TECHNICAL NOTE N° IDB-TN-03354

Conceptual Framework for Interoperability in Educational Information Systems in Latin America and the Caribbean: Foundation, Strategies and Enabling Conditions. With Applications and Lessons from the Argentine Case

Javier Eusebio
Marcelo Perez Alfaro
Tamara Vinacur

Inter-American Development Bank
Education Division

June 2026

Conceptual Framework for Interoperability in Educational Information Systems in Latin America and the Caribbean: Foundation, Strategies and Enabling Conditions. With Applications and Lessons from the Argentine Case

Javier Eusebio
Marcelo Perez Alfaro
Tamara Vinacur

Inter-American Development Bank
Education Division

June 2026

JEL Codes: I20, I21, I28, O38
Keywords: Interoperability, educational information systems, digital transformation, data governance.

Technical Note N°

Conceptual Framework for INTEROPERABILITY in EDUCATIONAL INFORMATION SYSTEMS in LAC

Foundations, Strategies, and Enabling Conditions

With Applications and Lessons from the Argentine Case

Javier Eusebio
Tamara Vinacur
Marcelo Pérez Alfaro

IDB

ABOUT THE AUTHORS

Javier Eusebio
Senior Consultant in Education Management Information Systems (EMIS) at the IDB. Systems Engineer from Universidad Tecnológica Nacional, with a Postgraduate degree in Business Administration from Universidad de Belgrano. Specialist in the design, evaluation, and strengthening of educational information systems. Co-author of the EMIS methodology and of the Optimal Functional Templates instrument. He has led technical assistance missions for ministries of education across Latin America and the Caribbean, advancing digital transformation, interoperability, data governance, and improvements in public educational management.

Tamara Vinacur
Senior Specialist at the IDB's Education Division in Argentina. She holds a Master's degree in Measurement, Evaluation, and Educational Statistics from Teachers College, Columbia University (New York). She previously served as a consultant for OEI, IIPE-UNESCO Buenos Aires, and CEPE/UTDT. She was Executive Director of the Educational Quality and Equity Evaluation Unit at the Buenos Aires City Ministry of Education (2015–2019) and held various positions at the National Ministry of Education and the Buenos Aires City Ministry of Education.

Marcelo Pérez Alfaro
Principal Education Specialist at the IDB since 2003. He has led policy dialogue and programs across various Latin American and Caribbean countries and co-leads the Digital Education Transformation and Smart Management team. He has extensive experience in strategic and budgetary planning within Argentine social-protection agencies, including the National Social Security Administration and the National Institute of Social Services for Retirees and Pensioners. He holds a degree in Economics from Universidad Católica Argentina, a Master's degree in Public Administration from the Harvard Kennedy School, and a Postgraduate degree in Economics from Instituto Di Tella.

External Collaborators:
Editorial review: Carmen Güiraldes
Layout and design: Patricia Peralta

http://www.iadb.org

EXECUTIVE SUMMARY[1]

In Latin American education systems, information is typically distributed across multiple platforms and registries that operate in a fragmented manner, in a context characterized by the coexistence of diverse systems and data sources with limited integration capacity. This situation constrains the articulation of information, hinders its timely use for decision-making, and restricts the development of more efficient services for students, teachers, and institutions. In this context, advancing toward interoperability schemes has become a strategic priority for the sector's digital transformation, by enabling the integration of existing systems, simplifying procedures for students and families, reducing duplications and administrative burdens, sustaining the traceability of student trajectories, and enabling educational analytics for evidence-based policies. This document proposes a conceptual and operational framework to guide countries in the region in the design of policies, regulations, and strategies to advance in that direction.

The framework is structured around four interdependent domains: legal, organizational, technical, and semantic; the latter aimed at ensuring shared meanings and the consistent use of vocabularies and classification systems. These domains operate across three complementary dimensions—the articulation of the education sector with other State sectors, coordination among territorial jurisdictions, and internal interoperability within the education system—and translate operationally into three pillars: interoperability architecture, master data management, and data governance. In addition, this working paper presents a practical five-step roadmap that guides ministries from minimum conditions and initial governance to the institutional, regulatory, technical, and financial sustainability of educational interoperability.

The document identifies enabling conditions and common barriers—technological, regulatory, organizational, and cultural. It also emphasizes the importance of strengthening institutional capacities, coordination across levels of government, and a culture of data use in educational management.

Keywords: interoperability, educational information systems, digital transformation, data governance.

JEL Codes: I20, I21, I28, O38.

1 This document was made possible thanks to the joint efforts and support of multiple institutions and professionals committed to improving the quality of educational information systems in Argentina and throughout Latin America and the Caribbean (LAC). We wish to express our sincere gratitude to colleagues at the Inter-American Development Bank (IDB), who contributed to identifying experiences and establishing contact with key stakeholders across the countries under analysis. We also thank the teams at the ministries of education of Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, and Uruguay, whose contributions and experiences were key to the case studies and recommendations included in this document. We are especially grateful for the comments of Martín Scasso. We likewise acknowledge the support of the *Secretariat of Education of the Ministry of Human Capital of Argentina*, the *Consejo Federal de Educación* (Federal Education Council), and the *Subsecretaría de Información y Evaluación Educativa* (Undersecretariat of Educational Information and Evaluation). We are particularly grateful for the comments of María Cortelezzi, Undersecretary of Educational Information and Evaluation. This work received technical and financial support from the IDB, whose Education Division, led by Mercedes Mateo Berganza, provided steady backing throughout the process. Finally, we thank the teachers, researchers, and education leaders whose daily commitment to improving the quality and equity of learning inspires our work.

Table of Contents

1. Introduction

The digital transformation of education systems in LAC faces a common challenge: the fragmentation of information and the limited capacity for integration among platforms, registries, and institutional actors. In this context, interoperability emerges as a strategic priority for achieving more articulated, efficient management oriented toward evidence-based decision-making.

The IDB has noted that the Education Management Information Systems (EMIS) of the region are characterized by the coexistence of parallel registries and limited integration capacity, which undermines the consistency and timeliness of available data (IDB, 2022). To address this situation, it is necessary to advance toward a regional conceptual framework for educational interoperability, conceived as a technical input to guide countries in the design and strengthening of policies, regulations, standards, and strategies for progressive implementation. Rather than prescribing a single model, the purpose of this working paper is to offer conceptual and operational guidelines, grounded in the IDB's accumulated experience in the education sector, and adaptable to the diversity of institutional contexts and levels of EMIS development.

The importance of interoperability frameworks has also been highlighted by regional organizations. The CAF and OEI warn that, in the absence of such frameworks, ministries of education tend to face fragmented information, duplication of efforts, and difficulties in orienting evidence-based policies (CAF & OEI, 2022). Along the same lines, ECLAC underscores that interoperability constitutes an enabling condition for the digital transformation of the State, by enabling integrated, people-centered public services with a rights-based approach (ECLAC, 2020).

The IDB's prior work in the social sector also provides a relevant frame of reference. Documents such as *El ABC de la interoperabilidad de los servicios sociales. Guía para Gobiernos* (IDB, 2019a) and *El ABC de la interoperabilidad de los servicios sociales: marco conceptual y metodológico* (IDB, 2022) demonstrate that interoperability becomes consolidated when robust regulatory frameworks, stable institutional structures, and governance mechanisms sustained over time are combined. These principles, applied to the education sector, make it possible to maintain coherence with previous experience while adapting to the specific challenges of education.

Within this framework, educational interoperability is understood as a structural attribute of the system, operating simultaneously across three complementary dimensions:

- the linkage of the education sector with other sectors of the State,
- **the articulation among jurisdictions or levels of government with responsibility for education management** —for example, national level with states/provinces and municipalities—, and
- the internal integration of the processes and systems that make up the education ecosystem.

These dimensions make it possible to understand how education fits into broader digital government architectures, how different territorial levels coordinate, and how information circulates within the sector. Each contributes a specific function: articulating with essential State registries, ensuring the consolidation of information and its national comparability in federal or decentralized systems, and sustaining operational coherence among pedagogical, administrative, and strategic processes within the ministry itself.

Across the region, diverse experiences of educational interoperability offer useful lessons. In **Uruguay**, the education strategy is articulated with a national digital government framework led by the *Agencia de Gobierno Electrónico y Sociedad de la Información y del Conocimiento* (Agency for Electronic Government and the Information and Knowledge Society, AGESIC). The *Plataforma de Interoperabilidad* (Interoperability Platform, PDI) and the RedUY network enable the secure exchange of information among public agencies, including educational ones. At the sectoral level, the GURI system and the *Registro Único del Alumno* (Single Student Registry, RUA) replaced —in 2015— the paper-based cumulative file with an integrated electronic registry, while in 2024 a unified online enrollment portal for basic education was added, strengthening data traceability and consistency.

In **Colombia**, the *Sistema de Matrícula* (Enrollment System, SIMAT) manages student enrollment at the national scale and feeds official statistical production, articulating administrative management with coverage and dropout indicators produced by the *Departamento Administrativo Nacional de Estadística* (National Administrative Department of Statistics, DANE). This circuit shows how interoperability can ensure the coherence and traceability of information between administrative records and statistics.

In **Chile**, the *Sistema de Información General de Estudiantes* (General Student Information System, SIGE) operates with identity validation through the Civil Registry and relies on interoperability agreements that enable data exchange between the ministry and the school management platforms of the *sostenedores*. A distinctive feature of this model is its openness to agreements with private actors, which facilitate interoperability in high-frequency processes such as attendance recording, showing that benefits can be achieved incrementally.

In **Brazil**, educational interoperability is embedded in a federal digital government ecosystem based on the Conecta gov.br strategy and the *Padrões de Interoperabilidade de Governo Eletrônico* (Electronic Government Interoperability Standards, ePING), which establish common guidelines for data exchange. In the education sector, beyond the statistical framework consolidated by the *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira* (National Institute for

Educational Studies and Research Anísio Teixeira, INEP) and the *Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute of Geography and Statistics, IBGE), notable is the integration between education and social protection: the *Cadastro Único* (Single Registry) automatically updates school attendance data through the *Sistema Presença* (Attendance System), developed by the Ministry of Education to monitor school attendance of social program beneficiaries), optimizing the verification of conditionalities and the coherence of national registries. Additionally, Brazil has a *Infraestrutura Nacional de Dados* (National Data Infrastructure, IND) that establishes norms, architectures, and tools for federal data interoperability, reinforcing the exchange ecosystem among education, social protection, and other public sectors. This case illustrates the potential of interoperability to strengthen both the targeting of social programs and the quality of administrative information.

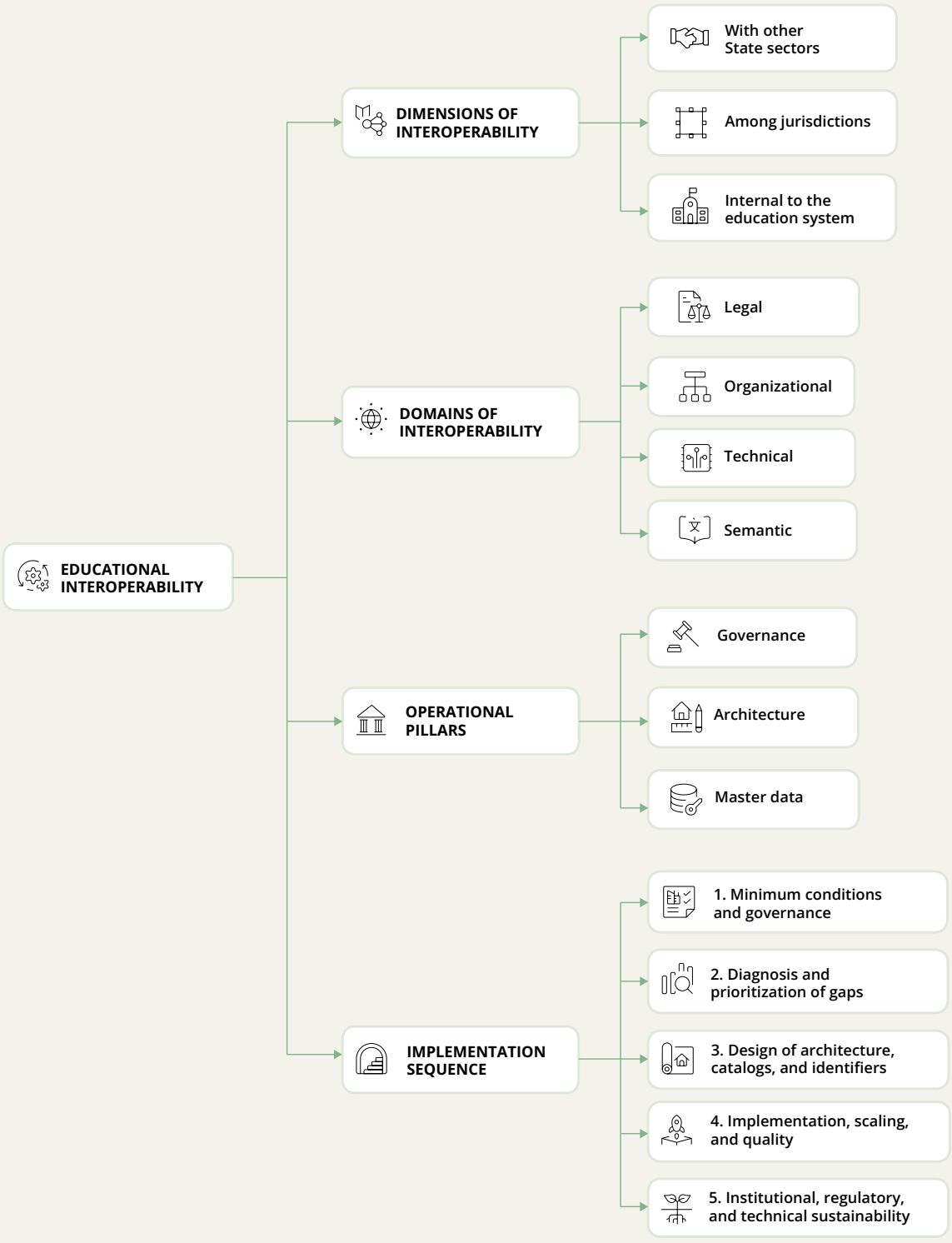
From these experiences, cross-cutting lessons emerge: the need to integrate system components, ensure the usability and accessibility of data, guarantee the sustainability of solutions over time, and strengthen the human and infrastructural capacities needed to operate them. Recent studies also warn that intra-ministerial compartmentalization remains a recurring obstacle and that strengthening governance —with clear roles, agreements, and standards— is a key requirement for achieving sustainable results (OECD, 2023).

