural efficiency to minimize materials. For example, low carbon alternatives such as wood and bamboo provide a more efficient green solution than more traditional materials such as steel, aluminum, plastic, and foam insulation (Salzer et al. 2017).

Low carbon alternatives such as wood and bamboo provide a more efficient green solution than more traditional materials such as steel, aluminum, plastic, and foam insulation

The measures for carbon emissions reduction related to **energy consumption** in PLEs vary from school to school due to their heating, ventilation, and air conditioning (HVAC) building systems (if any in place) and the various daily school activities. Generally, energy use is required for lighting, refrigeration, use of computer equipment, cooling, ventilation, heating, and water heating, among others needed for learning activities in a specific context. By conducting energy audits and understanding which school activities require energy, it

is possible to establish a baseline to measure the operational carbon consumption of PLEs and propose energy efficient measures. For example, a simple measure to increase energy efficiency in existing schools is to replace incandescent bulbs with energy-efficient LED lights (which also provide better illumination for learning activities); doing so will significantly decrease energy consumption as LED lights consume less energy and have a longer lifespan than traditional bulbs. The school's carbon footprint will be reduced given the lower GHG emissions associated with lower electricity use.

Renewable energy and passive design approaches will contribute to reducing energy consumption, enabling the provision of basic electricity for school activities. For example, implementing solar panels or wind turbines in existing schools can reduce reliance on traditional energy sources in areas where there is access to electricity. In remote areas where schools do not have access to electricity, solar panels can give schools a degree of energy independence to provide essential education services or to allow community activities. Furthermore, solar panels generate cost-savings due to lower energy bills, their long lifespan, and their lower maintenance costs in the long term. Once schools have invested in the initial installation costs, they can enjoy decades of free and clean energy. Incorporating from the start passive design strategies for cooling, heating, and ventilation—like courtyards or cross-ventilation—can provide a more comfortable environment for learners while reducing energy consumption.

Solar panels can give schools a degree of energy independence to provide essential education services or to allow community activities

Promoting active and **sustainable transportation** modes such as walking, biking, carpooling, and public transportation will help decrease carbon emissions associated with students', teachers', and staff members' commutes. Likewise, implementing bus- or van-sharing programs for field trips will reduce a school's carbon footprint.

Finally, a lifecycle cost analysis to estimate an intervention's full lifecycle costs—from immediate intervention (rehabilitation, retrofitting, or new construction) to costs related to O&M and final demolition—will increase the efficacy of the decision-making process. Including such a holistic approach can improve the long-term sustainability of PLE interventions.

Box 10. Case Study: Safer, Inclusive, and Sustainable Schools Project (P175308)—Romania

The Romania project aims to enhance the resilience, energy efficiency, and learning environment of selected schools while increasing institutional capacity for integrated investments in Romania's school infrastructure. Key energy efficiency activities include improving building insulation to reduce energy consumption, installing efficient heating and cooling systems, and where possible and cost-efficient, incorporating renewable energy sources such as geothermal heat pumps, solar hot water systems, and photovoltaic systems. Comprehensive energy audits are conducted to identify potential savings and inform these improvements. The project also explores broader sustainability measures like reflective roofs, rainwater harvesting, and zero waste practices to better manage climate change risks and promote sustainability in school operations. These measures aim to create a more sustainable and energy-efficient learning environment, contributing to the overall resilience and sustainability of school infrastructure in Romania.

Additional information:

- Romania - Safer, Inclusive and Sustainable Schools Project
- Romania Safer, Inclusive and Sustainable Schools

Water efficiency

This characteristic pertains to **water consumption** in WASH facilities, landscaping, heating and cooling, and kitchens or cafeterias. Conserving water has a direct impact on cost **savings** for school buildings (O&M) and reduces their ecological footprint while promoting sustainable practices for the school community. For instance, **wastewater reuse** mechanism for non-potable uses such as greywater for landscaping or flushing toilets can contribute with cost savings and promote sustainability simultaneously. Likewise, implementing water conservation technologies when constructing a new school building or rehabilitating an existing one is one of the most effective measures for water efficiency. For instance, installing faucet shut-off controls in lavatories, low-flow toilets, or zero-flow urinals helps monitor water use, when budget permits. This type of technology ensures these facilities are operating adequately and avoids unnecessary use of water. Improving irrigation techniques for landscaping contributes to reducing water use. Water efficiency must be considered during the design phase of the irrigation system to ensure optimal performance; this involves planning the irrigation schedule, estimating the amount of water required for the landscape, and considering the area's natural precipitation and the slope of the terrain during the design stage. For example, two measures to improve irrigation systems in existing schools are to: (1) hire a professional to audit the existing system to propose a water-efficient irrigation system; and (2) install or replace clock timers for water irrigation control. Another more expensive but highly efficient measure for new schools is rainwater **harvesting** systems for

Water efficiency must be considered during the design phase of the irrigation system to ensure optimal performance

toilet flushing and irrigation. Last, by implementing energy efficiency measures to reduce the need for cooling and heating for school activities, the amount of water required reduces as a causal effect.

Box 11. Case Study: Rainwater Systems in Schools—Burundi

The World Food Program Burundi and UNICEF Burundi installed rainwater harvesting systems, including hand-washing facilities, in various schools with school canteens in the province of Kirundo to facilitate hygiene in the school environment. These systems have greatly improved the lives of students and teachers by providing a reliable source of clean water. This initiative addresses the critical issue of water scarcity, ensuring that students have access to safe drinking water and proper sanitation facilities. The availability of water has not only improved hygiene and health conditions but also enhanced the overall learning environment, allowing students to focus better on their studies without the burden of water-related challenges.

The rainwater harvesting systems are a sustainable solution that promotes water efficiency by capturing and storing rainwater for various uses within the school. This approach reduces dependency on external water sources and mitigates the effects of water shortages, particularly during dry seasons. By implementing such systems, the school sets an example of environmental stewardship and resource management, demonstrating the importance of innovative solutions in addressing water scarcity and improving educational outcomes.

Additional information: Rainwater harvesting systems at school improve pupil's lives in Kirundo.

Waste management

The waste management characteristic refers to **construction waste** and the **daily waste** generated during the operation of school buildings and activities.

Implementing a waste management system to effectively dispose of **construction waste** and selecting construction materials both contribute to reducing the footprint of a green school. During the construction phase, the main goal is to divert construction waste and demolition debris from landfills. Diversion methods include: reducing the packing or unpacking of materials; using scrap materials effectively; recycling or returning materials; and contracting specialized firms to deal with specific materials. Some ways to mitigate the amount of packing (cardboard) are: purchasing materials in bulk; avoiding individually packed materials; using returnable containers; reusing nonreturnable containers; and designating multiple uses for plastic barrels. Recycling damaged products or materials is another successful action to consider during the construction phase.

The presence of a **waste disposal system** in a school to separate, reduce, recycle, and compost organic waste is the best waste management option. Separating waste requires labeled bins for different kinds of waste: paper, plastic, glass, cans, and organic waste. Reducing waste involves teaching the school community to recycle, reuse, and compost school waste. Reusing waste implicates creating a potential second use for waste, like using plastic bags as bin liners or teaching students to recycle paper for future school activities. Recycling waste requires connecting with local authorities in charge of recycling separated waste. And composting organic waste consists of separating organic waste like food or vegetable scraps, leaves, and grass clippings to properly dispose the separated waste or use it for composting the school gardens.

The presence of a waste disposal system in a school to separate, reduce, recycle, and compost organic waste is the best waste management option

Box 12. Case Study: Comprehensive Green School Initiative—India

The Government of Gujarat, India, initiated the Green & Sustainable School Program in 2013 to improve the quality and resilience of schools. Green & Sustainable School Program focuses on sustainable development, along with maintaining green in the context of ecological balance through the active participation of students, teachers, and the community. The program's aspect of 'Green' is about the present generation's responsibility to improve the future generation's life by restoring the previous ecosystem and resisting contributing to future ecosystem damage. The goal of the program is to sensitize and mobilize schools to become sustainable ecosystems and let children play a key role, with the following objectives to: (i) learn the importance and benefit of green schools, (ii) develop creativity and better understanding among the children, (iii) learn the concepts of science, mathematics, social science and language in the world around the children, and (iv) create innovative ideas for the society.

The program includes the following activities: (a) rainwater harvesting system and water management, (b) plantation, (c) solar energy and solar cooking, (d) energy conservation practices, (e) waste management, and (f) school safety plan and overall school augmentation & modification.

Over time of its implementation, the program helped to sensitize children and the community towards the environment, create favorable learning and teaching conditions, and enable the involvement of the community to sustain and maintain good practices as well as properties. Other effects of the program implementation included a healthier and more pleasant environment around school in the village/neighborhood, improvement of trust and faith of parents towards school, better health outcomes of children, and increased enrolment and retention of students. The program has been mobilizing resources and received support from a series of government and international projects.

Additional information:

- Gujarat Council of School Education
- Schools Go Green in Gujarat, India

Sustainable construction materials

The sustainable construction approach refers to: (1) the use, type, and source of **construction materials**; (2) the **passive design approach**; and (3) the **community-based approach** to build schools with local materials aligned with the cultural and local context of a certain area.

Sustainable materials for green PLEs should be reusable, biodegradable, recyclable, renewable, and energy efficient during the construction phase. Materials for rehabilitation or new school construction should be: environmentally friendly, to reduce the ecological footprint of the school; locally available, to reduce the environmental impact associated with transportation of materials and to promote local labor; affordable, to reduce construction costs; and locally appropriate for the specific context. Some sustainable construction materials are bamboo, wood, clay, compressed earth blocks, locally sourced timber, precast concrete, cork, reclaimed metal, insulating concrete forms, and timbercrete.[16]

Traditional or vernacular architecture provides solutions that can be key for sustainable construction

Traditional or vernacular architecture provides solutions that can be key for sustainable construction. The **passive design approach** usually responds to local climatic and weather conditions by using locally sourced materials, and consists of design strategies for daylighting, natural ventilation, and solar energy. For instance, thermal chimneys (used for centuries) can significantly improve the natural ventilation of indoor spaces. A **community-based approach** during the planning, design, and construction phases contributes to inclusivity, affordability, and community participation, ensuring that cultural and contextual needs are addressed while fostering a sense of ownership and commitment. By incorporating local architectural styles, traditional construction techniques, and local construction technologies, the school becomes more of an inclusive space that respects the community identity. Such a community approach is cost-efficient given the use of local materials, labor, and expertise.

16 Timbercrete is an environmentally friendly construction material, produced from a mixture of sawdust and concrete. It reuses waste products and replaces some energy-intensive components of conventional concrete.

Box 13. Case Study: Building Ecological and Sustainable Schools—Burkina Faso

The Kéré Foundation has built innovative constructions for educational facilities in Burkina Faso since 2001. The sustainable architecture combines local knowledge, sustainable materials, and modern construction techniques. The first and most renowned project is the Gando Primary School in the province of Boulgou, built cooperatively by the whole community. The school design addresses common problems of PLEs in the area, such as poor lighting and ventilation in addition to high costs, a lack of resources, climate issues, and construction affordability. The main construction material to create structurally robust bricks is clay/cement hybrid (clay is typically used in the area for traditional housing). It is easy to produce, provides thermal comfort against the hot climate, and is locally available. Throughout the design and construction process, working with local masons, traditional building techniques and modern engineering methods were combined to produce the best-quality building solutions while simplifying construction and future maintenance. After the first the primary school, the Foundation built additional amenities for the school campus and the community, including a primary school extension and teachers' housing. More amenities still under construction include a library, a secondary school, and a women's center.

