Digital Education

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Education Management and Information Systems (SIGEDs) in Latin America and the Caribbean: *the road to the digital transformation of education management*

Elena Arias Ortiz
Javier Eusebio
Marcelo Pérez- Alfaro
Madiery Vásquez
Pablo Zoido

Education Division
Inter-American Development Bank
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Introduction

Education Management and Information Systems (SIGEDs[1]) intervene in all aspects of the operation of the early, primary and middle or secondary cycles of public education systems. Their functions range from the parameterization of rules on resource allocation to the provision of information in real time.

A SIGED can be defined as the set of key educational management processes required for the design, registration, generation, exploitation and dissemination of strategic online information in an integral manner in the framework of specific legal, institutional and technological infrastructure. A SIGED should allow a complete and efficient management of the relevant processes at all the levels of the education system (central, regional and schools themselves), incorporating new technologies (Arias Ortiz et al., 2019).

The COVID-19 pandemic has underscored the importance of up-to-date digital information systems for monitoring students' learning and their participation in the education system. For example, attendance data can serve to identify students at risk of dropping out; information about enrollment at public schools can be used to reorganize groups of students in line with strategies for reopening schools with social distancing; and data about enrollment in the private sector can be used to estimate the potential influx of students into the public sector.[2] However, little up-to-date and comparable information is available about the level of development of SIGEDs in Latin America and the Caribbean (LAC) and, therefore, about the type of use to which they can be put or the amount of investment required for their transformation.

In general, the region's SIGEDs have been built without an integral vision of countries' education systems. They tend to consist of a series of isolated tools and platforms, sometimes with redundant functions, designed to solve specific information needs associated with the incumbent political administration. A short-term view prevails, with priority given to rapid results, and this has a significant impact on how IT solutions to support education management are planned, developed and implemented.[3] This has resulted in the generation of disperse, inconsistent and low-quality information that does not meet education systems' current needs (Arias Ortiz et al., 2019). When the needs of the education system as a whole are taken into account, it is possible to develop established SIGEDs, capable of managing the relevant processes efficiently and taking advantage of digital technologies. The digital transformation of a SIGED brings with it a series of efficiency gains in the management of an education system that include:

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1 From the name in Spanish: Sistema de Información y Gestión Educativa.

2 See https://www.globalpartnership.org/blog/using-administrative-data-design-approaches-school-reopening.

3 See Arias Ortiz et al. (2019), chapter 2, for a detailed analysis of the principal challenges currently observed in the management of education systems.

1. The availability of timely, high-quality information for the design of policies and the allocation of resources (human, physical and financial).

2. The time saved through digitization of administrative tasks that were previously carried out manually, with the resulting better use of human resources.

3. Budgetary savings, thanks to more efficient use of resources as a result of the availability of high-quality information and time savings.

What does the evidence tell us about management improvements? A SIGED has a broad scope, in terms of both processes and, as mentioned above, the educational levels it covers. Gathering rigorous evidence about their effect on the management of a system of this type can, therefore, be complex. In fact, to the best of our knowledge, no such rigorous evaluations exist. There is, however, emerging evidence of the benefits that improving certain components of a SIGED has in terms of efficiency, dropout and learning. For example, greater use of a portal for communicating with parents through a learning management system (LMS) platform is associated with positive effects on learning (Bergman, 2016). In other words, SIGEDs should be seen as platforms for improving the management of an education system.

What is the state of progress of SIGEDs in LAC countries? To what extent do the region's management systems take advantage of technology? In light of the very limited systematic and comparative information available to answer these questions, the Digital Education project of the Inter-American Development Bank (IDB) is seeking to improve the efficiency of education management by examining how the daily processes it involves are carried out, their level of automation and the use they make of digital technologies (Arias Ortiz, et al. 2019). In this context, a diagnostic study of 16 of the region's public education systems[4] was conducted. This document presents a summary of the study's main findings, drawing attention to good practices and the lessons learned in the digital transformation of the SIGEDs. In addition, it puts forward policy recommendations for the development of efficient education management systems.