This document also incorporates applications and lessons from the Argentine case. Without constituting a central or exhaustive analysis, it systematizes findings from EMIS maturity diagnostics conducted across various jurisdictions, along with examples of recent national initiatives backed by regulations of the *Consejo Federal de Educación* (Federal Education Council, CFE). These include the *Base Nacional Homologada* (National Harmonized Database, BNH), established in 2025 as the sole official statistical source for compulsory common education and organized into four interoperable blocks; the *Relevamiento Nacional de Personal Educativo* (National Survey of Educational Personnel, ReNPE 2025), conceived as a mandatory two-stage survey with an initial data load from the personnel module of the *Sistema Integral de Información Digital Educativa* (Comprehensive Digital Education Information System, SInIDE); and the *Motor Unificado de Análisis y Reporte de Datos* (Unified Data Analysis and Reporting Engine, MUAR), currently under validation as an active feedback analytical tool. This approach seeks to maintain coherence with the accumulated experience of the IDB and other regional organizations, while drawing on comparative cases and Argentina's institutional evolution.

This working paper includes a practical section presenting five steps for launching educational interoperability, offering governments an operational guide to translate conceptual guidelines into immediate and sustainable actions.

Within this framework, the document moves from conceptual foundations toward practical application. The opening sections present the principles and conditions that enable educational interoperability; the middle sections develop the dimensions of interoperability, the domains, and the operational architecture; and the final sections propose a practical roadmap for implementation, including the five steps to initiate educational interoperability processes. Diagram 1 synthesizes these elements and offers a reading guide to the proposed conceptual and operational framework.

Diagram 1. Educational Interoperability: Conceptual and Operational Framework



Source: own elaboration

2. Conceptual Framework and Domains of Educational Interoperability

Interoperability can be understood as the capacity of information systems and the processes that underpin them to exchange data, share information, and generate knowledge within a framework of ethics, security, and rights protection. In education, it takes on a distinct character: integrating information on students, teachers, institutions, and resources to ensure traceability, consistency, and the timely availability of reliable data for management and decision-making.

More than connecting systems, interoperability organizes processes and standardizes data so that education policies are grounded in valid, comparable, and verifiable evidence. Under this approach, data are not produced as an external input nor loaded on an ad hoc basis; rather, they emerge directly from the day-to-day management of the education system: enrollment and seat assignment, attendance, grades, promotions, certifications, teacher payroll, infrastructure, and financing. Each of these actions generates records that, once structured and validated, become reliable information that feeds back into decision-making and improves management itself. This cycle—management that produces information, and information that guides management—is essential to sustaining processes such as the issuance of digital certificates, student trajectory monitoring, the planning of educational provision, and efficient resource allocation. To understand how these data circulate, educational interoperability operates simultaneously across three complementary dimensions:

i. interoperability between the education sector and other sectors of the State;
ii. educational interoperability among jurisdictions with responsibility for education management (where applicable given the country's territorial structure), for example, national level with states/provinces and municipalities; and
iii. internal interoperability within the education system itself.

These three dimensions allow for distinguishing among exchanges that take place outside the sector, between territorial levels of the system, and within the education ecosystem itself. Their presence and scope depend on each country's degree of centralization or decentralization, and they constitute the conceptual basis for organizing governance, data architecture, and the use cases prioritized in educational interoperability processes.

The international frameworks cited above—particularly those developed by the IDB and the OECD—agree that educational interoperability should be governed by a common set of guiding principles (IDB, 2022; OECD, 2023):

- **Equity and accessibility**, to ensure that all students and teachers are represented in the records, without territorial or socioeconomic exclusions.
- **Data protection and privacy**, with particular attention to minors, who require enhanced safeguards.
- **Institutional accountability**, which ensures the quality and continuous updating of information at each level.
- **Standardization and openness**, which facilitate systems integration through common and preferably open standards, reducing costs and avoiding technology lock-in.

These principles constitute cross-cutting criteria that guide the design, implementation, and evolution of the institutional capacities developed across the four domains defined in this document. Within this framework, they are complemented by a people-centered services vision, in which the use of data must translate into tangible benefits for students, families, and school communities.

Box 1. Interoperability ≠ Integration

Unlike systems integration—which seeks to unify functions or databases on a single platform—interoperability aims to enable the secure, controlled, and reusable exchange of information between distinct systems, preserving institutional autonomy and accountability for data. It does not require unified platforms or centralized solutions, but rather agreements, standards, and mechanisms that ensure consistency and traceability.

This approach prevents fragmentation, reduces duplication, and fosters collaboration based on trust, clear rules, and data agreements—core principles for its application in the education sector.

Ultimately, interoperability is an attribute of the education ecosystem: its purpose is not to integrate systems, but rather to facilitate cooperation and the reuse of data across internal and external areas, ensuring that information circulates securely, consistently, and under defined institutional agreements.

The Four Domains of Educational Interoperability

The IDB has underscored that interoperability rests on four interdependent domains—legal, organizational, technical, and semantic—whose balanced development is a necessary condition for education systems to advance from incipient levels toward consolidated stages (IDB, 2019b; OECD, 2023).

Legal domain. Provides the enabling framework for information exchange with legal backing. In education, it includes the protection of personal data, the validity of certificates and diplomas issued in digital environments, access to public information, and interinstitutional agreements that regulate data flows across sectors. Without a robust regulatory framework, the “once-only” principle loses effectiveness, and jurisdictional disputes arise between agencies (EU, 2024).

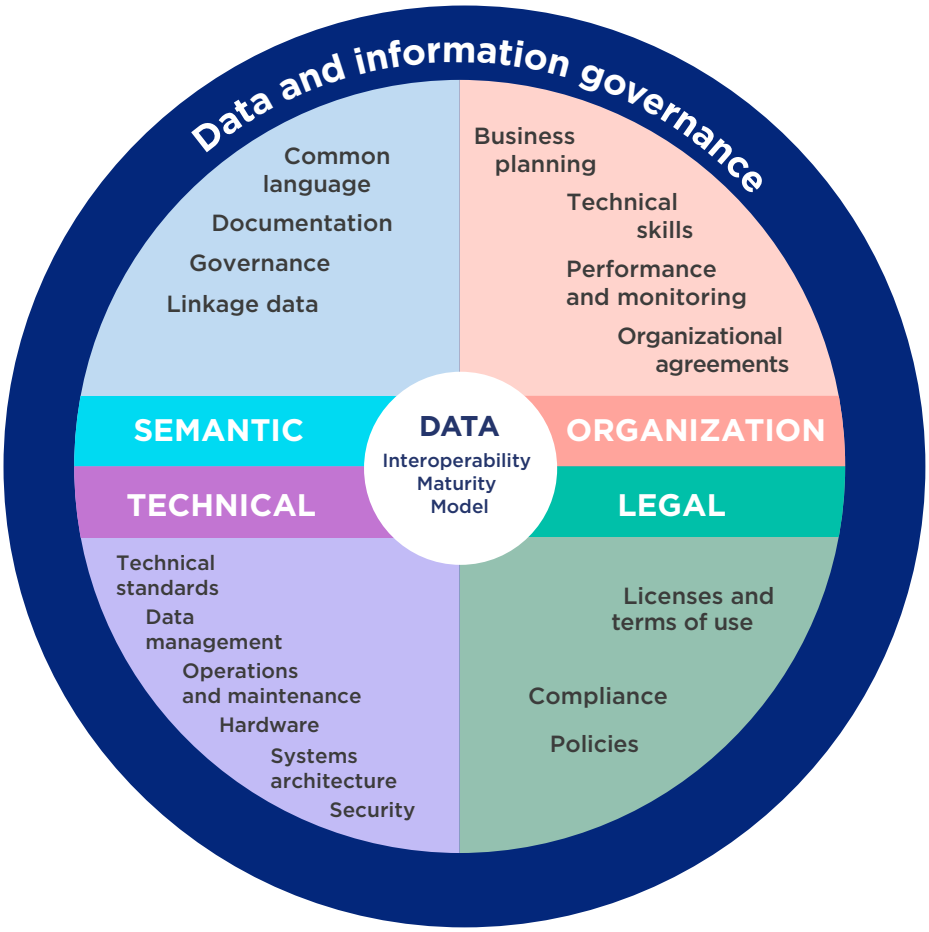
Organizational domain. Structures institutional cooperation and the definition of roles to ensure the reliable production and use of data. This entails multilevel coordination arrangements (national–provincial/state–local) and multi-stakeholder arrangements (pedagogical, administrative, statistical, identity, social protection), along with formal mechanisms such as interoperability committees, RASCI[2] matrices, service level agreements, and change management plans. The evidence shows that the greatest progress has been made in contexts with stable ministerial structures and sustained political leadership (IDB, 2022).

Technical domain. Encompasses the architecture and integration mechanisms that make interoperability possible, both operationally and analytically. It includes unique identifiers and master catalogs, APIs and services based on open standards, messaging models, security controls (authentication, encryption, vulnerability management), separate environments for development, testing and production, and backup and recovery protocols. Without scalable architectures and common standards, education systems tend to fragment and reproduce information silos (OECD, 2023).

Semantic domain. Ensures that data share a common meaning, avoiding divergent interpretations. It comprises ontologies, vocabularies, and classification systems—for example, what is meant by *regularly enrolled student*, *excused absence*, or *teacher leave*—as well as business rules and academic calendars. The adoption of official classification systems and standardized nomenclatures makes it possible to organize information uniformly and facilitate its comparability at the regional and international levels.

2 A RASCI matrix is a management tool used to define roles and responsibilities within a project, process, or work team. The acronym stands for: **Responsible**, in charge of executing the task; **Accountable**, answers for the execution of the task and holds decision-making authority over it (only one A per task); **Supportive**, provides support to the Responsible role in carrying out the task; **Consulted**, whose opinion is sought before a decision is made or an action is taken regarding the task (two-way communication); and **Informed**, kept informed of decisions made and actions taken, and may need to act based on the information received (one-way communication).

Diagram 2. The domains of interoperability and their respective sub-domains



Source: BID, 2022.

Interdependence and Maturity

The four domains of interoperability reinforce one another. Advancing only on the technical front, without a shared semantic layer, generates inconsistencies; strengthening the legal dimension without organizational capacity produces formal compliance with limited impact; and reinforcing the organizational domain without technical architecture leads to the coexistence of parallel and fragmented systems.

On the maturity scale used by the IDB in EMIS diagnostics—which classifies institutional development into four levels: Latent (1), Incipient (2), Emerging (3), and Established (4)—progress between levels requires convergent advances across the four domains of interoperability: legal frameworks that are both in force and applied, active governance mechanisms, technical architecture with standardized identifiers and services, and shared semantics through official nomenclatures.

Reaching the Established level entails not only having consolidated frameworks and systems in place, but also ensuring broad coverage, effective interoperability, and the systematic reuse of data in pedagogical, administrative, and strategic management (IDB, 2022).[3]

The Three Dimensions of Educational Interoperability

Educational interoperability operates simultaneously across three complementary dimensions. These dimensions help clarify how information circulates within the education ecosystem, how it articulates with the territorial structures of the State, and how it connects with other government sectors that deliver essential services. This distinction is particularly relevant in LAC, where federal or decentralized systems coexist with centralized ones, and where the provision of educational services depends both on internal ministry areas and on external agencies with critical functions.

A. Interoperability between the education sector and other sectors of the State

Interoperability between the education sector and other sectors of the State encompasses the information exchanges required to articulate education management with cross-cutting systems such as identity, civil registry, social protection, health, finance, infrastructure, and human resource management. This dimension enables critical functions for public administration, such as the identity validation of students and staff, payroll updating, verification of conditionalities associated with social programs, investment planning, and the compatibility of financial administration systems. Cases such as the coordination between the *Sistema Presença* (Attendance System), and the *Cadastro Único* (Single Registry) in Brazil, identity validation through the Civil Registry in Chile, and the integration of education personnel systems (Ministry of Education) with financial administration systems (Ministries of Economy/Finance) across various Argentine jurisdictions illustrate the relevance of this dimension. Its development requires enabling regulatory frameworks, inter-agency data-sharing agreements, and standards that guarantee security, traceability, and rights protection.