Additional information:

- Kéré Foundation
- Gando Primary School

Do you want to learn more about ensuring green PLEs?

(1) UNOPS's Infrastructure for Climate Action highlights some of the key steps that practitioners can take to ensure infrastructure projects incorporate climate adaptation and mitigation measures, while still aiming for long-term sustainability.

(2) Read the brief on Embodied Energy for recommendations to reduce energy consumption in the production of a building.

(3) Review the Inter-American Development Bank's (IDB) Module 3: Environmentally Friendly School Infrastructure, Module 4: Energy Savings, Efficient Use, and Alternative Technologies, Module 7: School Green Areas, and Module 8: Selecting and Using Sustainable Materials. These modules cover planning for new and existing schools, estimating energy use, assessing green spaces, and offering recommendations to cut energy use, boost greenery, and establish ongoing monitoring.

(4) The World Bank's Education Sector Note on Applying the World Bank Group Paris Alignment Assessment Methods outlines sector-specific issues for applying the Bank's Paris Alignment assessment methods to operations with education sector activities.

(5) The World Bank's Greening Public HD Buildings in Croatia identifies and proposes how to address key regulatory and implementation challenges and best practices in green design, construction, and renovation of public Human Development buildings.

(6) The World Bank's Designing Energy Efficient Kindergarten in Russia discusses an example of an early childhood development facility intervention in the Khanty-Mansyisk region of the Russian Federation and its potential to produce efficiency gains.

(7) OECD's Climate-resilient Infrastructure highlights emerging good practices and remaining challenges across OECD and G20 countries.

(8) Maximizing Climate Co-Benefits in Education Operations provides step-by-step guidance on how to integrate climate action within Education (EDU) operations and maximize Climate Co-Benefits (CCBs).

(9) See Bali's Green School and Kenya's Uaso Nyiro Primary School for concrete design examples of green PLEs.

(10) Watch a summary video on Africa's Waterbank School project that discusses the potential of rainwater harvesting in schools.

(11) The Greening Public Human Development Buildings in Croatia policy note identify, first, how to address some of the key regulatory and implementation hurdles that Croatia is facing in greening their HD infrastructure while improving HD outcomes; and second, to compile best practices and examples in green design, construction, and renovation of public HD buildings.

5.4. Create Healthy PLEs

What is a healthy PLE?

A PLE is considered healthy when it provides the conditions for students and teachers to: (1) remain in good health; and, more than that, (2) thrive physically and mentally. As living organisms, people have fundamental biological needs for cleanliness in their surroundings if they are to avoid illness. We are also only able to operate in quite restricted ranges of, for example, temperature, beyond which we become uncomfortable. Unpleasant as this is in itself, being outside of our comfort zone also undermines our capacity to concentrate and learn. It should be remembered that the most basic purpose of habitations, such as schools, is to create microclimates that are protected from the unmediated rigors of the weather/climate.

Why are healthy PLEs essential for education?

Healthy PLEs are fundamental to effective learning in two ways. First, PLEs with healthy environments help prevent physical illness, ensuring that students can attend classes regularly and focus on their studies without the hindrance of health-related issues. Second, a positive internal environment is crucial for maintaining students' concentration and fostering their enthusiastic engagement with their education. Providing healthy PLEs supports students' physical well-being, as well as their academic success.

Access to WASH services in schools has been linked to better health and increased attendance rates for girls (Bundy et al. 2005; Adukia 2017; Ortiz-Correa, Resende Filho, and Dinar 2016). The UN estimated that in 2020 about "a quarter of primary schools globally do not have access to basic services such as electricity, drinking water and basic sanitation facilities" (UN Secretary-General 2023). World Bank guidance (World Bank 2020) about WASH clearly spells out the need for not just sanitation, but also good handwashing facilities, without which the transmission of diseases in likely to occur. A study focused on poor-quality drinking water in U.S. schools revealed that it directly correlates with reduced test scores (Marcus 2023). The general condition of school facilities has also been found to have a strong impact on teachers' attendance at work (Chaudhury et al. 2006) and their intention to remain in the teaching profession at all, more so than salary levels (Buckley, Schneider, and Shang 2004; Plotka 2016). For students, a study investigating the impact

The general condition of school facilities has also been found to have a strong impact on teachers' attendance at work

of the building condition of 236 schools on academic achievement (Maxwell 2016) found that it accounted for 70 percent of the variance in the outcome measures, as mediated by the impact on the school's social climate and student attendance.

Incorporating good design elements—such as windows, shading and cross ventilation—plays a significant role in achieving a high level of IEQ. Factors such as appropriate daylight (Rea, Bullough, and Figueiro 2001), artificial light levels (Winterbottom and Wilkins 2009), air quality (Coley, Greeves, and Saxby 2007; Bakó-Biró et al. 2012) and temperature (Wargocki and Wyon 2007), and good acoustics (Klatte et al. 2010) and the absence of nuisance noise (Shield and Dockrell 2008) are all essential for meeting basic human physiological needs. Where these are not within acceptable limits, pupils' capacity to learn is eroded. Taken together these factors have been shown to explain 8 percent of the variation in pupils' academic performance (Barrett et al. 2015). Views of nature (Benfield et al. 2015) have been linked to higher test scores, while access to outdoor spaces and the presence of natural elements within the classroom—such as plants or wooden furniture—have been found to positively influence writing activity (Mårtensson et al. 2009; Barrett et al. 2016). This effect seems to be stronger for students' self-directed activities than for passive listening (López-Chao, Lorenzo, and Martin-Gutiérrez 2019), a finding aligned with literature on the positive links between exposure to nature and enhanced creativity in play (Campbell and Frost 1985).

Views of nature have been linked to higher test scores, while access to outdoor spaces and the presence of natural elements within the classroom—such as plants or wooden furniture—have been found to positively influence writing activity

Finally, assuming that a school was built to a good standard in the first place, it is essential to maintain it in good condition over the decades that it will typically remain in use. Without this, the state of the building will inevitably deteriorate. One of the biggest risks is that spaces become damp and spores proliferate, negatively impacting occupants' health, especially in relation to respiratory diseases. For example, a European study found that dampness and mold problems caused respiratory-related absenteeism in Finnish schools (Borràs-Santos et al. 2013). In addition, if surface finishes are not well maintained and, where appropriate, painted, keeping them clean becomes problematic. This increases their likelihood of harboring infections and leading to person-to-person transferal. As the World Health Organization (2018) states: "Well-designed, well-constructed, well-maintained building envelopes are critical to the prevention and control of excess moisture and microbial growth" (p. 92) [and] "There is no exposure value for mold growth that can be considered safe for health" (p. 91). On a positive note, evidence shows that, mediated by the social climate and a desire to attend school at all, a school in good condition improves students' educational outcomes (Maxwell 2016).

How to create healthy PLEs? What are the key characteristics of healthy PLEs?

Adequate basic provision

To achieve healthy schools, a minimum level of basic utilities is a prerequisite to underpin the creation of healthy conditions that help avoid negative consequences, especially ill health. For example, an adequate supply of clean, potable **water** is vital, providing drinking water to avoid dehydration and for washing hands to avoid, or at least minimize, the transmission of diseases. Likewise, as pupils and teachers spend many hours each day in school buildings, they need access to **WASH facilities** including good-quality sanitation, such as toilets, as well as a hygienic and **functioning sewage** disposal system. Without these necessities, attendance reduces, and the risk of illness rises.

An adequate supply of clean, potable water is vital, providing drinking water to avoid dehydration and for washing hands to avoid, or at least minimize, the transmission of diseases

Underlying these requirements and the IEQ factors discussed next is the provision of power, usually **electricity**. Pumps and controls for water and sanitation and for cleaning equipment rely on power. Similarly, without power, heating (and possibly cooling) and lighting is hard to deliver, as is ICT infrastructure.

Box 14. Case Study: Lilongwe Water and Sanitation Project (LWSP)—Malawi

In 2022, Chisiyo Primary School in Lilongwe, Malawi, faced a severe water and sanitation crisis, with erratic water supply and dilapidated toilets insufficient for its 4,500 students. According to WaterAid (Malawi), adequate WASH services remain a big challenge in most schools in the country, with some lacking sanitation facilities and less than 5 percent providing handwashing facilities with soap. Without WASH facilities in schools, children are more likely to get ill and miss out on an education. This situation heightened the risk of waterborne diseases, including cholera, and negatively impacted students' health and attendance, particularly for girls. The 2022 cholera outbreak in Malawi saw 10,823 reported cases and 316 deaths, exacerbated by poor sanitation and lack of safe water. With support from the World Bank-financed Lilongwe Water and Sanitation Project (LWSP), over 25,000 students from 12 primary schools in urban Lilongwe now benefit from improved water supply and sanitation facilities. Chisiyo Primary School, for example, received a new water connection and four new toilet blocks by the end of 2023, significantly improving sanitation and hygiene conditions. To ensure sustainability, students contribute 100 Malawi Kwacha ($0.059) each per term towards the water bills, ensuring uninterrupted water supply. The intervention is expected to lead to better health and increased school attendance, contributing to improved learning outcomes. Additionally, the LWSP provided clean water and sanitation facilities to communities in Lilongwe, reaching around 13,600 people. This initiative highlights the critical impact of adequate WASH facilities on education and community well-being.

Additional information:

- Improving Water and Sanitation Facilities in Malawi's Urban Schools for Better Learning Outcomes
- Lilongwe Water and Sanitation Project

Indoor environmental quality

This characteristic seeks to ensure a healthy indoor environment in PLEs to improve students' performance and teachers' productivity. The school building design should provide students and staff with: good **indoor air quality**, adequate **natural and artificial lighting**, comfortable **temperature and humidity levels**, acceptable **acoustic** conditions, and access to **green spaces**.

In many situations good **indoor air quality** in schools can be achieved by opening windows, ideally on opposite sides of the classroom and at different levels, encouraging natural cross-ventilation.[17] This enables the exchange of indoor with outdoor air, such that the increased air turnover in the space ensures a regular supply of fresh air. This is facilitated by positioning buildings to exploit prevailing winds, with, if possible, any smell-producing facilities downwind. In most classrooms with typical occupancy, the air quality will become poor if some sort of air exchange is not induced. It can be hard to recognize poor air quality, but a relatively cheap carbon dioxide monitor can help train occupants to be sensitized to this issue. Monitors can be used to check for other air pollutants too. If a mechanical HVAC system is being used, its performance should be monitored and maintained by inspecting filters, checking airflow rates, and controlling the source of contaminants to ensure enough clean and fresh air flows in the room.