For the diagnosis of the SIGEDs, an information-gathering instrument was designed, structured around six key education management processes: i) physical infrastructure and equipment; ii) schools; iii) students and learning; iv) human and budgetary resources; v) digital content for student learning and teacher training; and vi) tools for strategic management, as well as two structural conditions: i) technological infrastructure and ii) governance and institutional framework. The development of each process and structural condition is classified in one of four levels: latent (1); incipient (2); emergent; (3) and established (4). The classification is based on the level of development of the main functionalities of each process and structural condition,

4 The 16 education systems analyzed correspond to: Argentina (provinces of Córdoba, Mendoza and Santa Fe), Brazil (state of Espírito Santo and municipality of Florianópolis), Colombia (city of Bogotá), Costa Rica, El Salvador, Honduras, Jamaica, Panama, Paraguay, Peru, Dominican Republic, Suriname and Uruguay (Council for Early and Primary Education). The systems were selected in order to include cases from the four regions of countries that are members of the Bank (Caribbean, Andean region, Central America and Southern Cone) and to represent a diversity of institutional arrangements. Some of the systems are managed nationally while others, such as those in Argentina, Brazil and Colombia, are managed by sub-national bodies (provinces, states and municipalities).

captured through closed-ended questions (between nine and 18 questions per process) (for further details, see Appendix A). The global SIGED score is calculated as the median of the score for each of the six processes and the two structural conditions.

One of the main findings is that the region's SIGEDs have a low level of development. In most cases, it is incipient (level 2 out of 4), indicating that the management processes that define the education systems are only partially covered and need to strengthen their strategic orientation. Peru and Uruguay, as well as the city of Bogotá (Colombia) and the province of Santa Fe (Argentina) have reached the emergent level and are, therefore, better prepared for a digital transformation of education management. However, no LAC system has reached the established level in which true use is made of technology to improve the efficiency and automation of education management. Throughout this document, examples are provided from countries such as Spain, Estonia, France and England, which are at a more advanced level and, therefore, offer clues as to how an established SIGED operates.

The education management processes in which a higher level of development is observed are those related to students and their learning: two systems (the state of Espírito Santo and Uruguay) have reached an established level of development in this field while five (the city of Bogotá, the Florianópolis municipality, Paraguay, Peru and the province of Santa Fe) are at the emergent level. Most countries have adopted unique identifiers for students and issue digital reports on their performance. However, very few have a system for student registration and enrollment or for issuing grades and certificates, implying that there is still much room for improvement. One of the least advanced processes is that involving tools for strategic management. On this, all the management systems analyzed have a latent or incipient level of development. The results indicate that the systems face great challenges as regards the quality and availability of data. This, in turn, limits the implementation of dashboards and the use of business intelligence tools, of which there is a low level of adoption in the region, and this hampers the generation and effective use of indicators about the education sector.

The results also show that the education systems analyzed face challenges on critical transversal issues as regards consolidating a vision of the SIGED as an integral management platform for the education system. There is a low level of interoperability between systems and applications and a lack of a long-term strategic vision. Moreover, human and financial resources for SIGEDs' development are scarce. In general, the level of systematization and automation of procedures is also low. Requests for resources and other formalities usually involve non-digital procedures, have to pass through different offices and are slow. This is the case, for example, of requests for teacher replacement, the management of sick leave and requests for emergency repair of school building infrastructure. Finally, the analysis shows that the region's SIGEDs are usually constructed with the information needs of the central level in mind. As a result, the existing management and information systems enable schools to respond to data demands from the central level, but schools have few tools to facilitate their daily activities, such as registering and monitoring students, teachers, or supplies and the budget. Paradoxically, although the available systems are geared to providing information for the central level and departmental offices, the information often fails to flow in an integrated or consistent manner or in the timeframe required