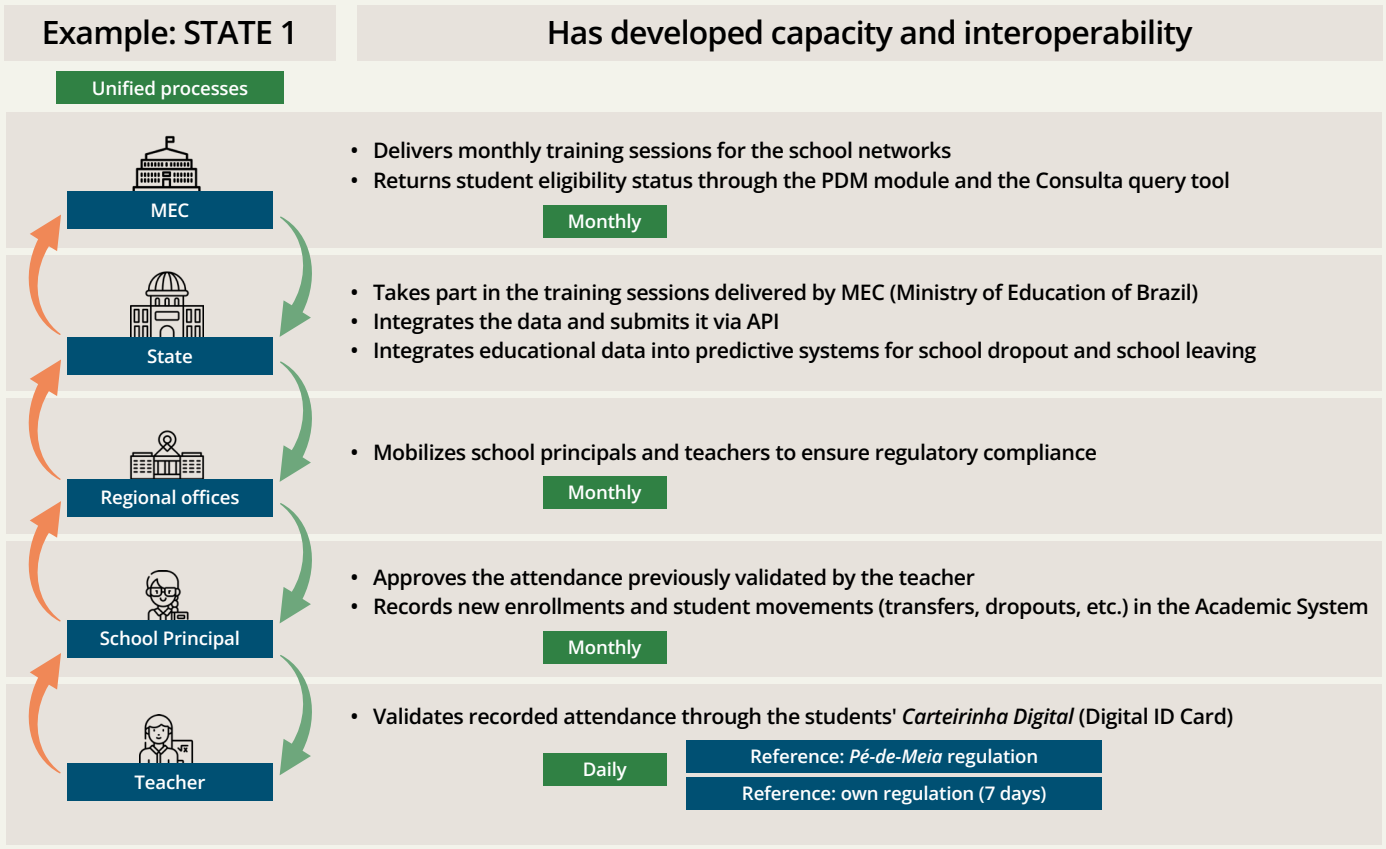
3 The EMIS methodology structures institutional assessment across five processes—Physical Infrastructure and Equipment, Educational Institutions, Human and Financial Resources, Students and Learning, and Tools for Strategic Management—and two structural conditions—Technological Infrastructure and Governance and Institutional Framework. To determine the level of development of each process or condition, the maturity of its subprocesses is analyzed on the basis of coverage, orientation, and systematization criteria, classifying them across the four aforementioned levels. The median of these results defines the level of each process, and, in turn, the median across all processes and conditions determines the overall EMIS maturity level.

B. Educational interoperability among jurisdictions

Educational interoperability among jurisdictions refers to the information flows that circulate between the different territorial levels with responsibility for education management—national, provincial/state, and municipal/local—and constitutes a structural element in federal or highly decentralized systems. In these contexts, interoperability does not mean technologically homogenizing jurisdictions, but rather articulating a federated structure based on shared nomenclatures, reconciliation protocols, and common rules for validation and quality assurance. The path of progressive consolidation in Peru—schools → UGEL (*Unidad de Gestión Educativa Local*, Local Education Management Unit) → DRE (*Dirección Regional de Educación*, Regional Education Directorate) → MINEDU (*Ministerio de Educación,* Ministry of Education)—and the articulation between provincial systems and SInIDE in Argentina are examples that show how this dimension sustains national comparability and statistical consistency in environments marked by territorial autonomy. Its central function is to ensure that data produced in each jurisdiction are compatible, traceable, and usable for planning, monitoring, and evaluation at the national scale.

A recent example that illustrates this dimension is the interjurisdictional architecture developed by Brazil's *Ministério da Educação* (Ministry of Education) under the *Pé-de-Meia* program, a national financial-educational incentive policy aimed at promoting retention and completion of secondary education among public school students. As shown in the diagram 3, the program's operation requires a regular flow of data between schools, municipal and state networks, regional bodies, each state's own academic systems, and the *Ministério da Educação* (MEC, Ministry of Education) as the national authority. Each level performs specific functions—attendance registration and validation, consolidation of student academic records, data reconciliation, and transmission via API—following common standards and deadlines defined at the national level. This federated model shows how, even with high territorial autonomy, it is possible to sustain interoperable processes grounded in standardized procedures, shared validation rules, common calendars, and a national layer of coordination and feedback. The Brazilian experience demonstrates that interoperability among jurisdictions can scale rapidly when incentives, standards, and governance are aligned, allowing locally produced data to be integrated without requiring technological homogenization.

Diagram 3. Federated Data Flow Between Schools, States, and the MEC of Brazil



Source: Ministry of Education of Brazil.

C. Internal interoperability

Internal interoperability within a jurisdiction's education system encompasses the information exchanges that take place between the processes and subsystems that make up the education ecosystem, including enrollment, student trajectories, assessment, certification, staffing and personnel files, school infrastructure, curricular offerings, planning, and financing. This dimension covers both the articulation among systems—for example, enrollment, trajectories, learning outcomes, and certifications—and internal coherence within each process, as occurs in the link between positions, appointments, and compensation, or between infrastructure, class sections, and building capacity. It constitutes the functional base of the EMIS, as it allows for reducing parallel records, preventing inconsistencies, sustaining student traceability, and ensuring that the information used by administrative, pedagogical, and strategic areas circulates in a timely, coherent, and reliable manner.

The presence and intensity of these three dimensions depend on the territorial and administrative organization of each education system. Educational interoperability

among jurisdictions fully takes shape only in federal or decentralized contexts, where responsibilities are shared across levels of government. By contrast, interoperability with other sectors of the State and internal interoperability within the education system are present in all countries, although their scope and complexity vary depending on the degree of centralization, the institutional architecture, and the level of integration of administrative and pedagogical processes. Recognizing these differences is key to adapting interoperability strategies to the actual structure of each education system.

Taken together, these three dimensions show that educational interoperability is a structural attribute of the system, not an isolated technological project. Its development requires a balanced combination of governance, standards, and institutional capacities that ensure the internal coherence of the education system, its territorial articulation where applicable, and its integration with the cross-cutting systems of the State. This integrated approach makes it possible to build a digital education ecosystem that is robust, sustainable, and oriented toward evidence-based decision-making.

3. Territorial Organization Scenarios

The territorial organization of education systems shapes how data are produced, managed, and consolidated, and determines the strategies needed to articulate interoperability. Across the region, two broad institutional arrangements can be distinguished: **centralized systems**, in which the national education authority holds direct responsibility for information management and consolidation; and **federal or decentralized systems**, in which different jurisdictions exercise their own competencies and actively participate in the production and use of data. These configurations should not be understood as rigid categories, but rather as predominant patterns that vary by process, institutional architecture, and the actual distribution of administrative and pedagogical functions.

Centralized Systems

In centralized systems, the national education authority directly administers most processes and information systems. The institutional chain is typically structured as: school → intermediate unit (if any) → national ministry.

The intermediate unit—for example, a region or territorial directorate—performs functions of support, supervision, or technical assistance, but does not operate as an autonomous level of data consolidation or formal data management. National consolidation takes place directly, which facilitates the standardization of nomenclatures, academic calendars, validation rules, and data-entry protocols.

Chile and Uruguay illustrate this arrangement. In Chile, the Ministry of Education operates the *Sistema de Información General de Estudiantes* (SIGE), integrating enrollment, attendance, and academic performance on a single platform with direct national consolidation. In Uruguay, the *Administración Nacional de Educación Pública* (ANEP, National Public Education Administration) manages the GURI system and the *Registro Único del Alumno* (RUA) as centralized repositories of student trajectories. The strength of this model lies in its technical and semantic homogeneity, although it can face challenges in adapting to diverse territorial realities or in developing close-to-the-ground management capacities when targeted interventions are needed.

Federal or Decentralized Systems

In federal or decentralized systems, different levels of government hold their own competencies in education, which means that the production, management, use, and consolidation of information are distributed across multiple levels. The minimum institutional chain always includes schools, a subnational level with

its own education authority—provinces, states, or equivalent entities—and the national ministry, responsible for the stewardship of the system and federal consolidation.

In many countries, this structure is supplemented by local or intermediate levels that carry out operational, supervisory, or territorial support functions, although not all of them hold formal consolidation responsibilities. Their names and roles vary across countries: *Unidad de Gestión Educativa Local* (UGEL) and *Dirección Regional de Educación* (DRE) in Peru; educational districts in Ecuador; district directorates in Bolivia; and municipalities in Brazil, which hold their own responsibilities for part of basic education—especially early childhood education and the early years of fundamental education—within a federal system in which competencies are distributed among the federal government, the states, and the municipalities.

Educational interoperability in these systems requires federated mechanisms capable of reconciling heterogeneous architectures, nomenclatures, and administrative timelines without imposing a single model. This calls for shared master catalogs, data validation and reconciliation protocols, clear inter-jurisdictional exchange rules, and distributed quality assurance mechanisms. This federated logic can be observed in the articulation between provincial systems and SInIDE in Argentina; in the integration of state and municipal networks in Brazil's *Censo Escolar*, coordinated by *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira* (INEP, National Institute for Educational Studies and Research Anísio Teixeira); and in the school → UGEL → DRE → MINEDU sequence that characterizes consolidation in Peru. The distinctive feature of these systems is that subnational levels directly produce, use, and govern data, so interjurisdictional interoperability constitutes a structural component of how the education system operates.

Internal Variations and Mixed Arrangements

Both centralized and federal systems show variations depending on the management process. Some centralized countries use intermediate units for specific functions without delegating consolidation authority, while in federal systems certain processes—such as standardized assessments or census-type statistical surveys—are operated centrally. Brazil and Argentina represent mixed arrangements in which the depth of federalism varies by process: for example, in Brazil the federal *Censo Escolar* coexists with fully operational state and municipal systems, and in Argentina provincial systems coexist with national census-type surveys. These variations do not constitute independent models, but rather functional expressions within the two main institutional arrangements.

Territorial organization directly shapes how the three dimensions of educational interoperability are expressed. In federal or decentralized systems, interjurisdictional interoperability is a structural cornerstone, since multiple levels produce and use information autonomously. In centralized systems, this dimension carries

less relevance or does not exist, given that consolidation takes place directly at the national level. In all cases, interoperability with other sectors of the State and internal interoperability within the education system are present, although their operational scope and complexity vary according to institutional architecture, the distribution of functions, and the degree of centralization of the education system. Recognizing these differences is essential for designing interoperability strategies that match the actual structure of each country.

Implications for Educational Interoperability

The different models imply differentiated systems architectures and governance arrangements. While centralized models can rely on unified platforms, subnational or territorial models require federated architectures that enable progressive data integration. Governance becomes more complex as the levels of consolidation increase, making it essential to establish clear rules for inter-jurisdictional coordination, interoperability protocols, and service level agreements. Likewise, priority use cases vary: in centralized systems, the emphasis falls on record homogeneity; in decentralized ones, on data reconciliation and comparability across jurisdictions. Implementation strategies must be adapted to the territorial structure, combining gradual approaches, demonstration projects, and data quality assurance mechanisms at each level.

4. Operational Framework for Education: Architecture, Master Data, and Governance

The three operational pillars presented in this section—interoperability architecture, master data management, and governance—do not constitute an alternative framework to the four domains of interoperability (legal, organizational, technical, and semantic). On the contrary, they express how the capacities associated with each domain are implemented in practice. Architecture primarily operationalizes the technical and semantic domains; master data management constitutes a concrete application of the semantic domain; and governance articulates the legal and organizational domains. The two frameworks are complementary: the domains describe what capacities must exist, while the pillars show how those capacities are organized and sustained in operation.

The following table presents the relationship between the interoperability domains—which structure the conceptual framework—and the operational pillars, which are developed below as cross-cutting implementation capacities.

Table 1. Relationship Between the Domains of Interoperability and the Operational Pillars

Interoperability domain	Associated operational pillars	How they relate
Legal	Governance	Enabling regulation, exchange agreements, data protection, legal validity.
Organizational	Governance	Roles, responsibilities, intersectoral and interjurisdictional coordination, institutional processes.
Technical	Architecture	Standards, APIs, security, exchange mechanisms, infrastructure.
Semantic	Architecture / Master data	Data models, master catalogs, unique identifiers, business rules, semantic consistency.