It can be hard to recognize poor air quality, but a relatively cheap carbon dioxide monitor can help train occupants to be sensitized to this issue

Adequate **lighting** for comfortable learning environments can be obtained through natural daylighting but also complemented with energy-efficient lighting systems such as LED lights. Solar orientation and room layout can improve the lighting of indoor spaces. Buildings should be oriented on the site to optimize solar gain and natural light exposure. Window placement, external shading devices, and room layout can allow a reasonable amount of natural light in while minimizing heat gain.

Achieving comfortable **temperature and humidity levels** is assisted by good choices regarding orientation and the provision of external shading and features that encourage cross-ventilation, as mentioned above. In addition, fans can help with temperature control and enhance air circulation in indoor spaces. Likewise, standalone humidifiers/dehumidifiers increase/reduce humidity levels to avoid dryness or mold growth in school spaces. If an HVAC system is present/planned, its size and capacity should be maintained/designed to provide sufficient air distribution, controlled levels of humidity, and proper airflow and ventilation.

17 Natural cross-ventilation is a design approach to guarantee a space is well ventilated. It consists of placing windows in parallel walls with the same dimensions and at the same level.

Acceptable **acoustic performance** can be obtained through the design or adaptation of school spaces, including their location. For most normal spaces with reasonable levels of occupancy, sound-absorptive surfaces—such as acoustic ceiling tiles or wall panels and maybe carpet tiles to floors—help reduce noise reverberation and can create a reasonable acoustic environment. This can be challenged by noise from adjacent sources such as other classrooms, noisy areas like music rooms and gymnasiums, or nearby roads. The best approach is to not place those noisy spaces close to classrooms, although this is unavoidable sometimes. Here, ensuring sufficient mass in the separating elements (walls and floors) and sealing gaps or openings to minimize sound transmission between adjacent spaces can provide the necessary insulation. However, if classrooms are too crowded and/or furniture without sliders/leg protectors is dragged across floors, then the only solution may be behavioral: pupils will have to reduce their noise levels.

Access to **green spaces** in schools can contribute to various aspects of student well-being, creativity, and educational experiences. The presence of natural elements in the classroom is thought to be beneficial to students' and teachers' well-being and particularly their creativity. This can be achieved through furniture made from natural materials (typically wood), the presence of plants within the space, and views of nature out of the windows. Beyond this, accessibility from classrooms to green outdoor areas offers additional spaces for learning and recreation. Linked directly to classrooms, green outdoor areas can act as an extension of the internal space, sometimes incorporating a covered region that also provides external shading to the classroom. Green areas provide opportunities for students to engage with nature, fostering environmental and sustainability literacy, and enhance students' health and well-being by promoting a sense of connectedness to nature. Incorporating features like vegetable gardens between buildings allows for gardening and cooking activities, encouraging hands-on learning experiences. Additionally, green spaces—encompassing gardens, trees, and open landscapes—create conducive environments for recess, recreational activities, and various learning activities. The inclusion of green spaces not only contributes to student performance but also enhances the overall comfort and satisfaction of the school community.

Green areas provide opportunities for students to engage with nature, fostering environmental and sustainability literacy

Box 15. Case study: Cool roofs promote learning in classrooms—Tanzania

In Tanzania, as in other countries, heat stress presents a growing threat to learning. By 2070, projections suggest that the annual number of hot days (where temperatures exceed 30°C) could more than double. For children in hotter regions - and in classrooms with construction features such as corrugated iron roofs and lack of window shading – this implies growing risk to education outcomes. The UK's EdTech Hub partnered with teachers in Pwani, Dodoma and Mora districts to pilot structural interventions to classrooms and measure impacts on indoor temperatures. School roofs were painted white on selected buildings. Sensors installed in classrooms revealed that temperature regularly reached 37°C prior to the intervention. A global meta-analysis of studies has suggested that a 1°C temperature reduction increases standardized test outcomes by around 2% (Wargocki et al. 2019). Replacing corrugated iron roofs (which absorb 50-90% of incoming thermal radiation) with white roofs cost approximately $300 per classroom. The white paint interventions were shown to reduce peak temperatures by approximately 3°C. Projections based on the measured heat stress reduction and local learning outcomes data indicate that scaling up cool roof interventions – and other passive design measures including solar shading, ventilation, orientation, and building materiality – offer a high benefit-cost ratio through averting learning loss due to excessive classroom heat.

Additional information:

- Should we paint all classroom roofs white to improve learning in Tanzania?
- The relationship between classroom temperature and children's performance in school

Effective maintenance

Buildings are put together with a "design life" in mind. This is often taken for granted, but in some fast-moving sectors (that is, retail or office), a building's lifespan can be as short as 10 years. For schools, a long-term perspective is more usual, and a 60-year design life is typical. This is tantamount to saying a school should last for the foreseeable future, and with **good maintenance** buildings can last for many decades. Less appreciated is that subcomponents of a building are not expected to last as long and periodic renewal should be expected. For example, windows and boilers typically last around 20 years, and internal or external decorations perhaps 5–7 years. It is routine to distinguish maintenance expenses from capital spending, and small budgets may be allocated at school level for O&M, often on an annual or biannual basis.

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Ideally, for significant subcomponents with a relatively long lifecycle, such as roof finishes, a "sinking fund" should be maintained so that when it is time to replace something, money is available. In practice, this is hard to achieve when there is a shortage of funds and more immediate educational demands. The problem is that, left unaddressed, the work needed will accelerate as the building ages and deteriorates. Thus a plan is needed

for when and which elements of school buildings may need attention, so that "planned maintenance" is possible. Schools may then either fund the work or seek funding from elsewhere. Of course, this should be considered when schools are built. Taking a "whole lifecycle" perspective at that point will ensure that the building is relatively easy to maintain. For example, the contract to build could include a requirement to provide 30 years O&M.

One more area of concern globally is lead pollution and should be assessed while implementing painting related activities in existing or new PLEs. According to recent studies (Larsen & Sánchez-Triana 2023), lead poisoning has massive effects on children's cognitive development and grownups' health outcomes. The global cost of lead exposure was USD 6.0 trillion (range 2.6–9.0) in 2019, which was equivalent to 6.9 percent (3.1–10.4) of the global gross domestic product. 77 percent (range 70–78) of the cost was the welfare cost of cardiovascular disease mortality, and 23 percent (22–30) was the present value of future income losses from IQ loss. The United States Environmental Protection Agency has developed a Lead Renovation, Repair and Painting Program (RRP), which recommends auditing all school buildings constructed prior to 1978 for dangerous lead pollutants. The program provides recommended test kits[18] that may be used to evaluate the level of lead in the paints within the building and recommend necessary action for replacement/repainting. Other countries are also taking action on this issue; see (Coulter et al. 2024).

Smaller, more routine/frequent maintenance items are normally handled at a local level. Such maintenance ranges from daily cleaning to weekly refuse removal to annual painting or other decorating. The presence of hazardous materials in the structure should be avoided, especially if they can enter the air as particulate matter that could be released by preparation work for decoration (or more significant alterations to the structure). Refuse should be collected and disposed of efficiently and hygienically to avoid conditions that attract vermin and their associated health risks. Funds for external and internal decorations could be spent cyclically so that recurrent costs are spread over the years. Although decoration sounds like a low-level priority, its neglect, especially external maintenance, can quickly escalate to create significant functional problems. The role of communities is critical for the proper maintenance and safety of schools. School management committees or other community-based structures can accumulate the "sinking fund" to cover the costs of materials or necessary services. In many cases, parents and local communities contribute to school maintenance in labor or materials. In remote areas, WASH facilities also require regular maintenance, therefore accumulation of funds by the local community might be a functioning mechanism of the regular maintenance.

School management committees or other community-based structures can accumulate the "sinking fund" to cover the costs of materials or necessary services

18 https://www.epa.gov/lead/lead-test-kits

Box 16. Case Study: Maintenance Management in Schools: Ministry of Education—Panama

The Ministry of Education (MEDUCA, in Spanish) of Panama implemented a school maintenance program named "Jornada de Mantenimiento" between 2015–2017. The program was designed with a community participation approach to conduct maintenance works in public schools across 10 provinces during the summer recess time. The program involved the participation of officials from MEDUCA; other government institutions such as the Ministry of Housing, Ministry of Environment, and Ministry of Health, among others; the military special forces; and individuals from the school community such as parents and teachers. The "Jornada de Mantenimiento" was a joint community effort that included the cleaning of green spaces, painting, basic repairs on the plumbing and electricity system, repair of furniture, and building of temporary classrooms.

Additional information: Jornada de Mantenimiento y Aseo en Escuela de Utivé.

Do you want to learn more about creating healthy PLEs?

(1) Read UNICEF's Drinking Water, Sanitation and Hygiene in Schools: Global Baseline Report 2018 for a better understanding of the state of WASH.

(2) Explore the World Bank's Operational Toolkit for WASH in Health Care Facilities and Schools, which contains nine modules to support all aspects of implementation, with a focus on sustainability and effective use of WASH services, and incorporates considerations for gender and inclusion and guidance on climate-resilient infrastructure and services.

(3) The World Bank's Menstrual Health and Hygiene Resource package guides task teams on how to design and monitor effective, inclusive, and sustainable menstrual health and hygiene initiatives as part of their WASH interventions.

(4) Explore the rationale behind countries' investments in school health and school feeding, uncover existing challenges, understand the significance of SABER School Health and School Feeding.

(5) Read WHO's Improving Health and Learning through Better Water, Sanitation and Hygiene in Schools, which helps assess the most important aspects of WASH in schools, identify gaps and priorities, and come up with a school-specific WASH improvement plan and a health-promoting school policy.

(6) Read the Clever Classrooms report, which highlights the significant impact of naturalness (light, temperature, and air quality), accounting for one-half of the learning impact.

(7) The Framework for Effective School Indoor Air Quality (IAQ) Management includes guidance documents and resources to help schools develop and sustain effective and comprehensive Indoor Air Quality management programs, or other overall health and safety initiatives. For additional evidence and guidance on improving the IEQ of PLEs, see Harvard's Schools for Health report.

(8) Read Chapter 7 of the World Bank's School Construction Strategies for Universal Primary Education in Africa, which briefly touches upon the type, cost, and schedule of each maintenance activity.

5.5. Foster Teaching- & Learning-Conducive PLEs

What is a teaching- & learning-conducive PLE?

Teaching- & learning-conducive PLEs are those that positively influence student engagement, teacher productivity, and the learning climate, ultimately affecting learning outcomes.

To enable an effective teaching and learning process, PLEs should provide sufficient space for learning and a positive ambient spatial experience in terms of the level of stimulation and options for ownership afforded. To be teaching- & learning- conducive, PLEs must ensure that spaces are: adequately aligned with the curriculum, provided with good quality furniture and ICT options, so that they are flexible and adaptable to accommodate current pedagogies as well as evolving ones.

Why are teaching- & learning-conducive PLEs essential for education?

Research over the past several decades has demonstrated the link between the design and physical conditions of PLEs and learning outcomes, shedding light on the disadvantages and lost learning opportunities caused by existing underperforming PLEs. Data show strong linkages between the design of PLEs and student learning outcomes, including critical 21st century skills. For example, an analysis of data from 21 Sub-Saharan African countries showed that when the condition of PLEs changed from “extremely bad” to “extremely good,” student performance increased by 10 percent of one standard deviation (Fehrler, Michaelowa, and Wechtler 2009).