to support correct decision-making, and this calls for parallel information gathering on paper. When comparing this study with previous research, it differs principally because it seeks to contribute to closing the knowledge gap about SIGEDs in LAC, with an emphasis on policy implementation and the management of educational processes. In this sense, both its scope, with a focus on education systems, and its approach, which focuses on processes, differentiate it from previous projects. Other relevant studies include, at a general level, the evaluation of information systems carried out by the International Monetary Fund (IMF) using the Data Quality Assessment Framework and, more specifically in the case of education, the World Bank's SABER-EMIS initiative, which assesses education information systems from an institutional standpoint and that of policies related to the quality of data collection and use (World Bank, 2018). However, while SABER-EMIS focuses on analysis at the policy and institutional level, SIGEDs emphasize the implementation of these policies and the management of educational processes (Arias Ortiz et al., 2019). The United Nations Educational, Scientific and Cultural Organization (UNESCO) has created OpenEmis, a tool that seeks to facilitate and promote the implementation of education information systems. This free software can be adapted to different education systems and contexts and permits interoperability with other systems and platforms.[5] In addition, UIS-UNESCO has launched a web portal devoted to education management and information systems that provides manuals, guides and conceptual frameworks for the design and implementation of more efficient systems.[6]

This document is organized as follows: Chapter 1 explains the methodology for measuring SIGEDs' level of development; Chapter 2 summarizes the main findings of the case studies; Chapter 3 sets out the study's results and the good practices that were identified; and Chapter 4 presents the main conclusions. Appendix A provides details of the measurement instrument used. Appendix B presents a summary of the SIGED profile for each of the 16 cases analyzed, identifying strengths, opportunities for improvement, recommendations for achieving an established SIGED and the lessons learned as well as a costing and strengthening plan for each case.

5 For further information about the OpenEMIS initiative see https://www.openemis.org/.

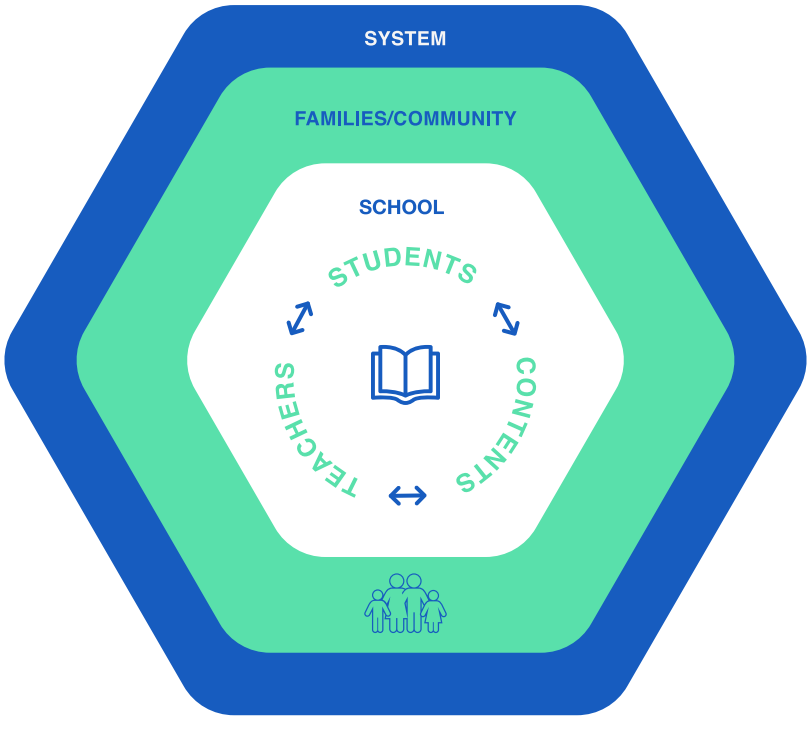
6 For further information, see http://emis.uis.unesco.org/.