Source: own elaboration.

In the education sector, the interoperability architecture, master data management, and sectoral governance are three pillars that must advance in a convergent manner. Without active governance, master catalogs risk becoming fragmented; without master records, the architecture becomes an empty shell; and without architecture, governance is left without operational support.

The IDB's experience in designing digital ecosystems for the social sector confirms that a sustainable interoperability model can only be consolidated when these elements are connected (IDB, 2019b).

Architecture

The interoperability architecture is the technical framework that enables the secure, consistent, and progressive exchange of educational information across systems, agencies, and territorial levels. Its function is to organize the digital components required for data to flow with quality, traceability, and rights protection, regardless of the technological platforms used by each country or jurisdiction.

In operational terms, the interoperability architecture in education should be understood as a set of three complementary layers. The *front-end* corresponds to the interfaces visible to end users—for example, school portals, enrollment modules, mobile applications, or dashboards for families—that allow information to be recorded or consulted. The *back-end* comprises the systems that manage the internal processes of the ministry and of educational institutions, such as student management, human resources, infrastructure, or finance. Finally, the *interoperability services layer* acts as a bridge connecting the two, ensuring that data flow securely, in a standardized way, and consistently across different systems.

Regional experience shows that when these layers are not clearly defined, integrations produce inconsistencies or technology lock-in that is difficult to sustain. For this reason, the IDB recommends that every ministerial procurement or development incorporate explicit interoperability requirements, the use of open standards, and security-by-design criteria (IDB, 2022).

In this document, the term "digital education ecosystem" is used to describe the articulated set of people, processes, norms, data, and technologies that interact to generate, share, and use educational information securely and efficiently. This ecosystem transcends individual platforms or applications, integrating dimensions of governance, interoperability, and knowledge management that make it possible to turn information into a public good at the service of education policy.

This pillar translates the capacities of the technical and semantic domains into operation, defining the standards, exchange mechanisms, and data models required for interoperability.

Master Data Management (MDM)

Master Data Management is a critical pillar of interoperability. Its purpose is to ensure that essential information within the education system is collected only once, validated, and reused across multiple processes, in accordance with the internationally recognized “once-only principle” (EU, 2024).

In LAC, diagnostic assessments show that the absence of consolidated master records remains one of the main weaknesses of EMIS in the region. Without centralized nominal registries of students, teachers, institutions, and school buildings—and without standardized connectors between these entities—it is impossible to ensure traceability of student trajectories, consistency in teacher payroll, or comparability across jurisdictions. This challenge is typically accompanied by the absence of homogeneous catalogs of education levels, modalities, infrastructure, or teaching positions, which increases fragmentation and hinders systems integration (IDB, 2022).

To develop this component properly, two concepts central to educational interoperability must be clarified: **master data** and **master catalogs**. **Master data** are fundamental and stable records that uniquely identify the key entities of the education system—students, teachers, positions (staffing roles), institutions, and school buildings—and serve as the basis for ensuring traceability, consistency, and uniqueness across management processes. **Master catalogs**, in turn, are standardized lists of classifications and attributes that organize data uniformly—such as nomenclatures of education levels and modalities, infrastructure codes, or categories of teaching positions—and establish a common language to avoid duplication, ensure comparability, and facilitate systems integration.

Interoperable identifiers also play a cross-cutting role: they ensure uniqueness and traceability across the entire ecosystem, whether based on national identity documents, school codes, or through pseudonymization mechanisms that protect personal information while maintaining the stability of the identifier across all systems. Finally, mechanisms of continuous validation and periodic data cleansing form the basis for building public trust in data quality—an indispensable condition for data to be used in analysis and planning.

Beyond its operational impact—reducing redundancies, saving resources, and improving coordination across areas—IDB diagnostic work shows that data quality and consolidation are necessary conditions for the development of educational analytics and management dashboards (IDB, 2022).

This pillar is the applied expression of the semantic domain, organizing the core entities of the education system through master catalogs and unique identifiers.

Data Governance and Institutional Framework

Data governance is the component that ensures the sustainability of interoperability processes. Without robust digital governance structures, technological advances lack continuity. In the education sector, this requires clear frameworks for quality, privacy, and ethics, along with differentiated responsibilities across planning, statistics, information technology, and data protection.

The greatest progress is observed in contexts with stable ministerial leadership and active intersectoral agreements (IDB, 2022). Such agreements—with civil registry, finance, infrastructure, or health—allow interoperability not to remain confined within the education sector, but to connect with critical processes such as student-level nominal records, payroll processing, and socio-educational traceability.

Governance also requires formal mechanisms for interjurisdictional coordination, particularly in federal countries, where data reconciliation between national and subnational levels is key to the coherence of the systems. To these are added instruments such as RASCI matrices, single data authorities for master catalogs, service level agreements (SLAs), and business continuity plans, which safeguard critical processes—such as enrollment, certifications, or teacher payroll—even in times of crisis.

A core aspect is the strengthened ethical framework for the handling of personal data, especially in the case of minors. Informed consent protocols, record anonymization, and the safeguarding of vulnerable populations must be accompanied by a risk-based approach that identifies threats related to privacy, algorithmic bias, and cybersecurity. In this regard, particularly relevant are the guidelines of the European Union's General Data Protection Regulation (GDPR) and regional frameworks such as Brazil's General Personal Data Protection Law (Law No. 13,709/2018) and Argentina's (Law No. 25,326/2000), which provide principles of transparency, minimization, and accountability. Far from curbing innovation, this ethical and regulatory approach makes it possible to advance toward responsible, secure, and trustworthy interoperability.

This pillar articulates the legal and organizational domains, ensuring the definition of roles, responsibilities, normative agreements, and mechanisms of intersectoral and interjurisdictional coordination.

5. Enabling Conditions and Common Barriers

Educational interoperability faces a set of necessary minimum conditions and recurring barriers that must be overcome to reach higher maturity levels. These barriers are typically grouped, in descriptive terms, into four main dimensions—technological, regulatory, organizational, and cultural—that cut across and affect, to varying degrees, the interoperability domains defined in this framework, including challenges associated with large-scale data management, security, and the adoption of standards, which reflect the need for sustained investment in digital infrastructure.

On the technological front, the most frequent constraints include uneven school connectivity, the lack of unified infrastructure inventories, and the absence of standardized criteria for enrollment, student trajectory, and teacher management processes, as EMIS diagnostics have shown. These gaps reveal that a minimum base of infrastructure and reliable repositories is not yet in place to ensure the secure and timely flow of information.

Regulatory barriers are linked to weaknesses in legal frameworks for data protection and to insufficient regulation of the legal validity of digital records. The need for specific protocols for minors and for parental consent mechanisms remains a critical issue for consolidating trust in the use of information.

On the organizational front, the main obstacles stem from limited coordination between levels of government and between areas within the same ministry, which generates overlaps and institutional fragmentation. These shortcomings are aggravated by the lack of stable teams with continuity, which limits the sustainability of digital policies.

Cultural barriers are equally significant: resistance to data sharing persists, along with distrust in the use of information and limited adoption of innovative processes, as well as the persistence of digital divides. Building a culture of interoperability that demonstrates tangible benefits is essential to reversing these attitudes. In this regard, moving toward interoperability does not only involve integrating systems, but promoting a transition from fragmented management schemes toward data-driven, articulated management models. This change requires revisiting institutional practices, strengthening trust across departments, and collaboratively building common frameworks, sustained by political leadership and clarity of objectives. International experience has shown that interoperability becomes consolidated when stakeholders perceive concrete results, such as the reduction of duplications, the improvement of indicators, the simplification of administrative processes, and savings in management costs (IDB, 2022; OECD, 2023).

These limitations cannot be overcome through regulatory frameworks or technological platforms alone. Sustained investment in human capacities is also required, particularly through training programs aimed at officials and teachers that strengthen the use of interoperable systems and the adoption of digital culture within the school community.

Regional diagnostic assessments show that these challenges are common gaps across LAC, where recurring patterns include the absence of master catalogs, the lack of consolidated school infrastructure inventories, weaknesses in data quality, and cultural resistance to information exchange (IDB, 2022; OECD, 2023). Added to this are technical challenges linked to the consolidation of data from multiple sources, the protection of privacy and security in distributed environments, and the effective adoption of interoperability standards, all of which require modernizing equipment, software, and infrastructure to ensure compatibility.

When minimum conditions are met, interoperability generates verifiable benefits. Among the most notable are improved data management, gains in productivity thanks to real-time information availability, greater scalability for incorporating new systems, and reduced operating costs by avoiding parallel and redundant developments (IDB, 2019b). To these is added a direct impact on day-to-day administrative processes: interoperability simplifies school procedures, reduces documentation requirements, prevents duplicate data entry, and enables students and families to access digital services that are simpler, faster, and more reliable. This people-centered approach improves the experience of the school community and strengthens the legitimacy of digital solutions. These benefits reinforce the sustainability of the digital ecosystem and bolster stakeholder confidence in the value of investing in educational interoperability processes.

In strategic terms, the conclusion is clear: before interconnecting systems, it is essential to close basic gaps and ensure that institutions reach a minimum level of maturity in the regulatory, technological, and organizational dimensions. The strengthening of educational interoperability must advance in a progressive and stepwise manner, first securing the essential foundations before deploying complex integrations, so that each step forward is sustainable over time.

Table 2. Main Barriers to Educational Interoperability, by Domain

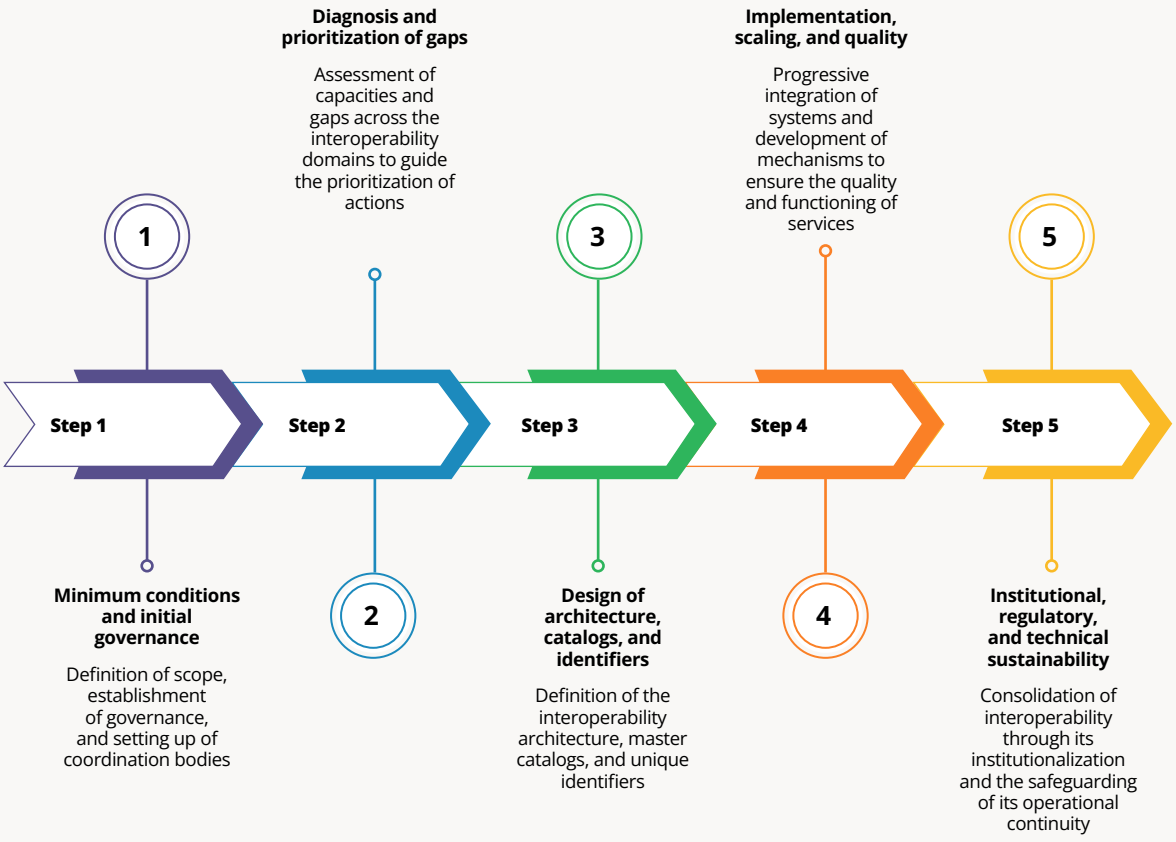
Domain	Main Barriers Identified
Legal	Outdated or restrictive regulatory frameworks on data exchange; absence of inter-institutional agreements defining responsibilities and safeguards.
Organizational	Institutional fragmentation, weak coordination across areas, frequent staff turnover, and lack of sustained leadership. Resistance to information sharing, a limited culture of data use for management, and a perception of interoperability as a threat rather than an opportunity.
Semantic	Absence or low adoption of common master catalogs, divergent classification systems across levels or jurisdictions, and lack of data-validation rules.
Technical	Non-interoperable systems, obsolete infrastructure, and lack of standards or secure mechanisms for data exchange.

Source: Own elaboration based on EMIS assessments and IDB documents (2022, 2019b).