PLEs have the potential to positively influence student engagement, teacher productivity, and learning climate, ultimately affecting learning outcomes (Barrett et al. 2015; Barrett et al. 2019). Small class size (low pupil:teacher ratios) is known to positively impact learning (Blackmore, Bateman, and Loughlin 2011), but is expensive. Adequately sized classrooms that can reasonably accommodate students are essential to avoid cramped conditions, which can lead to reduced academic performance and behavioral problems (Maxwell 2003). A comparative study of students in India in “contained” spaces with limited views out found they experienced greater incidence of depression and anxiety and reduced productivity (F. Asim, Chani, and Shree 2021). But the issue of space goes beyond mere comfort and is strongly related to the flexibility of space usage (Abbas and Othman 2010); for example, the ability to adapt the classroom layout to align with desired pedagogical

But the issue of space goes beyond mere comfort and is strongly related to the flexibility of space usage

approaches is crucial and probably requires participatory design between educationalists and designers (van Merriënboer et al. 2017).

Factors such as having an attractive, distinctive space (Kumar, O'Malley, and Johnston 2008), good-quality, age-appropriate furniture (Leung and Fung 2005), and opportunities for students to display their work (Maxwell and Chmielewski 2008) all play a significant role in creating a balanced and engaging learning environment. It is important that the visual complexity of spaces (Fisher, Godwin, and Seltman 2014) and the use of color (Godwin and Fisher 2011) strike a balance that avoids both chaotic and monotonous spaces, so that the ambient stimulation is optimal for learning. Research evidence has highlighted the importance of factors such as students' sense of ownership and choice within their classroom. Taken together, the above factors have been found to explain 8 percent of the variation in learning (Barrett et al. 2015).

Highly flexible spaces with less structure may not suit all students

Little consensus exists on the optimal pedagogy employed within spaces, but interestingly, a study conducted in Russia demonstrated positive learning impacts even with just *some* use of alternative teaching approaches instead of the usual front teaching approach (Shmis et al. 2021). An Australian study (Imms and Byers 2017) found that alternative, flexible arrangements of furniture had definite impacts on teachers' practices and students' perceptions, but more mixed impacts on math achievement. These last were positive for a high-achieving group and positive and negative, respectively, for two mixed-ability groups. This suggests that highly flexible spaces with less structure may not suit all students. For example, a Canadian study (Halidane et al. 2023) found mixed mental health impacts of flexible seating options, which were generally positive for girls, but negative for boys and, it would seem, for teachers. Care is especially needed for students with disabilities where innovative spaces are being created (Page, Anderson, and Charteris 2023). This highlights the need to not simply drive pedagogical change through imposed space arrangements (Byers, Imms, and Hartnell-Young 2018), but rather to seek a fit with students' and teachers' needs and aspirations now and, through built-in flexibility, in the future. In terms of spaces conducive to learning, these findings emphasize the importance of creating flexible arrangements in schools that could support diverse pedagogies without a necessity of significant reconstruction. This applies to newly designed schools for the most part. As to the existing PLEs that need interventions, creating more flexible solutions should be considered at the design stages where possible, and flexible furniture solutions may also be applied.

To be "fully functioning," a school must be adequately equipped for learning with good-quality desks, tables, and chairs, which are "conducive to learning" (Glewwe et al. 2011). However, the use of ICT in schools carries more complex effects. An OECD study found that moderate levels of ICT use in the classroom can be beneficial, but too much can have serious negative impacts on achievement. "The results show no appreciable improvements in student achievement in the countries that had invested heavily in ICT for education ... ensuring that every child attains a baseline level of proficiency in reading and mathematics seems to do more to create equal opportunities in a digital world" (OECD 2015).

The alignment between the spaces and the learning process starts during the design phase. To embed an educational perspective into the PLE design, a participatory process is critical when constructing and refurbishing schools. This approach connects the physical spaces with the learning process, ensuring a better match between design and use. As described in the "Constructing Education" framework (Duthilleul et al. 2021), participatory design should be embedded in the process to ensure that key measures, such as the interaction between educators and architects and the consideration of the experiences and opinions of different stakeholders (city officials, school principals, and teachers) are addressed in the design phase.

To embed an educational perspective into the PLE design, a participatory process is critical when constructing and refurbishing schools

How to foster teaching- & learning-conducive PLEs?

Adequate capacity

The size and density of occupation of classrooms plays a critical role in teacher/student and student/student relationships. Uncomfortable environmental conditions such as high temperatures, high noise levels, and overcrowding can cause interpersonal disputes, hostility, and even violence (Griffit and Veitch 1971). Strong evidence from around the world supports the benefits of smaller classes, including better academic results (Blackmore, Bateman, and Loughlin 2011; Brühwiler and Blatchford 2011).

This is a good example of the complex dynamics in achieving optimal learning environments by providing **sufficient space for learning**. If classrooms are too crowded, there is a problem unless class sizes are reduced. This is often achieved by introducing shift systems, but these reduce and erode the quality of pupils' time in school. Ideally, more classrooms should be built, but in dense urban spaces this can be difficult. In either case, more teachers are needed. Going beyond the PLE, a low student:teacher ratio is the surest way to improve results but is expensive. Thus any discussion of adequate PLE capacity

has to go hand-in-hand with consequential staffing and pedagogical considerations, or any partial solution will not work in practice.

Finally, overall school size can impact education outcomes. A major literature review (Leithwood and Jantzi 2009) on school size concluded that smaller schools contribute positively to student outcomes, including higher student achievement, better attendance, higher graduation rates, and greater engagement in extracurricular activities, especially for disadvantaged children (Leithwood and Jantzi 2009).

Box 17. Case Study: School expansion—Rwanda

A remarkable case of school infrastructure expansion is the project Quality Basic Education (financed by the World Bank) in Rwanda, which demonstrated that school capacity plays a key role in accessing education and reducing overcrowding. The project aimed to reduce overcrowding, double-shifting, and distance to schools. During the project, 22,500 classrooms, 31,000 gender-segregated and accessible toilets, and accessible handwashing stations were constructed in 1,100 schools. As a result, the student:classroom ratio decreased by 33 percent at the primary level, from 73 students per classroom in 2019 to 49 in 2021. In addition, 2.07 million 5- to 14-year-old children (64 percent of the relevant age group) now live in a 2-kilometer (km) catchment area of the new schools and classrooms; of these, 68,000 were saved from walking very long distances (previously 5–7 km).

Additional information: Rwanda - Quality Basic Education for Human Capital Development Project.

Optimal spatial experience

The spatial experience is easy to overlook, but the **ambient** qualities of spaces we inhabit affects how we feel, behave, and perform. To be conducive to learning, it is now known that the general level of **stimulation** and the opportunities for **ownership** matter.

In fitting out and decorating spaces, and when teachers “dress” their classrooms, it is important not to create a chaotic or boring ambient spatial experience. This relates to the background **level of stimulation** provided by the space, which should be pitched at a moderate level. The overall effect is made up of a combination of several factors, which can be balanced out. This involves the visual complexity of the space (including the roof structure if visible), the colors used on the walls, and the effect of displays on the walls and (sometimes) hung across the room. It sounds complicated but is quite easy to assess if the teacher just stands back and takes a bird’s eye view.

In fitting out and decorating spaces, and when teachers “dress” their classrooms, it is important not to create a chaotic or boring ambient spatial experience

As well as giving pupils a choice of learning settings to suit their needs, as far as possible the classroom should acquire a distinctive character that reflects students' "**ownership**" of it. This can be reflected, for example, in the room's decoration, displaying students' work and putting their names (and maybe pictures) on their trays for their exercise books or lockers. The aim is to create the opposite of an anonymous box, but rather a distinctive space about which pupils can rightly say "This is our classroom."

The classroom should acquire a distinctive character that reflects students' "ownership" of it

Box 18. Case Study: CECREA, Centros de Creación, Ministry of Cultures, Arts and Heritage —Chile

Chile's CECREA "Centros de Creacion" programme, launched in 2014 as part of Chile's Educational Reform, fosters creativity in children and youth through arts, sciences, technology, and sustainability. It responds to Chile's low PISA 2014 creativity scores by providing interactive learning spaces. Co-designed with underserved communities, CECREA uses continuous participation of 7–19-year-olds ("Escuchas" or listening sessions) to tailor activities. Workshops and experiences support collective and individual projects within and outside school hours, empowering young minds to explore and innovate.

Centers exist nationwide with flexible, purpose-built infrastructure that adapts to users' needs, ensuring creative stimulation. The architectural design of CECREA centers was shaped by the actions, emotions, and sensations expressed by children during the "Escuchas," resulting in the creation of different spaces:

Spaces for Imagining and Creating

- Dirty space for hands-on creativity with washable materials and display walls.
- Clean space for robotics and programming.
- Soundproof sound space for music and recording.
- Movement space with double-height area for physical activities.
- Communication space for broadcasting and discussions.
- Semi-outdoor workshop space for construction and experimentation.

Spaces for Gathering, Debate, and Leisure

- Welcoming active waiting area with displays.
- Cozy quiet lounge for reading and reflection.
- Interactive loud lounge for dancing, playing, and music.
- Plaza forum for debate and civic engagement.

Adaptable Support Structures

The building design incorporates metal mesh walls for children's use as a multipurpose canvas, ceiling structures for hanging elements, and outdoor areas for nature-based activities, allowing for ongoing transformation that promotes ownership and engagement with the PLE.

Additional information: CECREA.

Fit with pedagogy

Increasing the effectiveness of PLEs is not only about investing more but also investing more wisely through designs with proven potential to enhance teaching and learning processes.

Primarily, PLEs' design needs to support the current or planned curriculum to ensure the availability and alignment of **spaces,** and of the **school as a whole,** with the expected teaching and learning activities that will take place in them. Classrooms, laboratories, libraries, and other facilities should be designed to facilitate the teaching methods and subjects outlined in the curriculum. Appropriate coordination is essential between the architect's work on the school design and pedagogical teams in charge of curriculum design and implementation. This is a process of developing a shared understanding, so it is important to establish feedback mechanisms involving teachers, students, and parents to allow dialogue on the effectiveness of the school building in supporting the curriculum and using this feedback to make necessary design improvements.

PLEs' design must ensure that classrooms can **flexibly** accommodate evolving pedagogies, support different types of learning, and allow individualization. As teaching methodologies and learning approaches continue to evolve, classrooms need to be as flexible as possible. While traditional classroom configurations may still be relevant in many cases, new school infrastructure investments should be future-oriented and capable of meeting changing requirements throughout their lifespan, for example by incorporating adjacent, linked rooms of various sizes to provide "agile" options. Moveable wall partitions between classrooms can allow for easy but more radical adjustments in size and configuration, enabling spaces to be arranged, combined, or separated as needed. The proposed changes are also relevant to existing schools that can be renovated or reconstructed. Not every design would allow for the integration of movable walls, but small adjustments in combination with furniture and equipment may create better learning spaces. Within classrooms, the possibility of creating a variety of learning zones with different characteristics is desirable. For example, primary schools can designate a wet area, a reading area, and options for group and individual work. With sufficient space, much of this can be achieved with furniture (Box 19).