CHAPTER 1

How to measure a SIGED's level of development?

In the well-known instructional core, Cohen and Ball (1999) identify the essential elements of any didactic process: students, teachers and content. The interactions between these three elements take place in a school, in a particular community and in the framework of an education system (Figure 1.1). These elements and their interactions are the factors that all SIGEDs must manage in order to guarantee the provision of educational services.[7]

FIGURE 1.1
Elements of the education system



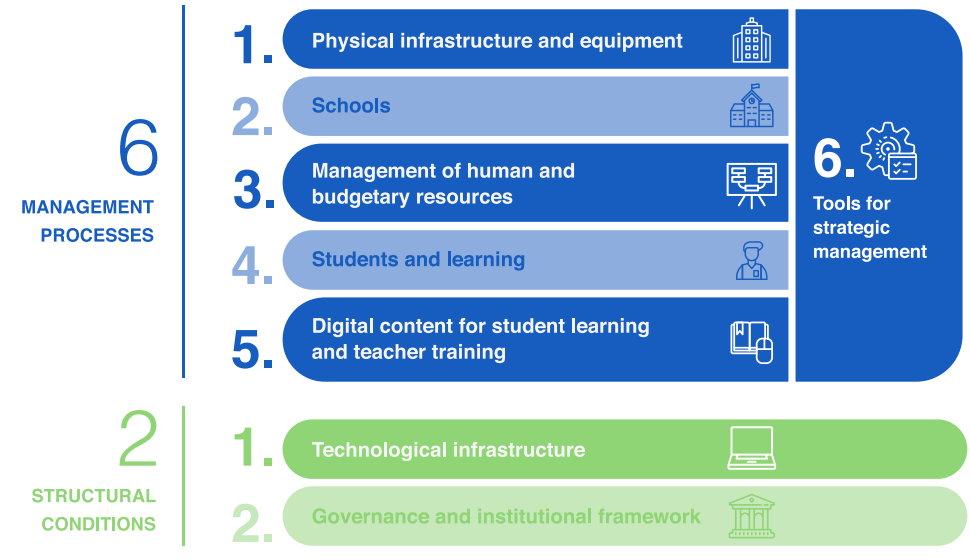
Source: Arias Ortiz et al. (2019) based on Cohen and Ball (1999).

In turn, these elements are the building blocks of an integral vision of education management processes in which six main management processes and two structural conditions are identified (Figure 1.2). To validate these processes, with their sub-processes, and structural conditions, two aspects were analyzed. First, the availability of these processes and conditions in all the region's SIGEDs and, second, their relevance in the education systems since more than 95% of the budget of education ministries is managed through them.

7 Some new approaches expand the frontiers of education systems to include students' social capital in addition to their families and community (Freeland Fisher and Fisher, 2018).

FIGURE 1.2

Management processes and structural conditions



Source: Arias Ortiz et al. (2019).

To arrive at a diagnosis of the development of each process and structural condition, the information-gathering instrument applies a series of closed-ended questions (between nine and 18 questions per process)[8] about the functionalities that should be performed by an established SIGED to integrate the interactions of the instructional core (see Appendix A). The instrument comprises a total of 119 questions out of which 113 closed-ended questions are used to calculate the SIGED's level of development.[9]

The instrument allows each question to be assigned a score, with discrete values between 1 and 4, depending on the functionality's level of development.[10] The score awarded to each of the items evaluated (sub-processes) reflects the level of development observed in it: latent (1), incipient (2), emergent (3) or established (4).[11] Each answer is also accompanied by a brief qualitative description that justifies the score assigned to the item evaluated.

---

8 Of the total 113 questions, 16 refer to the structural condition of technological infrastructure; nine to the structural condition of governance and institutional framework; 14 to the process of managing physical infrastructure and equipment; 13 to the management of schools; 13 to the management of human and financial/budgetary resources; 18 to the management of students and learning; 14 to the management of digital content for student learning and teacher training; and 16 to tools for strategic management.