6. Five Steps to Promote Educational Interoperability

The implementation of educational interoperability does not follow a single, linear process, but it can be organized as a progressive sequence of five steps that structure the advance from initial conditions to the consolidation of institutional capacities. These steps should be understood as an orienting guide that helps to plan and prioritize initiatives across diverse contexts. Diagram 4 summarizes this sequence and its progressive character. The five steps articulate and mobilize, in an integrated manner, the legal, organizational, technical, and semantic domains across the different dimensions of educational interoperability.

Diagram 4. Roadmap to Promote Educational Interoperability



Source: own elaboration.

Making progress on educational interoperability requires combining diagnosis, definition of use cases, and a governance framework that ensures institutional continuity. The IDB has developed an institutional maturity model for the four domains of interoperability —legal, organizational, technical, and semantic— designed for the social sector as a whole. This document incorporates a simplified checklist, tailored specifically to the education sector and included as an annex. This tool does not replace the full model; it serves as a practical instrument to facilitate an initial diagnosis, structure the discussion, and prioritize gaps in a consistent way.

The five proposed steps constitute a practical roadmap for promoting educational interoperability, organizing and strengthening existing or incipient processes and guiding their consolidation and institutional sustainability at different maturity levels.

Each of the four domains of interoperability translates into specific decisions within this roadmap. The legal domain is reflected in the regulatory frameworks that enable information exchange and in the inter-institutional agreements that formalize responsibilities. The organizational domain guides the creation of governance structures, the definition of roles, and change management. The technical domain takes shape in systems architecture, open standards, APIs, and security mechanisms. Finally, the semantic domain underpins the creation of master catalogs and master records that ensure consistency and a shared language. The five proposed steps articulate these domains in a progressive and coordinated manner, ensuring that progress in one drives progress in the others.

Regional evidence shows that the greatest returns are achieved when education systems consolidate nominal enrollment registries, guarantee the traceability of student trajectories, and integrate teacher payroll information into interoperable schemes. These elements not only strengthen educational planning and management but also enable efficient resource allocation policies —including the estimation of an Optimal Functional Template (*Planta Óptima Funcional*, POF) for each institution— within broader smart spending strategies, always in alignment with national or interjurisdictional guidelines, according to the territorial model. On this basis, the document presents a practical five-step framework to guide ministries in implementing educational interoperability. It is not a detailed operational plan, but a set of guidelines that each country or jurisdiction will need to develop within its own strategic and operational plan, adapted to its level of institutional maturity and its territorial context.

The five steps cover, in an integrated and sequential way, the four domains of interoperability —legal, organizational, technical, and semantic— and make it possible to progressively address the three dimensions defined in this document: articulation with other State sectors, coordination among territorial levels where applicable, and internal interoperability of the education system. **Step 1** secures the minimum conditions and establishes initial governance; **Step 2** diagnoses and prioritizes interoperability gaps; **Step 3** designs the architecture, master catalogs, unique identifiers, and business rules; **Step 4** implements, scales, and ensures the quality of data and services; and **Step 5** consolidates institutional, regulatory, and technical sustainability. Taken together, these steps allow domains and dimensions to advance in a convergent manner.

Table 3. Correspondence Between the Practical Steps and the Domains of Interoperability

Step	Main Domains	Critical Decision	Key Deliverables
1. Secure minimum conditions and governance	Legal / Organizational	Formally designate the responsible authority and the interoperability committee, defining their institutional scope and their mandate across the three dimensions of educational interoperability.	Resolution or administrative act; stakeholder map; preliminary institutional scope; regulatory and governance guidelines; 90-day work plan and meeting schedule.
2. Diagnose and prioritize interoperability gaps	Legal / Organizational / Technical / Semantic	Identify capacities and gaps across the four domains and define the level of institutional maturity, covering the three dimensions of interoperability.	Diagnostic and maturity report by domain; inventory of systems and information flows; regulatory analysis; identification of master catalogs and business rules; map of risks and dependencies.
3. Design the architecture, master catalogs, and identifiers	Technical / Semantic / Organizational	Select data standards, exchange mechanisms, master catalogs, unique identifiers and business rules, and define institutional responsibilities.	Reference architecture; master data management plan; unique identifiers; initial set of business rules; RASCI matrix; security and privacy-by-design guidelines.
4. Implement, scale, and ensure data and service quality	Organizational / Technical / Semantic	Select suitable pilots and define a scaling model aligned with governance and architecture.	Implemented and documented pilots; quality and reconciliation rules; interoperability manual; service-level agreements; scaling plan and timeline; initial analytical repository.
5. Consolidate institutional, regulatory, and technical sustainability	Legal / Organizational / Technical / Semantic	Institutionalize the governance mechanisms, regulatory updates, and technical processes needed to sustain interoperability.	Interoperability manual; regulatory updates; operation and maintenance procedures; annual monitoring plan; key indicator reports; service-level agreements; updated RASCI matrix.

Source: Own elaboration.

Step 1. Secure Minimum Conditions and Governance

Every interoperability process must begin by securing basic preconditions. This means having explicit political sponsorship, allocating an initial budget (even if modest), forming a core team with continuity, and establishing an interoperability committee with a formal mandate. This initial governance should include clear responsibilities, intersectoral agreements with key entities (civil registry, finance, health, infrastructure), and a change management and communication plan that addresses the cultural and organizational barriers identified in Section 5. From the outset, the composition and mandate of this committee should cover the three dimensions of interoperability defined in this document: articulation with other State sectors, coordination among territorial levels where competences are distributed, and internal interoperability of the education system itself.

- **Critical decision:** formally designate the responsible authority and the interoperability committee, defining their institutional scope and mandate across the three dimensions of educational interoperability.
- **Deliverables:** a resolution or administrative act establishing the governance of the process; a preliminary map of stakeholders and institutional scope; regulatory and governance guidelines to initiate the process; a 90-day work plan and the committee's meeting schedule.
- **Risk to mitigate:** ending up with governance whose operational and budgetary capacity is limited and therefore unable to sustain the process beyond the initial phase.

Box 2. Critical Elements of Effective Governance

Organizational domain

- Sustained political sponsorship from the highest authority.
- Explicit roles and responsibilities across ministerial areas.
- A mandate with decision-making authority and an allocated budget.
- Representation of the key areas linked to the three dimensions of interoperability: articulation with other State sectors, interjurisdictional coordination where applicable, and internal management of the education system.
- A change management and communication plan.

Legal domain

- A resolution or regulation authorizing the exchange of educational data.
- Formal intersectoral agreements (civil registry, finance, health, infrastructure).
- Data protection and privacy guidelines (especially concerning minors).

Semantic domain

- Agreement on principles for master catalogs, classification systems, and business rules to guide the subsequent development of the technical and semantic domains.

Step 2. Diagnose and Prioritize Interoperability Gaps

The second step consists of rigorously identifying the current state of the system across the four domains of interoperability (legal, organizational, technical, and semantic). This diagnosis should make it possible to determine the maturity level of the educational information system, as well as the existing capacities and the gaps to be addressed in the following steps.

The analysis should consider interoperability across the three dimensions defined in this document: articulation with other State sectors, coordination among territorial levels where competences are distributed, and internal interoperability of the education system. To this end, it is necessary to review the current regulatory framework, institutional processes, the inventory of systems and platforms, the availability of master catalogs and data quality criteria, data governance practices, and existing formal or informal mechanisms for information exchange.

This diagnosis should rely on standardized tools, such as the EMIS maturity matrix and the guidelines in Annex, which allow for a consistent assessment of the state of progress in each domain. The exercise should be participatory, involving technical leads, process owners, and technology teams, and should document not only the current state but also risks, critical dependencies, and opportunities for improvement.

- **Critical decision:** identify capacities and gaps across the four domains and define the level of institutional maturity, covering the three dimensions of interoperability.
- **Deliverables:** diagnostic and maturity report by domain; inventory of systems and information flows; analysis of the regulatory framework; identification of available master catalogs and existing business rules; map of risks and dependencies.
- **Risk to mitigate:** producing an incomplete diagnosis that underestimates institutional, regulatory, or technological gaps, leading to unrealistic planning for the following phases.

Box 3.
Key Elements for Assessing Maturity in Educational Interoperability

Legal domain

- Existence of regulations that authorize data exchange and set conditions for the protection of personal data.
- Intersectoral and, where applicable, interjurisdictional agreements or conventions.
- Definition of institutional responsibilities for the handling of educational data.

Organizational domain

- Clarity of roles and responsibilities for managing data and processes.
- Technical capacities of staff and mechanisms for intersectoral and interjurisdictional coordination.
- Documented procedures for managing, updating, and resolving inconsistencies.

Technical domain

- An up-to-date inventory of systems and available information on existing architectures, integrations, and interoperability mechanisms.
- Security and access-control mechanisms.
- Minimum infrastructure conditions for information exchange.

Semantic domain

- Availability and use of master catalogs, unique identifiers, and standardized business rules.
- Data quality, consistency, and timeliness.
- Common criteria for interpreting and using data across areas and institutions.

Step 3. Design the Interoperability Architecture and Data Management Mechanisms

The third step consists of defining the interoperability architecture and the mechanisms that will enable the secure, consistent, and progressive exchange of educational information. This definition should respond to the diagnosis carried out in the previous step and take into account the institutional decisions made regarding the three dimensions of interoperability: articulation with other State sectors, coordination among territorial levels where competences are distributed, and internal interoperability of the education system.

The design should include the definition of technical standards, data models, and exchange mechanisms, as well as the consolidation of master catalogs, unique identifiers, and business rules that ensure semantic consistency. It is also necessary to establish institutional and operational responsibilities through RASCI matrices[4], to define versioning and updating mechanisms for catalogs, and to agree on security and privacy-by-design practices.

Together, these elements make up a reference architecture that guides subsequent development, regardless of the technology platform used in each country. This architecture should be progressive, allowing for the gradual incorporation of systems and adapting to the territorial model.

- **Critical decision:** select the standards, exchange mechanisms, and data models that will serve as the basis of the system, defining master catalogs, unique identifiers, business rules, and institutional responsibilities.
- **Deliverables**: reference architecture; master data management plan; definition of unique identifiers; initial set of business rules; RASCI matrix.
- **Risk to mitigate:** adopting overly centralized designs, or designs tied to a specific platform, which hinder scaling and sustainability.

4 For practical guidance, see the template for preparing RASCI matrices included in the IDB document (2019a), "Interoperabilidad en el Sector Social: Guía metodológica y marco de referencia para América Latina y el Caribe" [Interoperability in the Social Sector: Methodological Guide and Reference Framework for Latin America and the Caribbean], which proposes a structure that can be adapted to different levels of institutional maturity.

Box 4 presents, for reference, functional components that tend to be present in educational interoperability initiatives as institutional capacities are developed and consolidated. It is not an evaluation scheme or a classification by levels.

Box 4. Technical, Semantic, and Organizational Components

Technical domain
- Reference models for the interoperability architecture.
- Definition of exchange standards (APIs, structured formats, authentication protocols).
- Security and access-control mechanisms.
- Guidelines for the progressive scaling of systems and services.

Semantic domain
- Initial master catalogs, with designated data stewards responsible for their updating.
- Unique identifiers for students, teachers, institutions, and programs.
- Business rules validated by the areas responsible for the processes.
- Procedures for versioning and publishing catalogs.

Organizational domain
- RASCI matrices that define operational responsibilities.
- Procedures for resolving inconsistencies and reconciling data.
- Coordination mechanisms among territorial levels where applicable.

Step 4. Implement, Scale, and Ensure Data and Service Quality

Once the reference architecture and the technical and semantic components have been defined (Step 3), the next challenge is to translate them into the actual operation of the education system. This step combines three essential dimensions: initial implementation, progressive scaling, and quality assurance for data and services. The evidence shows that interoperability processes are more sustainable when they advance through focused pilots, with verifiable results and clear mechanisms for gradually expanding their scope.

a. Initial implementation (pilots)

Pilots constitute the first practical validation of interoperable services. Their scope should be limited, measurable, and focused on critical processes, securing early results that strengthen institutional confidence. In this phase, it is essential to assess technical performance, user adoption, and the quality of the data generated. Documenting lessons learned and resolving inconsistencies early are key to preparing for scaling.

b. Progressive scaling

Once the pilot phase has been completed, scaling should be carried out in an orderly manner, with defined phases, support mechanisms, and data reconciliation rules that ensure traceability and consistency. This process must be aligned

with the governance defined in Step 1 and with the architecture and catalogs established in Step 3. Scaling can take different forms —sequential, by institutional levels, or by process— provided that semantic consistency, technical standards, and governance agreements are maintained.

c. Data and service quality assurance

Quality is a pillar of sustainable interoperability. This requires clear validation and reconciliation rules, data contracts, service-level agreements (SLAs), and continuous monitoring mechanisms. Having an analytical repository —such as a data warehouse or a data lake— facilitates the monitoring of critical indicators and the detection of duplicates, errors, and latency. Training users and technical teams is an indispensable component for ensuring operational consistency throughout all phases of the process.

- **Critical decision:** select pilots appropriate to the institution's level of maturity and define a scaling model aligned with the governance and architecture already established.
- **Deliverables**: operational, documented pilots; quality and reconciliation rules; interoperability manual; service-level agreements; scaling plan with phases and timeline; initial analytical repository.
- **Risks to mitigate:** pilots with no operational impact; scaling with inconsistent rules; absence of support mechanisms; uneven data quality.

Box 5. Minimum Operational Maturity Criteria for Scaling a Pilot

Technical component
- Stable, documented operation of the interoperable service.
- Effective integration with the defined master catalogs and business rules.
- Security mechanisms applied in line with the established architecture.

Organizational component
- Effective adoption by key users.
- Designated support teams with secured funding.
- Documented procedures for operation and maintenance.