Within classrooms, the possibility of creating a variety of learning zones with different characteristics is desirable

PLEs as a whole (schools) can be conceived to support diverse types of learning activities. More than 20 (Nair 2009) types of learning activities have been identified but to support these, PLEs need to offer different types of spaces. So, the careful spatial design of individual classrooms can facilitate activities, such as teamwork, individual

work, project work, learning through play, artistic work, etc. However, this flexibility can be extended through the use and connectivity across various learning spaces, such as collaborative workspaces, outdoor learning facilities, and libraries. In situations where it is not spatially feasible or cost-effective to accommodate specialized classrooms, such as science laboratories or art rooms, alternative solutions can be considered. For example, multipurpose rooms that can be used for various school activities, combined with the use of science kits and ICT devices, can serve as viable alternatives.

Box 19. Case Study: Pedagogical reform of PLEs—Tajikistan

The Republic of Tajikistan has recently initiated a major reform of the national school education system by raising the standards of the PLEs accompanied by institutional quality assurance reforms that will ensure compliance and enforcement of the proposed standards. The standards are packaged under the National Framework for Teaching and Learning Environments, based on the RIGHT+ principles. The national framework is the first instance in Central Asia when policy links pedagogy and spaces. Implementation of the framework will help design new and improve existing schools of the country to (i) link curriculum and learning spaces, (ii) define the minimum standards for school infrastructure, (iii) ensure modern elements of learning environments, like foldable walls and flexible furniture, (iv) ensure inclusive and accessible WASH facilities, (v) introduce green technologies in the curriculum and energy efficient and climate-smart solutions in school infrastructure, and (vi) define the broadband internet connectivity and solutions for different types of schools. The institutional quality assurance part of the national framework will help the country monitor quality and ensure that teacher practices and school-level policies are aligned with RIGHT principles. It is important that the reform also supports comprehensive teacher training to provide them with all necessary tools and knowledge of leveraging PLEs as a “third teacher”.

The World Bank project supports the implementation of this reform, which in turn includes the action plan that will bring all schools in Tajikistan to a new level over several years of implementation.

Additional information:

- МУҲОКИМАИ “ЧАҲОРЧӮБАИ МИЛЛИИ РУШДИ ТАҲСИЛОТ ДАР ҶУМҲУРИИ ТОҶИКИСТОН”
- Tajikistan - Learning Environment : Foundation of Quality Education Project

Equipped for learning

In creating PLEs it is easy to underemphasize the physical “content” provided in the spaces, especially as these elements are often considered late in a project when money is tight. A learning-conducive PLE should have sufficient and good-quality **furniture** as well as appropriate access to **ICT infrastructure**, as these are some of the most immediate items that users of the learning spaces will interact with.

The provision of good-quality **furniture and equipment** for the functioning of academic, administrative, and complementary spaces is a basic condition for pedagogical success. This includes age-appropriate desks and chairs for students and storage, presentation, and display options. This not only provides physical comfort, but also demonstrates that students are valued. As mentioned above, the provision of appropriate furniture can open up the possibilities of creating learning zones even within a basic classroom. Furniture that is relatively easy to move creates flexibility to create different configurations to support different pedagogical approaches. The layouts can be in rows for teaching from the front, or islands of tables for group work, or nooks for individual study. These can vary from day to day or even throughout the course of a day. Similarly, teacher and administrative offices, to the extent they exist, need to be properly equipped with appropriate furniture, as do other common facilities, such as kitchens and hallways.

The provision of appropriate furniture can open up the possibilities of creating learning zones even within a basic classroom

An appropriate **ICT infrastructure** is essential to enable the development of digital skills. It can also facilitate blended education modalities supporting learning continuity during disruptions. In some contexts, this infrastructure may include access to laptops and learning devices; in others, it may include radio or TV programming in addition to distributed learning materials. The use of ICT should be appropriate to the country's situation and the pedagogy being pursued, and any investment prioritized in this context.

Finally, it is worth mentioning that student achievement and other educational outcomes are not simply about the availability of resources, but also the quality of those resources and how effectively they are used (Gamoran, Secada, and Marrett 2000). Therefore, the introduction of new furniture, equipment, or ICT infrastructure should be accompanied by capacity development processes for their optimal use. Ideally, this should begin before the selection between options, so that practitioners on the ground can bring their local knowledge and needs to the process, gain ownership, and take on the resulting possibilities with enthusiasm.

Box 20. Case Study: National Digital Education Plan—Uruguay

This initiative commenced in 2006 with the aim of providing every student and teacher in primary and lower secondary public education with a personal computer. Internet access in schools, educational resources, as well as pedagogical services were also to be addressed. This ambitious aspiration had high-level political support from the President and was steered by a strategic board. Significant public funding was allocated (~ USD 100/childyear; ~ 0 .02 percent of the country's GDP). By the end of 2009 all 341,259 children and 18,000 primary school teachers had received their laptops. At this stage the program received additional external funding and was broadened and deepened to address communities and greater integration with mainstream pedagogy.

In the COVID-19 pandemic the infrastructure that had been created was remodeled and augmented through "Ceibal en Casa" to make more comprehensive the range of learning materials available remotely and to support digital interaction between teachers, students, and their families. The OECD's 2022 PISA study reveals that, if need be, children in Uruguay are about as prepared to study virtually as the OECD average.

Additional information (general and of Covid-19 period):

- Lessons from Uruguay (Plan Ceibal)
- Education continuity during the Coronavirus crisis - Uruguay: Ceibal en Casa

Do you want to learn more about fostering teaching- & learning-conducive PLEs?

The following resources provide additional evidence related to the connection between PLEs and teaching and learning outcomes as well as guidance on improving PLEs to support educational outcomes:

(1) The World Bank's The Impact of School Infrastructure on Learning.
(2) Council of Europe Development Bank Constructing Education: An Opportunity Not to be Missed.
(3) The Clever Classrooms report underscores the substantial impact of individualization (ownership and flexibility), contributing to about one-quarter of the learning impact, and the level of stimulation (an appropriate level of complexity and color), also accounting for approximately one-quarter of the learning impact.
(4) OECD's Designing for Education: Compendium of Exemplary Educational Facilities.
(5) Series of School User Survey and TIMSS analysis reports from Russia 1 and 2.
(6) Pedagogical Evolution in the United Kingdom

5.6. Achieving +Effective Implementation of Infrastructure Investments

What is +Effective implementation?

+ Effective implementation is about ensuring that the Education Infrastructure Management System (EIMS) at the national, regional, or local level puts the RIGHT elements into effect at scale, coherently, and progressively.

It not only needs to support the translation of the RIGHT+ factors into solutions that fit with the particularities of the specific location but also implies articulating the different elements of the EIMS, such as data, planning tools, institutional processes, and feedback mechanisms, as well as the participatory processes during the planning, design and construction phases (Duthilleul et al. 2021). Doing so will ensure that the RIGHT factors are applied to all PLEs via systemic changes in regulation, investment planning, or supervision mechanisms, and not individually targeted to one-time projects or interventions. The scope of actions and changes made will depend on the specifics of each country's EIMS and its institutional and regulation environment. For example, a project could be triggered by a change in building regulations to ensure the use of green technologies for construction, a review of prioritization criteria to avoid rehabilitating schools at risk from natural hazards, or creation of multistakeholder committees to ensure public-private bilateral coordination for school construction regulation and practices. The main objective is to ensure that measures are in place to promote the RIGHT factors and best practices at the system level, while maintaining a broad view of the potentials for synergies. Implementation can also be focused on different levels of resolution: that is, for a country, a region, or a particular project. The RIGHT+ factors need to be implemented in all these instances, but the level of detail may vary from context to context.

The scope of actions and changes made will depend on the specifics of each country's EIMS and its institutional and regulation environment

How to achieve +effective implementation of RIGHT factors?

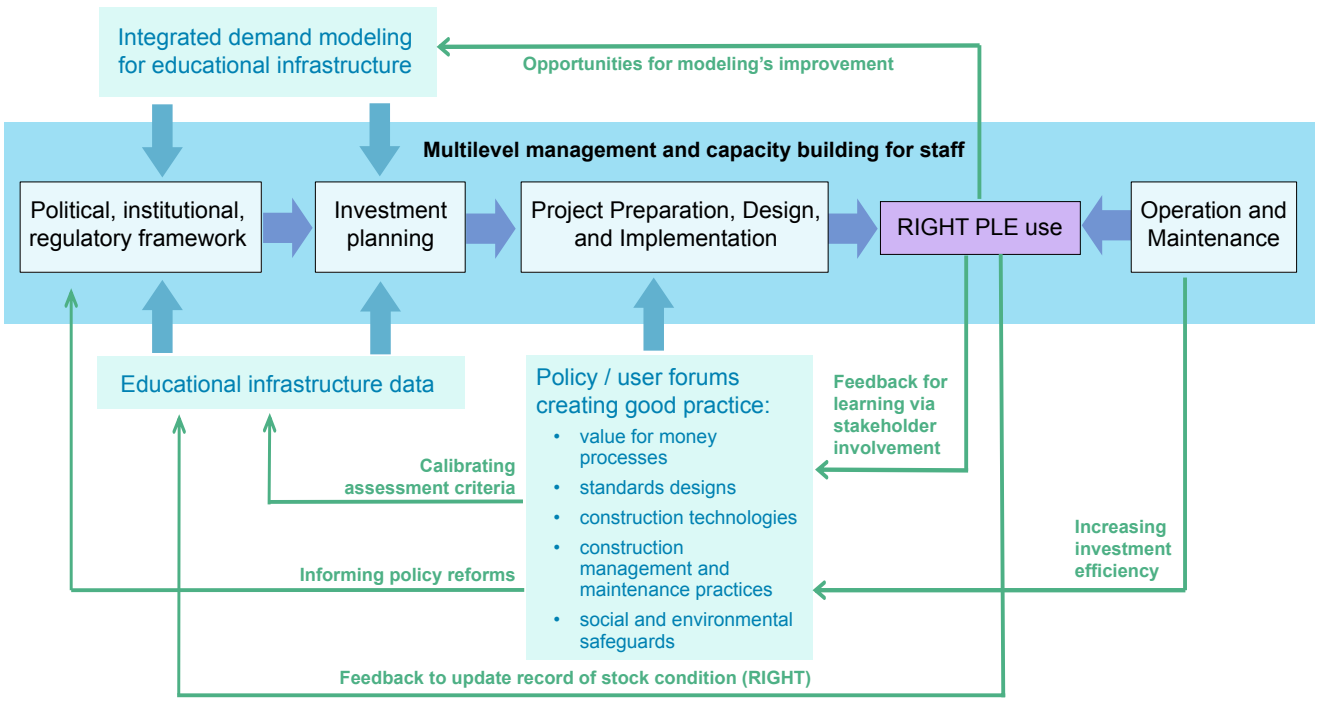
Effective implementation of PLEs at scale relies on ensuring that the appropriate infrastructure management components are in place in a coherent manner and are gradually implemented.

First, educational infrastructure management systems need to take into account that PLE challenges need to be addressed at scale by ensuring a system approach through (1) policy,

institutional, and regulatory frameworks that (2) support the investment planning, and (3) inform project preparation, design, and implementation, as well as (4) O&M. To deliver the educational infrastructure investment process, this system needs to be coherent, as the components need to be articulated in terms of their logic and sequencing, as well as internally consistent across the different levels. For example, PLE investment plans need to be formulated and implemented according to the National-, municipal-, or authority-level institutions and processes following the school infrastructure management model.

Second, the dynamic of the education infrastructure management system must be progressive, ensuring that the system "learns" to optimize investments across the whole educational system via data feeding about: supply and demand; the creation of macro spaces at national level to inform investment planning; the integration of multilevel stakeholders; capacity building; and the generation of micro spaces at local level to prepare and implement projects (Figure 2).

Figure 2. Educational infrastructure management processes (EIMP)



Source: Team's elaboration based on European Commission 2022.

In practical terms, it may only be possible to make progress in small, pragmatic steps, but cumulatively these can add up to significant change over time (Box 21).

Box 21. Case Study: Progressive, Pragmatic Progress Via Decision Support Data—The Philippines

Triggered by a series of natural disasters in which the Philippines' school infrastructure incurred significant damage, a World Bank project was approved to support the resilient recovery of disaster-affected schools in selected regions of the country. This project will finance the repair, rehabilitation, retrofitting, reconstruction, and site improvements of schools that were severely affected by earthquakes and tropical cyclones in recent years. In this project, 4 of the 5 RIGHT factors were incorporated in the project design. The key characteristic is one of structural resilience (R). Simultaneously, data on the national school stock held by the Department of Education (DepEd) were examined and linked to analyses of building types and their likely structural performance. In parallel, aided by technical assistance (TA), it was logical to extend the project to include the distribution and demand for school places (I), two factors then used to identify priority schools. The TA next extended beyond the project to draw in more DepEd data, augmented with other data (for example, demographic) on issues such as school condition (H) and teaching facilities (T). The data were also used to create geographical illustrations to better inform policy choices. Thus, consideration was extended beyond the initial project focus to pragmatically address more RIGHT factors (as far as possible given the data available) so that decision making in future projects can be more comprehensively considered.

Additional information:

- Philippines - Infrastructure for Safer and Resilient Schools Project
- World Bank Approves Support to Help Ensure Safer, Resilient Schools and Strengthen Recovery in the Philippines

Infrastructure management cycle

The infrastructure management cycle encompasses the planning and allocation process of funding resources along the different phases of the infrastructure lifecycle (planning, design, implementation, and O&M). Understanding how this process is embedded and operates within a public investment system is essential for delivering and improving educational infrastructure investments at scale. At high level, it can be described through four main stages (Figure 2).

The infrastructure management cycle encompasses the planning and allocation process of funding resources along the different phases of the infrastructure lifecycle

The first stage relates to the **political, institutional, and regulatory framework** that governs both public investments in general and education sector-related investments specifically. In principle, education policies should guide school infrastructure investments. The correlation between education policies and infrastructure requirements arising from these policies, however, is not always straightforward. Policy changes might lead to

increased demands on school infrastructure, which may be unaffordable. The institutional setting assigns infrastructure management roles and responsibilities under either a centralized or decentralized system. The regulatory framework, in turn, relates to legal provisions within the country's public investment system, building codes, and related education sector instruments. Policy reforms to overcome gaps and shortcomings in this framework (for example, outdated building codes) are strategically relevant to improve the implementation enabling environment.

The second stage of **investment planning** focuses on estimating the need for investment at scale and prioritizing and allocating resources in line with policy priorities and the education sector's financial capacity. Thus, the demand for educational infrastructure and its O&M is estimated, and an intervention strategy for the PLE network defined. This strategy takes the form of medium- to long-term plans, including implementation arrangements and monitoring and evaluation mechanisms, among other aspects. Such plans offer education administrators and infrastructure managers a roadmap to achieved target results by ensuring the articulation of investments across the school portfolio. Unfortunately, this stage is frequently missed in many LMICs, rendering the decision-making process about investments subject to short-term demand and unarticulated priorities, and highly vulnerable to politicians' interest.

The third stage is project-oriented, targeting specific schools, and is related to **project preparation, design, and implementation**. It derives from the education strategy's vision; general plan provisions and operates through the public investment system. Typically, multigovernmental levels and multiagency arrangements are involved (for example, centralized school designs and decentralized construction). This stage is strategic to progressively "learn" to better optimize investments across the whole educational system. Thus, it offers evidence-based data to assess effectiveness and efficiency of school infrastructure investments at local level and opportunities for user forums with contributions from stakeholders. For every construction or rehabilitation work, architects, engineers, and educators should collaborate to find the best design solution that better suits the needs of the users. In addition, teachers, students and the school community should be part of the participatory design process to express their needs and use of spaces during daily school activities. Infrastructure managers can also assess the appropriateness of standard designs and construction technologies as well as improvement opportunities for environmental and social impacts. That is why a school infrastructure management information system is instrumental to enable this dynamic feedback and learning process.

For every construction or rehabilitation work, architects, engineers, and educators should collaborate to find the best design solution that better suits the needs of the users

The final stage is **O&M**, the quality of which directly impacts users' experience. Lack of O&M protocols, training, and funding lead to poor PLEs and deterioration of infrastructure over time. Unfortunately, this is the case in most LMICs. Policy reforms and multiyear budget provisions are therefore critical steps to overcome this challenge.

Box 22. Case Study: Good Estate Management in Schools and Lifecycle Costing—United Kingdom

The Asset Management Planning in the UK raised a lot of interest in 1999 as the UK government allocated an investment in school infrastructure of about GBP 6 billion, mainly to support school maintenance and improve school buildings. The condition of allocation was the increased effectiveness and efficiency of the fund's utilization. This was ensured by the Asset Management Plans (AMPs) developed by the Local Education Authorities (LEAs). AMPs framework had to include the following elements: (i) local policy statement; (ii) condition surveys; (iii) suitability assessment; (iv) sufficiency needs; (v) determining priorities; (vi) option appraisal; and (vii) implementation.

AMPs were further developed by the Department for Education into a Good Estate Management for Schools, which were first introduced in 2018 and have been constantly updated since then. Part of the planning is a strategic vision based on the lifecycle approach to infrastructure. The UK and other countries started focusing on optimizing the investments with the cost of ownership throughout the lifecycle. The cost of the building over its lifetime consists of stages that span far beyond its construction and occupancy. The initial investment is only about 25 percent of the cost, while the other 75 percent accumulates over the lifetime and, if not optimized, may generate significant inefficiencies. Life Cycle Costing and Assessment (LCC and LCA) may help design buildings that maximize efficiency and cut emissions significantly.

Additional information:

- An Update on Asset Management Plans in the United Kingdom
- Good Estate Management for Schools
- Combining life cycle costing and life cycle assessment for an analysis of a new residential district energy system design

Management improvement processes

Improving school infrastructure at scale is not only a long-term effort but also a funding challenge in terms of available funding. Increasing the efficiency and efficacy of PLE investments is by far the most strategic objective for boosting RIGHT+ PLEs. In simple terms, it entails systematically enhancing the quality of processes through which investments are defined, planned, and implemented and resulting assets maintained. Besides meeting the public investment system's requirements, dynamic improvement based on users' and stakeholders' feedback, integrated demand modeling for educational infrastructure, and effective communication are required.

The whole management improvement process is a task for education administrators and policy makers and consists of three main aspects: (1) creating the conditions through **multilevel stakeholder** integration by drawing from previous school investments; (2) developing **capacity building** among staff and infrastructure managers at national and local level to broaden their mindset, knowledge, and motivation to take a role of change agents; and (3) generating macro and micro spaces for **multilevel feedback** from users and administrators to improve the overall management process.

Creating the opportunities for learning from **multilevel stakeholders** should be drawn from previous school investments projects. A wealth of hard-earned experience and lessons learned are created through any school-related project, either a program for school investments or a particular individual school project. Every stakeholder involved will have seen different things about the whole planning investment process or the whole project investment cycle—and, for some, the suitability in-use of the spaces created in particular projects. Unfortunately, most people have to move swiftly onto the next challenge, so project learning is easily lost unless specific efforts are made to capture. Capturing project learning can be seen as creating good practice to guide and influence future projects. A practical guide piloted by the Constructing Education framework includes four phases for collaboration in the construction process: (1) the initial planning phase, guided by a shared vision for what education should be; (2) getting ready to move into the new building; (3) moving in; and (4) reflecting on the new spaces and making adjustments for future cooperation. The pilot showed that additional funds needed to engage with principals and teachers represent, on average, between 1% and 5% of the cost of building a new school. (Duthilleul et al. 2024).

Every stakeholder involved will have seen different things about the whole planning investment process or the whole project investment cycle

At the local scale, one of the simplest ways is to invite various **stakeholders** to a meeting, focused, for example, on users' experience of the spaces provided and the management processes involved. Those invited could be teachers and administrators from representative bodies at national or regional level, or from a particular locality. If the topic is the efficiency and efficacy of the construction process, invitees could additionally include designers and builders. For strategic issues, much can be gained from multistakeholder meetings, ideally involving community representatives, where different perspectives are surfaced and debated with a view to finding mutually beneficial solutions. If a longer-term commitment can be made to this type of engagement, then a small part-time secretariat to organize meetings and capture the proceedings can be very cost-effective.

On a larger scale, where a project or situation is of heightened interest, it can be beneficial to carry out a targeted intervention to rapidly elicit learning or test ideas in that particular area. This could occur where an unusual challenge arises, such as providing infrastructure in remote locations. Here, consideration of a range of such instances could be enlightening, and the learning from an "extreme" case could prove beneficial to replicate solutions in more typical cases. It might be that the challenge is more of an opportunity to intervene at scale in a country, say where work is needed on a given common school type, and focused interventions on possible options could be very widely used across similar contexts. This could provide an opportunity to further investigate how buildings targeted because of, say, their lack of resilience could simultaneously address teaching and learning or inclusiveness (that is, the other RIGHT factors). Such targeted interventions can take various forms depending on their scale: informal consultations; commissioned mini-case studies, possibly including cross-case analyses; or research interventions where changes are tried and studied in real time. Thus, involving stakeholders at multiple levels can also be beneficial to intervene at large scale.

Systematic **capacity building** is fundamental at all management levels. At the system level, enabling conditions can be created by strengthening the regulatory framework, enhancing planning tools and information management systems, providing trainings for staff and infrastructure managers, and creating incentive mechanisms to foster evidence-based approaches for school infrastructure management. These actions lead to an increased technical institutional capacity that benefit the whole investment system. A very productive connection between analysis and decision making is boosted by identifying key technical officials based on the institution's mandate, setting the spaces for technical discussions, seeking technical endorsement after agreements, and finally incorporating those agreements into strategic plans, policies, and standards that will guide PLE interventions. In low-income countries (LIC) with very low capacity to manage school infrastructure, efforts should be primarily focused on allocating human and technical resources to ensure effectiveness of the capacity building activities planned to improve the whole management process.