Data quality component
- Automated validation of the unique identifier and basic consistency rules.
- Verifiable reduction of duplicates, errors, or inconsistencies.
- Business continuity plan with tested reversibility.

Step 5. Consolidate Institutional, Regulatory, and Technical Sustainability

The final step aims to ensure the continuity, scalability, and stability of the educational interoperability process. Unlike the previous steps—focused on initial governance, diagnosis, architecture, and pilots—the goal here is to establish the permanent mechanisms that allow interoperability to be sustained as an institutional capacity, rather than as a temporary project.

Sustainability requires progress across three complementary dimensions: institutional, regulatory, and technical, underpinned by stable financing mechanisms that ensure the operational continuity of the solutions implemented.

From the institutional standpoint, it is necessary for the agreements reached in previous phases to be consolidated into formal management structures, with documented roles, responsibilities, and processes. This entails keeping the Interoperability Committee active, periodically updating the RASCI matrix, and ensuring stable coordination mechanisms with other State sectors and, where applicable, with different jurisdictional levels.

On the regulatory front, sustainable interoperability requires clear frameworks governing the protection of personal data, the legal validity of digital records, information exchange between institutions, and the definition of operational obligations for the responsible areas. The regular updating of these instruments, with technical and legal input, is essential to ensure continuity and prevent regression.

From the technical standpoint, sustainability requires securing the operating, monitoring, and support conditions that allow interoperable services to function continuously. This includes managing the versioning of master catalogs, periodically updating business rules, monitoring critical data quality indicators, documenting APIs, and maintaining service-level agreements (SLAs) with the teams responsible for infrastructure and support.

To maintain coherence with the previous steps, these elements must be articulated with the architecture defined in Step 3 and with the scaling and quality mechanisms established in Step 4. Interoperability only becomes sustainable when the institutional framework, regulatory environment, and day-to-day operations evolve in a convergent manner, facilitating continuity beyond administrative cycles.

- **Critical decision:** ensure that governance mechanisms, regulatory frameworks, and technical processes are institutionalized and have operational, financial, and legal continuity.
- **Deliverables**: interoperability manual; updates to the applicable regulatory framework; operation and maintenance procedures; annual monitoring plan; key indicator reports; service-level agreements; updated RASCI matrix.
- **Risk to mitigate:** interruption of governance; obsolescence of regulations or catalogs; lack of sustained financing; staff turnover without knowledge transfer; progressive degradation of data quality.

Box 6. Minimum Indicators for Monitoring the Sustainability of Interoperability

Technical component

- Percentage of records with a valid unique identifier.
- Percentage of master catalogs published, versioned, and with active updating rules.
- Percentage of prioritized processes with a documented API and an active service-level agreement.
- Average data update latency in prioritized use cases.

Organizational component

- Percentage of Interoperability Committee sessions held as planned.
- Training coverage by role (leadership, technical teams, end users).
- Existence and semi-annual updating of the RASCI matrix.

Data quality component

- Initial completeness rate of master records.
- Rate of duplicates and inconsistencies reconciled per cycle.
- Percentage of systems applying common validation and reconciliation rules.

Legal and ethical component

- Annual updating of the regulatory framework related to data protection and the legal validity of digital records.
- Existence of impact assessment procedures and privacy audits.

These five steps offer a structured methodological framework for initiating and sustaining educational interoperability processes, but they need to be translated by each ministry into a strategic and operational plan suited to its own institutional reality. This adaptation must take into account existing capacities, the territorial distribution of responsibilities, the maturity of information systems, and the current regulatory framework. What is essential is to advance progressively, ensuring that each step consolidates the foundations for the next and that incremental gains strengthen the institutional confidence needed to sustain the effort over time. Interoperability is not a one-off project, but an organizational capacity built through technical, regulatory, and governance decisions that evolve in a convergent and sustained manner.

7. Applications and Lessons from the Argentine Case

The Argentine case offers a singular example of how a federal education system can advance toward interoperability on the basis of explicit regulatory frameworks, enabling infrastructure, and sectoral mechanisms in the process of consolidation. Over the past two decades, the country has developed relevant institutional and technological foundations: the deployment of the *Red Federal de Fibra Óptica* (Federal Fiber Optic Network, REFEFO, since 2010) as a territorial connectivity policy; the creation of the *Sistema Integral de Información Digital Educativa* (Comprehensive Digital Education Information System, SInIDE, 2012–2014) as the first national repository; and digital government and data protection frameworks that have contributed to enabling the secure exchange of information between agencies.

This process reached an inflection point in 2024–2025, with the institutionalization of three strategic federal-level mechanisms: the *Base Nacional Homologada* (National Harmonized Database, BNH), approved as the official statistical source for compulsory common education (CFE 494/2025); the *Relevamiento Nacional de Personal Educativo* (National Survey of Educational Personnel, ReNPE 2025), conceived as a mandatory survey and initial data load for the personnel module of SInIDE (CFE 478/2024); and the *Motor Unificado de Análisis y Reporte de Datos* (Unified Data Analysis and Reporting Engine, MUAR), currently under validation as an analytical feedback tool. Complementarily, the *Sistema Integrado de Información Social* (Integrated Social Information System, SIIS) constitutes an initiative aimed at advancing intersectoral interoperability between education and social policies.

These milestones mark a transition from a scenario of provincial fragmentation—documented in EMIS diagnostics conducted between 2020 and 2025—toward a federal digital ecosystem with defined interoperability rules. This set of developments seeks precisely to address the historical challenges of data integration and the strategic use of information in a federal system, offering lessons of high value for other countries in the region.

This section is structured in two complementary parts. First, it presents the national federal-level initiatives—BNH, ReNPE, MUAR, and SIIS—which constitute regulatory and institutional responses to overcome fragmentation and advance toward an interoperable ecosystem. These initiatives are grounded in explicit CFE legal frameworks and establish common rules for the 24 educational jurisdictions. Subsequently, it systematizes the consolidated findings of EMIS diagnostics conducted between 2020 and 2025 in Argentine provinces, which make it possible to identify recurring patterns of fragmentation, incipient strengths, and strategic challenges in the subnational management of educational information. The articulation of both parts shows how provincial diagnostics and federal decisions

feed back into each other, offering a comprehensive view of the Argentine process and lessons that can be extrapolated to other education systems in the region.

National-Level Initiatives

In recent years, Argentina has advanced a set of national-level initiatives aimed at strengthening the construction of master records and the integration of information in a federal system, based on the linkage between provincial systems and national repositories. Given that the national government does not manage schools directly, these advances focus on regulatory harmonization, the standardization of classification systems, and the progressive consolidation of data from the 24 educational jurisdictions.

The ***Base Nacional Homologada*** (National Harmonized Database, BNH) is configured as one of the pillars of Argentina's educational information policy. Its recent development is linked to the approval of CFE Resolution 494/2025, which redefines its scope in regulatory and institutional terms. More than a nominal student repository, the BNH is organized into four interoperable blocks: Persons (covering both students and educational personnel), Study Plans (qualifications and certifications), Organizations (schools and functional staffing), and Infrastructure. This structure enables a progressive and scalable approach aimed at improving the traceability, consistency, and comparability of educational information.

The resolution establishes that the BNH is the sole official statistical source for compulsory common education, defining that the production of indicators, planning, and resource allocation at the national level are based on data consolidated in the BNH. In terms of governance, it assigns technical leadership to the *Dirección Nacional de Información y Estadística Educativa* (National Directorate of Educational Information and Statistics, DNIEE), within the *Subsecretaría de Información y Evaluación Educativa* (Undersecretariat of Educational Information and Evaluation, SSIEE), and designates the *Red Federal de Información Educativa* (Federal Educational Information Network, RedFIE) as the federal coordination space with the jurisdictions. It also mandates the production of periodic public reports approved by the CFE and establishes formal mechanisms for data access and use.

In operational terms, during 2024 the BNH advanced in the integration of information with significant coverage in the snapshots taken (April and October), incorporating data on students and schools across different education levels and management sectors. These advances reflect meaningful progress in the consolidation of nominal information at the federal scale, although challenges remain regarding full coverage, data validation, and the systematic use of data for statistical production.

In this regard, the BNH is projected as a strategic instrument for educational interoperability, insofar as it articulates different dimensions of the system—persons, organizations, study plans, and infrastructure—and lays the groundwork for a more integrated use of information, even as its full consolidation as the sole statistical source continues to be an ongoing process.

The ***Relevamiento Nacional de Personal Educativo*** (National Survey of Educational Personnel, ReNPE) 2025, approved through CFE Resolution 478/2024, represents a significant step forward in the construction of a federal, nominal registry of teaching and non-teaching staff. Unlike previous education censuses, designed as one-off surveys, the ReNPE is conceived as a mandatory mechanism structured in two complementary stages: the administrative migration of jurisdictional administrative data, aimed at consolidating an initial national roster, and a direct online consultation with personnel through a web-based system, designed to verify and complement the information with the active participation of each educational agent.

The resolution establishes that the results of the ReNPE directly feed the positions and personnel module of SInIDE, integrating the "personnel" dimension within the Persons block of the BNH. This advances the articulation between survey operations and digital management systems, moving beyond the logic of isolated surveys and laying the foundations for the construction of a federal registry of educational personnel. This framework provides the information system with relevant inputs for managing payroll, competitive appointments, substitute positions, and career planning, although its consolidation will depend on the sustainability of the updating and validation mechanisms over time.

The implementation of the survey assigns clear responsibilities to RedFIE, reinforcing the federal governance model that characterizes Argentina's educational information system. Furthermore, the ReNPE incorporates personal data protection and confidentiality provisions, in line with Article 97 of the National Education Law, which establishes an appropriate framework for the use of information for statistical and educational management purposes.

In strategic terms, the ReNPE 2025 introduces a transition toward survey modalities more closely integrated with the digital ecosystem of SInIDE and the BNH. This evolution is particularly relevant for federal countries in the region, where the integration of subnational records into national systems poses significant governance and standardization challenges.

Complementarily, the ***Motor Unificado de Análisis y Reporte de Datos*** (Unified Data Analysis and Reporting Engine, MUAR) is currently under validation, conceived as an analytical tool for the active return of information to the jurisdictions and for fostering the strategic use of data in educational decision-making. This mechanism seeks to capitalize on the nominal base of the BNH and the SInIDE modules, providing an analytical layer oriented toward the generation of indicators and management reports in a timely manner.

Finally, the ***Sistema Integrado de Información Social*** (Integrated Social Information System, SIIS), promoted by the Ministry of Human Capital, constitutes a relevant initiative for advancing intersectoral interoperability between education and social policies. Through agreements with ANSES[5], RENAPER[6], and other State agencies, the SIIS seeks to integrate social and administrative registries, enabling use cases such as the validation of student nominal records, the targeting

5 *Administración Nacional de la Seguridad Social* (National Social Security Administration)
6 *Registro Nacional de las Personas* (National Registry of Persons)

of educational scholarships, and socio-educational traceability. This approach illustrates the potential of linking educational records with broader social databases, although its effective development will depend on the consolidation of institutional agreements and sustained technical capacities.

Within this framework, the *Sistema de Gestión Escolar* (School Management System, SGE), promoted from the national level, constitutes a complementary component oriented toward school management in the field. It is a solution that has been implemented across various jurisdictions, currently reaching 11 provinces, and incorporates a flexible adoption strategy for jurisdictions that need to strengthen their management capacities. The SGE includes functionalities related to enrollment, attendance, student trajectories, and institutional management, providing a relevant operational base for generating and systematizing data at the school level. In a heterogeneous federal context, tools of this kind contribute to reducing capacity gaps between jurisdictions and to strengthening the conditions upon which educational interoperability processes are built.

Taken together, these initiatives advance the construction of a federal ecosystem for the integration and exchange of educational data, in which the BNH contributes nominality and comparability, the ReNPE strengthens information on teaching and non-teaching staff, the MUAR incorporates strategic analytical capacities, and the SIIS promotes articulation with other social policies. More than a fully consolidated model, this set of mechanisms reflects a progressive process grounded in regulated federal instruments, with defined responsibilities and mechanisms under development. In its trajectory, it offers relevant lessons for other contexts in the region facing similar challenges of interjurisdictional coordination.

Lessons from EMIS Diagnostics: Consolidated Findings 2020–2025

This section integrates the results of diagnostics applied between 2020 and 2025 in nine Argentine jurisdictions, maintaining the confidentiality of the original reports and presenting the findings in consolidated and anonymous form.

The methodology developed by the IDB to measure the maturity level of EMIS structures the analysis around five core processes and two structural conditions:

Core processes:

4. Management of physical infrastructure and equipment.
1. Management of educational institutions.
2. Management of human resources and budget.
3. Management of students and learning.
4. Tools for strategic management.

Structural conditions:

1. Technological infrastructure.
2. Governance and institutional framework.

Each process and condition is assessed on a four-level maturity scale: Latent, Incipient, Emerging, and Established. This framework makes it possible to comparatively measure the situation of educational information systems in each jurisdiction, identify common patterns, and highlight both strengths and structural gaps.

The analysis presented in this section aims to offer an integrated view of the advances, challenges, and variations observed in the provincial diagnostics, with the objective of providing technical inputs for the strategic planning of EMIS strengthening in Argentina.

Cross-cutting findings

Across the set of jurisdictions analyzed, EMIS are located mostly at Incipient maturity levels (Level 2), with some processes at Latent (Level 1) and isolated advances toward Emerging (Level 3), with no Established systems (Level 4) recorded to date.

The most recurrent cross-cutting characteristic is fragmentation: legacy systems, provincial developments, and external solutions coexist without interoperating with one another. This situation gives rise to information silos, duplication of administrative burdens—particularly between nominal records for day-to-day management and aggregated statistical surveys—and marked latency in data availability for planning. As a result, both schools and ministry technical teams invest resources in redundant tasks that affect the quality and timeliness of information.

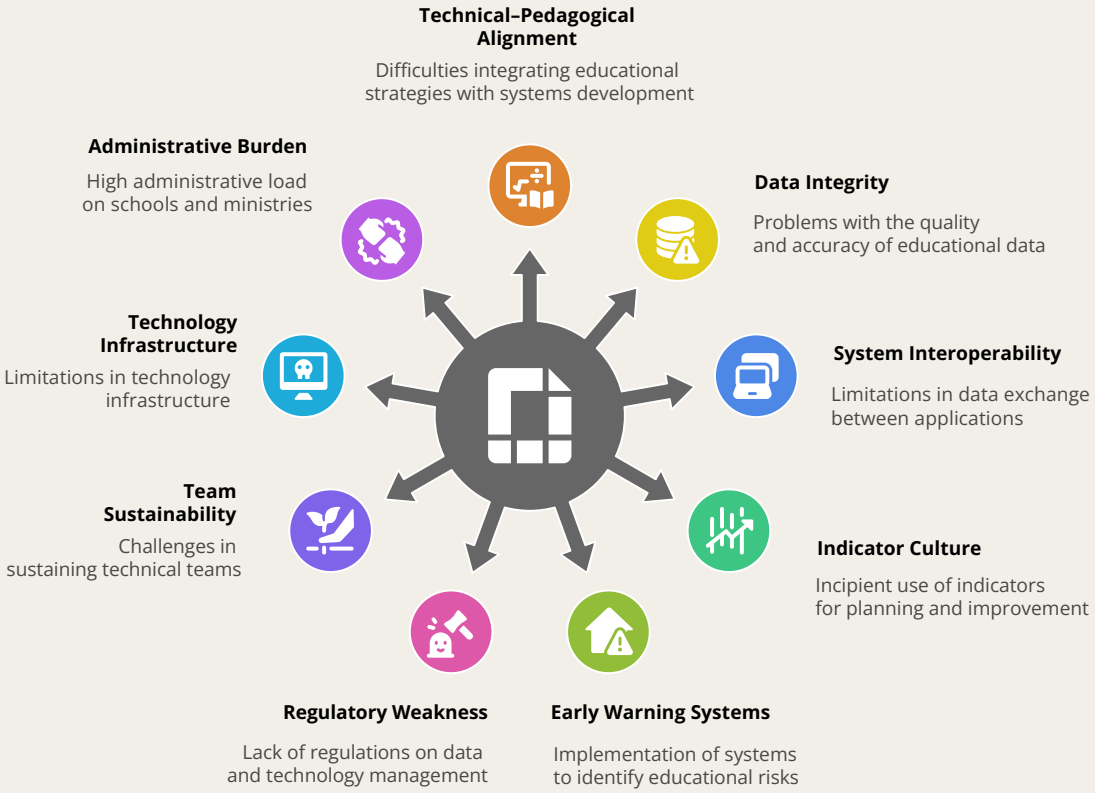
At the level of technological infrastructure, an Incipient state predominates, with cases dropping to Latent and isolated advances toward Emerging. Obsolete platforms, insufficient backup schemes, the absence of robust cybersecurity protocols, and limited school connectivity—especially in rural areas—are common features. The lack of a minimum technology base in classrooms and school buildings restricts the real-time use of applications and services.

Governance is generally in an Incipient or Latent condition. Although there are isolated political impulses and technically experienced teams, strategic EMIS plans with a medium-term horizon, multi-year financing, or institutionalized change management mechanisms are not systematically identified. High staff turnover and the absence of stable structures weaken the continuity of initiatives and favor reactively oriented projects.

Regarding the strategic use of information, the situation remains between Latent and Incipient. Although dashboard prototypes and indicators have been developed, the absence of a central data repository—such as a data warehouse or an educational data lake—and the limited availability of business intelligence tools restrict their impact on management. Published information is typically based on aggregated data with high latency, which diminishes its usefulness for guiding pedagogical planning and public policy decisions.

Across all jurisdictions, a lack of clear regulatory frameworks for data management and interoperability is also evident, as is the weak articulation between educational strategies and the development of information systems, which hinders the integration of digital tools with educational policy priorities.

Diagram 5. Main Challenges of Provincial EMIS



Source: own elaboration.

Recurring strengths

Despite the structural limitations noted above, the diagnostics make it possible to identify Incipient and, in some cases, Emerging capacities that constitute a solid foundation for advancing the strengthening of provincial EMIS.

First, the consolidation of unique identifiers stands out—national identity documents (DNI) for students and teachers, CUE[7] codes for institutions, and codes for positions and posts—which enable information traceability and lay the groundwork for building master records and unified files.

Second, a gradual process of migration from paper-based records to digital systems is underway, particularly in the management of attendance, grades, teacher leave, and competitive appointments, as well as in school enrollment. Although incomplete, this shift represents progress toward more agile and traceable administration.

Several jurisdictions have also developed dashboard prototypes and indicators for monitoring enrollment, infrastructure, and human resources. While their use remains incipient, they reflect a growing interest in data-driven management and open the path for strengthening business intelligence tools.

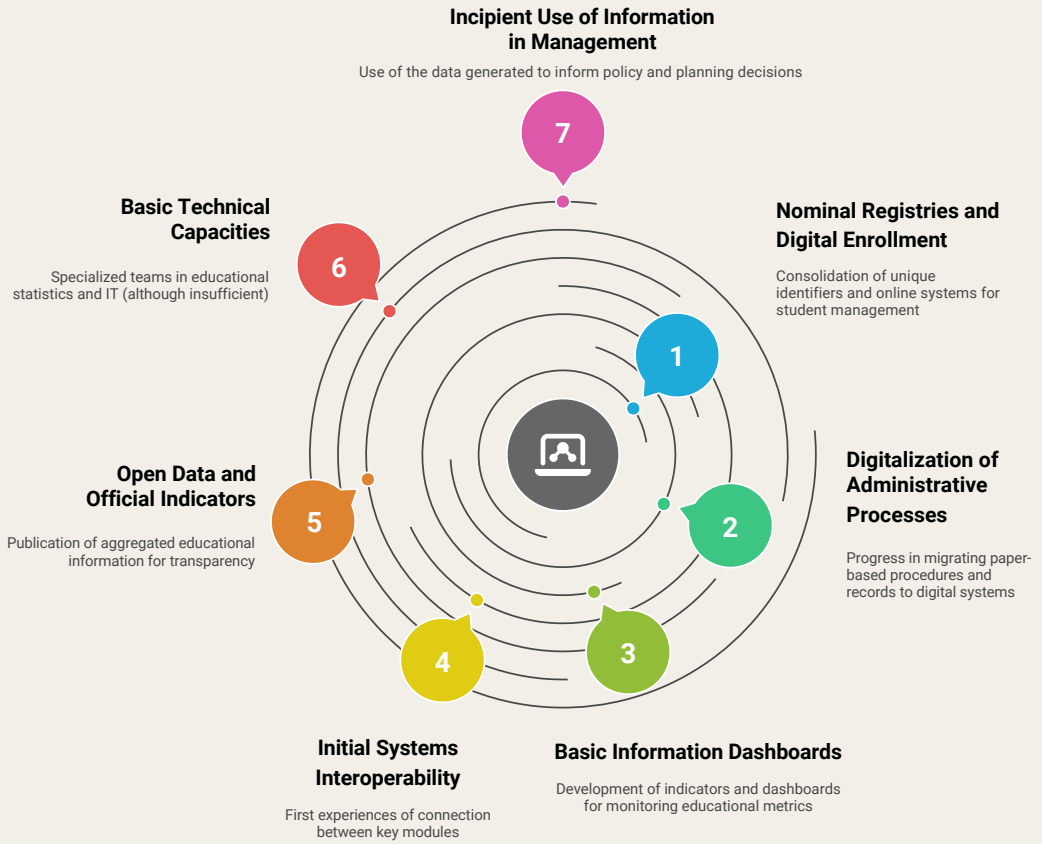
7 *Código Único de Establecimiento* (Unique School Code)

Another strength lies in the first experiences of connectivity between key modules, such as the partial linkage between enrollment and teacher positions, or between personnel payrolls and salary records. Although fragmentary, these initiatives demonstrate the technical feasibility of advancing toward interoperability schemes.

The publication of aggregated educational information—particularly that derived from the *Relevamiento Anual* (Annual Survey), a statistical survey in operation since 1996—contributes to transparency and public accountability. However, given its census-based nature and temporal lag, this data primarily serves an analytical and structural monitoring function rather than providing timely support for operational management. Its value lies in offering comparable historical series and a macro-level view of the education system, complementary to recent advances in nominal records and interoperable systems.

Finally, the existence of specialized technical teams in educational statistics and information technology deserves mention, whose experience is key to sustaining modernization initiatives, even when their staffing levels and institutional stability are insufficient. In some cases, isolated uses of information in educational policy decision-making are also identified, anticipating the potential for a more systematic exploitation of data.

Diagram 6. Identified Progress in Provincial EMIS



Source: own elaboration.

Differentiated advances in maturity levels

The analysis of recent experiences based on the application of the EMIS instrument shows that processes and structural conditions do not typically develop in a homogeneous manner. Uneven advances between components are frequently observed, reinforcing the need for comprehensive approaches that make it possible to identify gaps, prioritize interventions, and avoid fragmented developments. In general terms, the processes of Management of Educational Institutions and Human, Budgetary, and Financial Resources are those most likely to achieve advances toward an Emerging level, although in a punctual manner and in specific contexts. These advances are supported by the existence of consolidated identifiers, stable administrative rules, and relatively complete payroll and establishment records.

Isolated advances toward an Emerging level are also observed in technological infrastructure, particularly in jurisdictions that have implemented environment separation (development, testing, and production) and basic backup protocols. Something similar occurs in governance, when sustained political leadership and the signing of intersectoral agreements are in place.

In contrast, the most significant lags are concentrated in the processes of Tools for Strategic Management and in components related to teacher training management, typically classified between Latent and Incipient. In the former case, the absence of a data warehouse or educational data lake and limited digital literacy in the use of indicators explain the low adoption of control dashboards. In the latter, the lack of integration between teacher training outcomes, personnel files, and competitive appointment processes limits the capacity to plan and manage the teaching career in an articulated manner.

Likewise, in the Management of Students and Learning, the nominality achieved in administrative records (Incipient) does not translate into day-to-day pedagogical management, as attendance and grades are typically recorded on paper or entered with a delay. Finally, in the Management of Physical Infrastructure and Equipment, the absence of a *Legajo Único de Edificios* (Unified School Building File)—Latent in several jurisdictions—prevents systematic linkage of investments with building conditions and educational outcomes.

Challenges for the consolidation of provincial EMIS

The diagnostics show that the main problem of provincial EMIS does not lie in the absence of data, but in fragmentation, the lack of integrations, and weak interoperability between systems. This situation explains the prevalence of Incipient and Latent levels across most processes and structural conditions.

To advance toward an Emerging level, it is essential to consolidate master records and unified files for students, teachers, institutions, and school buildings, underpinned by data quality rules and reconciliation mechanisms that are also harmonizable at the national level. Equally, the development of an interoperability architecture with open standards is a priority, enabling the reduction of duplications, the improvement of traceability, and the integrated use of available information.

Technological infrastructure constitutes another strategic axis: minimum connectivity, security, and processing capacity gaps must be closed, together with the provision of a minimum technology base in schools that enables the day-to-day use of systems. Without these conditions, real-time nominal management is not viable.

On the governance front, sustained advances depend on the formulation of strategic plans with a multi-year horizon, high-level political backing, and the allocation of stable budgetary resources. The institutionalization of change management mechanisms and the reduction of high technical staff turnover are necessary conditions for ensuring continuity and scalability.

As a short-term strategy, the prioritization of critical processes—such as unified enrollment, teacher competitive appointments and substitute positions, and digital certification—can generate early results that strengthen the confidence of key actors and serve as a driver for scaling interoperability to other areas.

In summary, the transition from an Incipient to an Emerging state in most processes will depend less on the isolated adoption of new technological platforms, and more on the construction of institutional capacities and solid governance, capable of sustaining strategic policies, financing, and the effective use of information for decision-making over time.

Table 4. Summary of EMIS Findings in Argentina (2020–2025)

Process / Structural Condition	Predominant Maturity Level	Recurring Strengths	Key Gaps and Challenges
Management of Physical Infrastructure and Equipment	Incipient / Latent	Basic identifiers and, in some cases, georeferencing of school buildings.	Absence of a Unified School Building File; incomplete records; weak articulation with construction and maintenance.
Management of Educational Institutions	Incipient, with isolated Emerging cases	CUE implemented; school–building relationship recorded; centralized study plans.	Duplication of data entry (daily systems vs. statistical surveys); lack of integration of the subject–teacher–schedule–section tuple.
Management of Human and Budgetary Resources	Incipient, with isolated advances toward Emerging	Unique identification of persons (DNI) and positions (CUPOF); attendance and leave records; first self-management portals.	Obsolete payroll systems; weak linkage between positions and budget; substitute appointments and competitive processes mostly manual; teacher training outcomes not integrated into personnel files or competitive appointment processes.
Management of Students and Learning	Incipient	Extended administrative nominality; family portals expanding.	Limited integration with social programs and external assessments; day-to-day pedagogical management on paper or with delays; limitations in student trajectory traceability.