At the individual level, the RIGHT approach asks everyone to take a broad view, often outside of their immediate expertise, to create as much educational benefit as possible out of each dollar of PLE investment. Those responsible for educational development will be focused primarily on students, teachers, and learning, but they have an opportunity to simultaneously **build capacity** for their core stakeholders to broaden their mindset,

At the individual level, the RIGHT approach asks everyone to take a broad view, often outside of their immediate expertise, to create as much educational benefit as possible out of each dollar of PLE investment

knowledge, and motivation to take a role of change agents. To be effective change agents, several aspects can be considered.

An open mindset is needed. It is hopefully easier to go beyond the normal educational aspects once the impacts on learning of all of the RIGHT factors are appreciated. This is why this approach note provides evidence for this. This is not a case of moving off the educational imperative, but rather pulling every lever available. Another aspect of this broadening of consideration relates to "diminishing returns." Once an issue has been addressed to a certain extent, further improvement is typically harder and harder to achieve. Conversely, it can be much more impactful to attack on a wider front. Besides, it takes courage to open up discussion in areas outside of one's immediate expertise. The more detailed content, examples from other contexts, and further reading suggestions will provide more opportunities to deepen knowledge.[19]

Once an issue has been addressed to a certain extent, further improvement is typically harder and harder to achieve

Opportunities to see interesting examples of school infrastructure investments can be beneficial for school infrastructure managers, alone or as part of a group, via, for example, a study tour. Actually, standing in a space and talking to those involved can provide a well-rounded understanding of what has been achieved and the problems faced. Obviously, this sort of accumulated experience is garnered via projects, through an individual's career, but the initiative suggested here is intended to accelerate and broaden the process. It also creates the opportunity for networking with colleagues, either informally or as part of a larger group. It could be that the initiative is taken to be one of those good practice examples others visit.

Paybacks accrue to the above personal investments, such as professional satisfaction in driving the creation of better PLEs, access to new knowledge, or the excitement of implementing new initiatives. It can also be career-enhancing, as visibility is raised within the organization—for all the right reasons.

Finally, at the local level, **multilevel feedback** from users and administrators and effective community engagement is crucial in the early stages of project design to better understand user needs and to tailor the RIGHT interventions to their multiple contexts. As part of the Environmental and Social Framework of World Bank lending projects, a stakeholder engagement plan must be developed to facilitate stakeholder consultations with the school

The micro consultation spaces are necessary to gather first-hand needs to later integrate the insights into RIGHT interventions for PLEs during project preparation

19 Complementary training materials will be provided, and these will also be accessed as part of the RIGHT+ toolkit.

community, including but not limited to a diverse group of learners, teachers, school staff, parents, and civil society organizations. The micro consultation spaces are necessary to gather first-hand needs to later integrate the insights into RIGHT interventions for PLEs during project preparation. The structure and frequency of consultations should be sufficient to collect the school community's needs for interventions in either existing or new PLEs.

Gathering first-hand needs of project users to identify gaps requires setting the spaces and dynamic for the dialogue, a good management level of expectations, and evaluation of the power structure within the group to get a balanced representation. For example, the participating group should ensure equal gender representation and include individuals with disabilities who can clearly explain their needs. Involving school communities is essential for integrating local insights into project design more effectively by tailoring the PLE's design to community needs. The interventions of RIGHT PLEs should be culturally appropriate, affordable, sustainable, and strategically located to benefit all students equally.

Box 23. Case Study: Strengthening Pedagogy and Governance in Public Schools Project—Uruguay

The World Bank is supporting the Constructing Education Pilot in School No. 190 in Montevideo, Uruguay, an adaptation of the Council of Europe Development Bank's Constructing Education Framework financed through the Strengthening Pedagogy and Governance in Uruguayan Public Schools Project. The pilot seeks to ensure that PLE are conducive to improved teaching, learning, and wellbeing by incorporating a comprehensive participatory approach in school infrastructure design and development. This includes consultations and joint work with the education community, starting from the initial planning of the architectural design into the occupation and use of the new facilities, as well as support and training for teachers and communities on the use of these new spaces to ensure that they help improve learning. Notably, the process is led by pairings of architects with pedagogical experts to ensure that learning remains at the center throughout.

Consultations and co-design workshops were held from early 2023 to mid-2024 with education authorities, the school principal, teachers, staff, students, and parents to understand what constraints existing spaces were generating for teachers in their daily practices, as well as to brainstorm ideas of how to use spaces more creatively. Based on these, an architectural project was designed for the expansion and rehabilitation of the school, including an innovative "hyper classroom" consisting of four flexible learning spaces that can be combined to practice new teaching dynamics, a main staircase whose steps could serve as a makeshift auditorium for school and community activities, and a new dining area that could be shared with the adjacent secondary school to better integrate the campus setting. This collaboration between architects and educators has enabled them to pursue architectural innovation while ensuring that it meets the school's and community's educational needs.

Additional information: Strengthening Pedagogy and Governance in Uruguayan Public Schools Project.

Educational infrastructure data

Governments often have an **education management information system (EMIS)** (Abdul-Hamid 2017) that compiles all education-related data. An EMIS most commonly includes basic information about schools, educational levels, enrollment, and geographic locations (if advanced system geolocation), among other education-related information. However, it is less common to find data about the physical characteristics of PLEs (also known as school inventory data). Such data describe classroom spaces and the school as a whole: for example, the number of buildings, their usage, amenities, furniture, equipment, other similar physical elements, construction materials (concrete, brick, wood, etc.), and physical conditions of PLE spaces. If available, these data are usually not integrated into the EMIS, mainly because the existing systems are fragmented from an IT standpoint and disconnected from a data management point of view. Sometimes even when an EMIS exists, units within or outside the government institutions do not speak to each other to systematically collect or manage information.

Thus, the EMIS should incorporate educational infrastructure data needed to perform analytics to support investment planning, and monitoring and evaluation during project implementation stages. While a range of IT solutions exist in the market, governments often opt for customized solutions based on their existing information system, if any. The best solution encompasses alignment of data collection forms across different units, systematic and periodic data collection, predefined algorithms for data processing in the back end, and a front-end site development for visualization and data transparency. The goal is to integrate all existing educational infrastructure data (already collected and coming data) into one robust EMIS and to incorporate newly produced information from the data modeling into the existing or newly built EMIS.

The EMIS should incorporate educational infrastructure data needed to perform analytics to support investment planning, and monitoring and evaluation during project implementation stages

Further, the availability of **data to perform analytics** plays a pivotal role in the preparation and implementation of investment projects. It allows policy makers to create evidence-based strategies and helps school infrastructure managers to improve their educational infrastructure management processes as well as to monitor the intervention's progress and measure its effectiveness during project implementation and post-O&M phases. The data pipeline for analytics is a series of steps to prepare raw data for analysis and visualization that goes from data gathering, cleaning, and wrangling to data analysis and modeling.

To what extent are data available? What level of granularity is required to perform analytics? What formats of data are ready for analytics? What sources of data are reliable? The more granular the gathered data, the better the accuracy of results when it comes

to data modeling for school infrastructure. A higher granularity of data means they are disaggregated into finer, more detailed units, while lower granularity refers to less detailed aggregation. For example, "available" enrollment data or population data aggregated at the national level can be used to formulate national policies but cannot estimate whether a school is overcrowded, or the potential associated needs for additional classrooms in existing schools, or the need to build new infrastructure due to local population growth. Additionally, data gathered from official sources are better than open-source data, as the latter can lead to biased results. For example, open-source data often do not map or render populations or infrastructure in rural or remote contexts. However, in FCV contexts or LIC where data are limited or not available in multiple dimensions, open-source data such as population data, building footprints, OpenStreetMap data, or satellite images can be beneficial to conduct high-level assessments and provide recommendations.

Data gathered from official sources are better than open-source data, as the latter can lead to biased results

Gathering data in the proper format, type, and source is relevant for a simple cleaning and wrangling step. The data format refers to the structure of the information stored according to set specifications for computing processes. Likewise, the availability of the data type (associated attribute) per variable is relevant to interpreting the value in a computer system. For example, "available" data shared in PDF format are sometimes unsuitable for data analytics unless the original format is software-based (for example, in Excel). If so, additional steps are needed to convert the shared data to a format for computing. If scanned from a document/form filled out manually (very common in LMICs), then the "available data" are not immediately available to perform data analytics but must first pass through a time-consuming cleaning and wrangling step to assimilate different formats, types, and sources of raw data for analysis. Such "available data" are useful to perform analytics and develop data models to define the interventions.

Finally, data analysis and modeling simultaneously inform the decision-making process to define interventions and effectively implement PLEs investments. While data analysis uses data to drive decisions, data modeling (such as hazard-related risk modeling, integrated demand modeling, or school network modeling) goes a step further by creating the architecture to make evidence-based analysis possible to inform policy and institutional reforms, investment planning and programming, and investment projects. For example, risk modeling—recommended under the resilient factor—is used to define whether the school is at risk given its vulnerability and exposure to a specific hazard. Without key data for risk modeling, it is unlikely to be possible to define a resilient intervention for a specific school building or a set of buildings. Another example is the use of data to model the optimization of the school network, recommended under the inclusive factor. Such

Without key data for risk modeling, it is unlikely to be possible to define a resilient intervention for a specific school building or a set of buildings

analysis requires spatial data related to the population, migration, projected demand, school capacity, and network data. Without these data, it will be difficult to identify which school of the PLE network might be a candidate for closing or merging interventions. The same logic applies to the other factors.

Box 24. Case Study: Leveraging Technology and Open Data for Resilient Education Infrastructure—Pakistan

After the massive floods in Pakistan in 2022 and the highest impact on the education sector, the government sought to prioritize reconstruction efforts and strengthen the resilience of its education infrastructure. To address this, the World Bank collaborated with the private sector, provincial education departments, and disaster management agencies to develop a tool to aid decision-making and priority setting. By utilizing a combination of government data, available open data, hazard data, daily rainfall data, satellite imagery, and machine learning models, the team developed a tool to facilitate national planning and monitoring efforts.

A comprehensive before-and-after flood analysis was developed using various data sources. This analysis assessed the impact of the 2022 floods on school accessibility, whitespace between schools, and the size of catchment areas around schools. Besides, the innovative use of open data enabled the team to estimate out-of-school children (OOSC)—both public and private and predict private school enrollments using a machine learning regression model. The desk-based findings were validated through in-person ground-truthing field interviews. The innovative use of data and analysis enabled the team to develop a data-driven tool to facilitate effective planning and tracking of interventions as well as prioritize their investments in the resilience of educational infrastructure.

Additional information: Building Evidence for Learning Acceleration in Pakistan: A Multi-year Knowledge Agenda.

Do you want to learn more about ensure +effective implementation of infrastructure investments?

The following resources provide additional evidence related to the connection between PLEs and effective implementation as well as guidance on good school management practices:

(1) Read the European Commission's Study on Smart, Effective, and Inclusive Investment in Education Infrastructure that offers 12 recommendations for countries to achieve smart, effective, and inclusive investment.

(2) Constructing Education: An Opportunity Not to Be Missed by Council of Europe Development Bank proposes a framework to guide investments in education infrastructure along four distinct phases.

(3) Read Romania—Advisory Services Agreement on Informed Decision-Making on Investments in Infrastructure (Vol. 2): Output 4: Final Report with a Recommendation for the Recipient's Strategy for Infrastructure Investments in Education Institutions.

(4) Read Section VI titled "Options for the Future" in the World Bank's Burundi School Construction for Basic Education report, which touches upon approaches for communal engagement during school construction, including topics such as contract management and communal financing.

(5) Read World Bank's School Construction Strategies for Universal Primary Education in Africa book, which explores various topics, including construction management approaches, scalability, community-based provision, maintenance, donor involvement, costs, and recommendations for enhancing resource efficiency.

(6) Review Section V and VI of the World Bank's Construction of Basic Education in Sudan, which summarizes main challenges, policy recommendations, and the responsibility of stakeholders, along with a matrix of these three main components.

(7) Read the Denmark approach to enable and sustain community engagement in school design by involving all stakeholders in the planning process. See more information (in Danish) about the Implementation of the Model School Program in Denmark .

(8) Read Managing for learning: Measuring and Strengthening Education Management in Latin America and the Caribbean.

6. Recommendations

The following section presents key overall recommendations for task teams working on PLE-related operations with the aim of improving the way PLE-related investments are designed in World Bank operations. The starting point of the RIGHT+ framework is that the Bank's PLE investments need to shift *from* disarticulated interventions that focus on immediate infrastructure needs in a limited number of projects very often selected without technical criteria *to* PLE interventions that focus on the learning process, use a comprehensive—the RIGHT+—approach, and rely on data and evidence-based criteria to build long-term solutions at scale.

First, PLE interventions can use the RIGHT+ to put the learning process at the center to align factors and develop relevant solutions to contribute to learning outcomes. Putting the learner at the center is the way to demonstrate that PLEs play an active role in the learning process, interacting with other nonphysical elements such as pedagogical practices or school climate, and being part of a broader environment represented by social, cultural, political, geographic, and other contextual aspects. Given that *learning for all* is the main goal of the education policy, this approach implies that task teams should focus on questions such as: Do PLEs ensure access for all students? Do PLEs provide the basic conditions for learning? Do PLEs facilitate successful teaching practices? Do PLEs ensure continuity of the teaching and learning process in the face of natural or man-made hazards? and Do PLEs contribute to the development of a greener future? These questions can help design an intervention, ensuring that it addresses not only the physical environment, but also its interaction with processes (pedagogy, technology, social interactions), actors (teachers, administrators, family), and context (social, economic, geographic, and/or political). The main recommendation is to ensure early participation in the design of PLE-related interventions with infrastructure teams as well as: pedagogical staff working in, as relevant, early childhood, primary, secondary, vocational, and higher education; teams managing the education management and information system; financial and administrative staff; social and environmental specialists; and other cross-cutting units such as special or intercultural education.

Putting the learner at the center is the way to demonstrate that PLEs play an active role in the learning process

Second, PLE interventions can be based on immediate needs as an entry point, but RIGHT+ framework can be used to expand into comprehensive and scalable solutions. Interventions can begin from multiple needs to build new schools to increase the student supply, retrofit the structures of school buildings to reduce their vulnerability to natural hazards, or improve WASH facilities to promote healthy environments. Triggering from those immediate needs task teams' further analysis could open new areas for

potential large improvement of the portfolio. Given that these interventions are typically a once-in-a-decade opportunity for the selected educational institutions, the maximum benefit must be ensured across the PLE network. For example, prefeasibility studies for a school renovation often reveal that classroom spaces are not flexible enough to support the pedagogical practices that will take place in them. Hence, task teams, policymakers, and practitioners can elaborate on questions such as: What is the typical school design being used? Are teachers consulted about these school designs? and Are satisfaction surveys used to understand the risk perception of the school community and to guide communication strategies? The same logic applies to opening a dialogue on the "green" factor, where task teams can, for example, ask: Do the bidding documents specify that local or low-polluting materials be used for construction? The logic here is to find the entry point and then extend to the other elements of the RIGHT+ framework. The main recommendation is to use the set of characteristics and attributes presented in Table 1 as a checklist to inform these questions during project preparation and implementation.

Third, when PLE interventions start with individual or small group of projects, the RIGHT+ can be used to ensure that solutions are built at scale. A World Bank program that contributes to the expansion or rehabilitation of hundreds of houses may be relevant and needed for certain communities. Similarly, a pilot project that changes the design of kindergartens may be a game changer for a particular community. However, the broader impact occurs when the transformations in these specific projects have a large-scale impact in the whole infrastructure network, whether preparing a prioritization criterion for a PLE's investment plans, changing a regulation to enhance the performance of all school buildings, or reconceptualizing design standards through new architectural principles. The simple question of how projects are prioritized can indicate the presence or absence of a technical criterion or a data-driven investment plan. To move in this direction, task teams, policymakers, and practitioners need to challenge the design of operations with questions such as: Is this operation only improving a subset of schools, or is it generating benefits for all existing and new education infrastructure in the network? and Are the architectural and engineering solutions identified for the specific subset of school designs replicable throughout the whole portfolio of PLEs? The "+" component presents several ideas to ensure the operation includes not only investment activities, but also contributes to improving the components of the school infrastructure management system such as the policy, institutional and regulatory framework, or supports the development of an evidence-based investment plan.

The broader impact occurs when the transformations in these specific projects have a large-scale impact in the whole infrastructure network

Fourth, the RIGHT+ can be used to ensure that definition of PLE interventions relies highly on baseline data[20] availability and data analytics. Data about three main areas are required: the school infrastructure and road networks (built environment); the school community they serve (socioeconomic and demographic environment); and the environmental conditions around schools (natural environment). Usually, these data are only partially available, are outdated, or are scattered. Therefore, an extra-mile effort to gather and improve baseline information at very early stages of the PLE project preparation is highly strategic. Task teams, policymakers, and practitioners can build on questions such as: Is the inventory of school infrastructure available and regularly updated? Does the EMIS include PLE-related data? How does PLE information flow from school through the education system? and How have PLE data been used to inform the investment decision-making process? In the face of data constraints, the level of definition of needs of interventions will be limited. Proxies can be used for preliminary estimation purposes, but a strategy should be established to progressively overcome the data gap. Moreover, building the baseline database often becomes a project's line of activity. It is important to stress that with no baseline data, no evidence can be built by data analytics to inform the definition of needs of intervention, nor can investments' needs and outcomes be estimated and monitored.

Proxies can be used for preliminary estimation purposes, but a strategy should be established to progressively overcome the data gap

Fifth, advancing toward RIGHT PLEs is a long-term effort that requires policy reforms in addition to investments. Typically, school infrastructure managers face constraints imposed by outdated regulations and the institutional framework under which schools are managed. Task teams, policymakers, and practitioners can better understand those challenges by asking questions such as: Was the country's building code recently updated? Do school design regulations meet up-to-date building code provisions? Are mechanisms in place to monitor and evaluate the construction quality in schools? Are maintenance protocols for school infrastructure in place? and Do local governments have the required capacity to manage school infrastructure? Policy reforms are required to overcome these types of challenges and create the enabling environment for changes to how school infrastructure is designed and built.

Finally, especially in low-capacity contexts, PLE interventions should be accompanied by a capacity-building process to enhance impact and sustainability. Typically, especially in low-capacity contexts, PLE-related interventions focus on

20 Data can be defined as factual information, including statistics and numbers. Baseline data measure the conditions before the intervention starts for later comparison.

implementing a few projects without developing key technical capacities for staff of project implementing units, such as training or developing information systems, regulations, manuals, and protocols. To assess the context, task teams, policymakers, and practitioners need to focus on questions such as: Do the authorities and technical and administrative staff have an agreed mechanism for prioritizing PLE investments? Do schools have a clear mechanism for responding to disasters? and Is the infrastructure specialist trained in innovative learning spaces, educational infrastructure planning, new construction methods, or new project management technologies? To answer these questions, it is recommended to conduct workshops and focus groups with policy and technical counterparts to understand where the key capacity gaps are and to ensure that the operation addresses them as a contribution to the project sustainability.

PLE interventions should be accompanied by a capacity-building process to enhance impact and sustainability

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ANNEX 1—CHECKLIST FOR THE RIGHT+ FRAMEWORK

To provide task teams with a comprehensive framework for analysis and project design, the RIGHT+ proposes a set of guiding questions and attributes that will facilitate informed decision making and collaborative problem solving. While the framework does not exhaustively address all PLE-related topics, it offers a robust foundation for task teams to develop effective solutions. The following list of questions is designed to assist task teams, policymakers, and practitioners in the analysis and design phase of an operation, ensuring a thorough and structured approach:

Resilience

(1) Are PLEs' site locations based on data about their exposure to natural hazards?

(2) Are school administrators aware of the exposure of PLEs to natural hazards?

(3) Do PLEs comply with building codes and regulations?

(4) Do PLEs count on disaster risk mitigation plans?

(5) Have PLEs benefited from postdisaster recovery programs?

Inclusion

(6) Are PLEs accessible to all students by any transport mode using a reasonable travel distance?

(7) Are PLEs designed with gender-sensitive considerations, provided with WASH facilities segregated by gender, and equipped with cleaning and menstrual hygiene supplies?

(8) Are PLEs accessible to students with disabilities through special transport, ramps or elevators, and disability designed toilets?

Green

(9) Are PLEs designed with energy efficiency measures?

(10) Are PLEs using water efficiently?

(11) Are PLEs making use of sustainable construction materials and community-based approaches?

Healthy

(12) Are PLEs provided with adequate basic services?

(13) Are PLE ensuring indoor environmental quality?

(14) Are PLEs being effectively maintained?

Teaching- & Learning-Conducive

(15) Do PLEs have adequate capacity to ensure learning for all students?

(16) Are PLEs providing optimal spatial experience through stimulation, ownership, and personalization?

(17) Are PLEs aligned to pedagogy through flexible spaces and using the school as a whole for learning?

(18) Are PLEs equipped with furniture, equipment, and information technologies?

Effective Implementation

(19) Are PLEs being planned at system level using an up-to-date policy, institutional, and regulatory framework?

(20) Are PLEs being planned at system level using short-, medium-, or long-term investment planning strategies?

(21) Are PLEs being operated and maintained via recurrent or annual funding and under the technical guidance of updated protocols?

(22) Are PLEs being managed by capable staff at all levels of the management process?

(23) Are stakeholders, administrators, and direct users involved in the planning, design, and implementation of PLE interventions?

(24) Are PLEs' interventions and estimation of investment needs informed by data analytics?

(25) Are PLEs supported by an education management information system?

APPROACH NOTE

RIGHT+ Framework for Physical Learning Environments (PLEs)

Guidance for Effective Implementation (+) of Resilient, Inclusive, Green, Healthy, and Teaching- & Learning-Conducive (RIGHT+) PLEs

Contact us at: physical_learning_environments@worldbank.org

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