Process / Structural Condition	Predominant Maturity Level	Recurring Strengths	Key Gaps and Challenges
Tools for Strategic Management	Latent	Dashboard prototypes and statistical reports.	Absence of a data warehouse or educational data lake; low indicator literacy; limited BI tools; use of aggregated data with high latency; absence of systems to identify educational risks.
Technological Infrastructure	Predominantly Incipient, with isolated Emerging cases	Environment separation (development, testing, production) in some jurisdictions; basic backup protocols.	Obsolete central infrastructure; poor school connectivity, especially in rural areas; lack of minimum technology base in classrooms; absence of robust cybersecurity protocols.
Governance and Institutional Framework	Incipient / Latent, with Emerging exceptions	Isolated political backing; scattered intersectoral agreements; existence of specialized technical teams.	Absence of strategic EMIS plans with a multi-year horizon; high staff turnover; insufficient regulatory frameworks for data management; weak articulation between educational policy and systems development; lack of change management mechanisms.

The consolidated analysis of EMIS diagnostics conducted across various Argentine jurisdictions between 2020 and 2025 confirms that the maturity of educational information and management systems is mostly at Incipient levels and, to a lesser extent, Latent, with isolated advances toward Emerging in specific domains. The recurring strengths—unique identifiers, incipient digitalization of processes, dashboard prototypes, first interoperability experiences, and specialized technical teams—constitute a real foundation upon which to build. However, system fragmentation, technological obsolescence, limited analytical exploitation of information, and weak institutional governance limit the consolidation of a fully integrated and strategic EMIS.

Looking ahead, the findings point to a clear roadmap: consolidating master records and unified files, strengthening the technological and institutional architecture, and equipping EMIS with strategic plans and multi-year financing. The prioritization of critical processes such as unified enrollment, teacher competitive appointments, and digital certification can generate early results that strengthen confidence and facilitate the transition toward higher maturity levels. As regional experience demonstrates, the true differentiator does not lie in the isolated adoption of new platforms, but in the capacity to articulate governance, interoperability, and data-driven management as structural axes of education policy.

Finally, it is worth noting that some jurisdictions in the country have initiated a second application of the EMIS instrument, with the aim of analyzing whether the actions undertaken since the initial diagnostic are moving in the intended direction. This exercise demonstrates the potential of the EMIS not only as a diagnostic tool, but also as an instrument for periodic monitoring and policy adjustment, and constitutes a valuable precedent for future implementations within the federal framework.

8. Strategic Recommendations and Conclusions

In most educational information systems, the central challenge is no longer to produce data, but to integrate, govern, and reuse them in a coherent way. The persistence of fragmented architectures and weak interoperability mechanisms limits the public value of the information available and is one of the main obstacles to the evolution of EMIS toward more articulated, efficient, and decision-oriented schemes.

In this context, interoperability is a strategic factor for the evolution of educational information and management systems toward more integrated and sophisticated stages of development. Its implementation requires a progressive strategy, backed by political will, clear regulatory frameworks, solid technical and institutional capacities, and sustained financing schemes that ensure its operational continuity and evolution over time, together with a long-term vision that combines sectoral actions with intersectoral articulation and a progressive transition toward data-driven management models. Progress is consolidated only when governance, master data, and technical architecture evolve in a convergent manner, ensuring stability and institutional continuity across the different dimensions of interoperability defined in this document.

A first step is to carry out a maturity diagnosis that makes it possible to identify strengths and gaps across the four domains of interoperability (legal, organizational, technical, and semantic). This initial baseline is key to prioritizing high-impact use cases, such as unified enrollment, student transfers, digital certification, or teacher–payroll integration. On this basis, each country can define a data management strategy tailored to its territorial model —centralized, federal, or with intermediate levels— and set clear indicators to monitor progress across the three dimensions of interoperability.

In the implementation stage, it is essential to consolidate master catalogs and unique identifiers for students, teachers, and institutions, and to run focused pilots in strategic processes that produce visible short-term results. In parallel, strengthening technical capacities in ministries and territorial administrations, together with interoperability agreements with other State sectors (civil registry, finance, health, infrastructure), broadens the reach of the benefits and reinforces the sustainability of the digital ecosystem. These actions make it possible to advance simultaneously in the intersectoral, interjurisdictional, and internal dimensions, preventing progress in one from being held back by lags in another.

The operation and scaling phase should aim to institutionalize data governance through clear roles and responsibilities, regulatory frameworks that ensure the

legal validity of digital records, and permanent monitoring mechanisms. One strategic component is aligning technology procurement and development with interoperability requirements and open standards, avoiding new forms of technology lock-in and ensuring that every investment reinforces the interoperable architecture of the system.

From a regional perspective, organizations such as ECLAC argue that interoperability should be conceived as a public good, whose shared development favors regional integration and strengthens international cooperation on digital government. Along the same lines, various analyses highlight the strategic opportunity to advance on common educational standards that strengthen the comparability and sustainability of digital ecosystems. The IDB concurs that educational interoperability requires regional and international frameworks that make it possible to align definitions, classification systems, and technical criteria in order to promote cooperation among countries.

In conclusion, the lessons gathered across the region confirm that advancing educational interoperability is essential to strengthen digital governance, improve the traceability of student trajectories, simplify processes, optimize the use of resources, and support evidence-based policies. The Argentine case shows that, even in heterogeneous federal contexts, it is possible to advance toward a hybrid model in which jurisdictions retain operational responsibilities while consolidation takes place on a unified national base governed by federal agreements. This experience —together with those of other LAC countries— confirms that educational interoperability should be conceived as a progressive, scalable, and cooperative process, capable of generating simultaneous advances across the three dimensions of interoperability and of linking the region to global standardization and collaboration initiatives. The proposed approach will make it possible to consolidate a robust, sustainable digital education ecosystem geared toward strengthening equity and educational quality in LAC.

Annex

Orientating Checklist for Educational Interoperability

This annex presents an orientating checklist to support ministries of education in a first diagnostic approximation of the state of interoperability of their educational information systems.

The checklist is organized around the four interoperability domains defined in this document—legal, organizational, technical, and semantic—and considers, for each item, its application across the three dimensions of educational interoperability:

a. internal interoperability within the education system,
b. interoperability among jurisdictions where territorial distribution of competencies exists, and
c. interoperability between the education sector and other sectors of the State.

The instrument adopts a binary logic (verified/not verified) and is not intended to calculate an aggregate score or a formal maturity level. Its purpose is to facilitate a structured reading of existing capacities, organize the technical and institutional discussion, and prioritize relevant gaps as an input for strategic interoperability planning.

This checklist does not replace the IDB's institutional maturity model for interoperability or other more detailed evaluation instruments. Its value lies in offering a common, accessible, and operational language that allows technical, regulatory, and management teams to rapidly identify enabling conditions that are present or absent, and to link them to the methodological steps developed in Chapter 6.

It is recommended that this annex be used as:

- a starting point for cross-area and cross-institutional discussions;
- an input for defining short- and medium-term priorities;
- support for deciding when to advance toward more in-depth diagnostics or more specialized evaluation instruments.

The application of this checklist should take into account the institutional and territorial context of each country or jurisdiction, avoiding mechanical interpretations and recognizing that interoperability is a progressive process, consolidated through technical, regulatory, and governance decisions that evolve in a convergent manner over time.

For its application, each item in the checklist may be marked simply using a **checkmark (✔)** when the capacity is present or formalized, an **absence mark (✗)** when it does not exist or has not been implemented, or **"Not applicable (N/A)"** when the item is not relevant to the institutional or territorial model of the country

or jurisdiction. This approach seeks to facilitate a quick and shared reading of the state of progress, avoiding ambiguous assessments and promoting technically focused discussions on the identified gaps.

Legal Domain

Verify the existence of regulatory frameworks, formal agreements, and institutional definitions that enable, regulate, and sustain the exchange of educational information, guaranteeing data protection, legal validity, and institutional continuity.

Item to verify	Internal interoperability	Interjurisdictional interoperability	Intersectoral interoperability
Regulations exist that enable the exchange of educational data in the relevant area.			
Agreements or conventions for information exchange between institutions and/or jurisdictions have been formalized.			
Clear institutional responsibilities for the handling and custody of educational data are defined.			
Current personal data protection and privacy guidelines exist, with particular attention to children and adolescents.			
Regulations recognize the legal validity of digital records and documents exchanged between systems.			
Mechanisms for regulatory updating are in place to keep pace with the evolution of interoperability processes.			

Organizational Domain

Verify the existence of governance structures, roles, organizational capacities, and coordination mechanisms that allow educational interoperability processes to be initiated, implemented, and sustained in an institutionalized manner.

Item to verify	Internal interoperability	Interjurisdictional interoperability	Intersectoral interoperability
Explicit and sustained political sponsorship from the highest authority exists for the interoperability process.			
Clear roles and responsibilities between areas and institutions for data and process management are defined.			
A formal interoperability committee or body exists, with a mandate, continuity, and decision-making authority.			
Formal coordination mechanisms between territorial levels and/or sectors involved are established.			
Sufficient technical capacities exist within the responsible teams (data, processes, technology).			
Institutional mechanisms and sustained financing schemes exist to ensure the operational continuity of interoperability initiatives.			
Documented procedures exist for managing, updating, and resolving data inconsistencies.			
A change management and communication plan associated with interoperability is being implemented.			

Technical Domain

Verify whether the minimum technical conditions exist—architecture, standards, security, and infrastructure—to enable the exchange of educational information securely, consistently, and scalably between systems and institutional levels.

Item to verify	Internal interoperability	Interjurisdictional interoperability	Intersectoral interoperability
An up-to-date inventory of systems exists, with information on architecture, integrations, and data flows.			
A reference architecture for interoperability has been defined, independent of specific platforms.			
Open exchange standards are used or have been defined (APIs, structured formats, protocols).			
Interoperability mechanisms have been implemented for information exchange between systems.			
Security and access-control mechanisms are applied in accordance with the defined architecture.			
Minimum technological infrastructure conditions exist to sustain information exchange.			
Interoperable services have basic technical documentation (interfaces, flows, usage rules).			
Service-level agreements (SLAs) exist for critical systems and services.			
Technical guidelines have been defined for the progressive scaling of interoperable systems and services.			
Technical monitoring mechanisms exist (availability, latency, errors) for interoperable services.			

Semantic Domain

Verify whether the education system has a common language, based on shared catalogs, identifiers, and business rules, that allows educational information to be interpreted, validated, and reused consistently across systems, areas, and territorial levels.

Item to verify	Internal interoperability	Interjurisdictional interoperability	Intersectoral interoperability
Master catalogs are defined for the key entities of the education system.			
Master catalogs have designated institutional data stewards responsible for their management and updating.			
Unique identifiers are used for students, teachers, institutions, and other critical records.			
Formalized business rules exist for validating and reconciling educational data.			
Common criteria are applied for interpreting data across areas, systems, or jurisdictions.			
Catalogs and rules have versioning and publication mechanisms.			
The quality, consistency, and timeliness of master data are verified.			
Procedures exist for resolving semantic inconsistencies between systems or levels.			

References

Banco de Desarrollo de América Latina y el Caribe (CAF) & Organización de Estados Iberoamericanos para la Educación, la Ciencia y la Cultura (OEI). (2023). *Consulta sobre el estado de madurez de la transformación digital de las Administraciones Públicas Educativas*. Caracas y Madrid: CAF & OEI. Available at: https://scioteca.caf.com/handle/123456789/2115

Inter-American Development Bank (IDB). (2019b). *El ABC de la interoperabilidad de los servicios sociales: Guía para Gobiernos*. Washington, DC: IDB. Available at: http://dx.doi.org/10.18235/0001799

Inter-American Development Bank (IDB). (2022). *El ABC de la interoperabilidad de los servicios sociales: marco conceptual y metodológico*. Washington, DC: IDB. Available at: http://dx.doi.org/10.18235/0001834

Inter-American Development Bank (IDB). (2022). *Los Sistemas de Información y Gestión Educativa de América Latina y el Caribe: la ruta hacia la transformación digital de la gestión educativa*. Washington, DC: IDB. Available at: http://dx.doi.org/10.18235/0003345

Comisión Económica para América Latina y el Caribe (CEPAL). (2020). *Gobernanza digital e interoperabilidad gubernamental: una guía para su implementación*. Santiago: ECLAC. Available at: https://www.cepal.org/es/publicaciones/47018-gobernanza-digital-interoperabilidad-gubernamental-guia-su-implementacion

Consejo Federal de Educación (CFE). (2024). *Resolución CFE N.° 478/2024: Relevamiento Nacional de Personal Educativo (ReNPE) 2025*. Buenos Aires: Ministry of Education of Argentina.

Consejo Federal de Educación (CFE). (2025). *Resolución CFE N.° 494/2025: Bases Nacionales Homologadas de información educativa*. Buenos Aires: Ministry of Education of Argentina.

OECD. (2023). *OECD Digital Education Outlook 2023: Towards an Effective Digital Education Ecosystem*. OECD Publishing, Paris. Available at: https://doi.org/10.1787/c74f03de-en

OECD. (2025). *Policies for the digital transformation of school education: Evidence from the Policy Survey on School Education in the Digital Age* (OECD Education Working Papers, No. 328). Paris: OECD Publishing. Available at: https://doi.org/10.1787/464dab4d-en

UNESCO Institute for Statistics (UIS). (2022). *Clasificación Internacional Normalizada de Programas de Formación de Docentes (CINE-T)*. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000383032

European Union (EU). Regulation 2024/903: European Interoperability Act. Available at: http://data.europa.eu/eli/reg/2024/903/oj


IDB