9 Six of the instrument's questions are open-ended and are designed to document the IT systems and platforms used in each management process.

10 For further information about the fieldwork and information-gathering instrument, see Appendix A.

11 If a sub-process does not perform as expected according to the SIGED definition (for that process), it is classified as latent. If its coverage is partial and it does not fulfill the orientation of the SIGED definition (for that process), it is classified as incipient while, if it fulfills the orientation of the SIGED definition (for that process), but its coverage is partial, it is classified as emergent. Sub-processes that have a proper orientation and a coverage of more than 80% and are systematized in relation to the SIGED definition are classified as established.

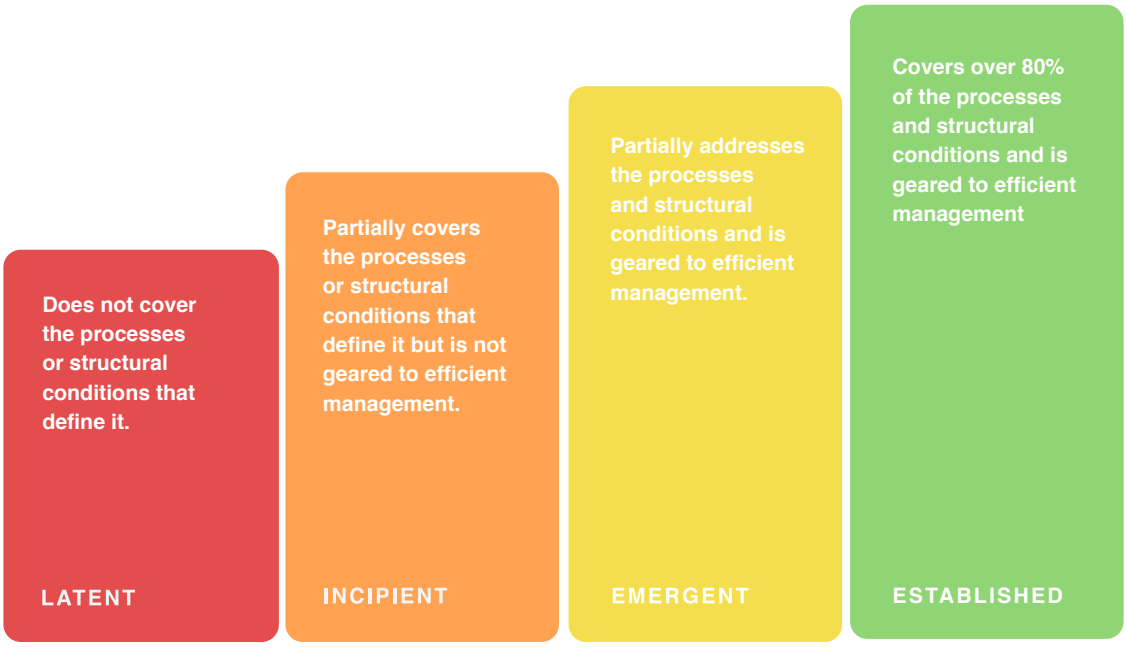
The SIGED's score is calculated using two levels of analysis. First, the median of the evaluation of all the corresponding questions is calculated for each of the six processes and two structural conditions. In this way, it is possible to identify the system's level of development in each of the areas analyzed. Second, the global SIGED score is obtained as the median of the evaluation the system has obtained for the six processes and two structural conditions.

Use of the median as a measure of central tendency for calculating the global score implies that the same relative weight is given to each of the processes and structural conditions. In practice, however, the processes for managing human and budgetary resources and students and learning, as well as the two structural conditions (technological infrastructure and governance and institutional framework) are of greater relevance. The structural conditions represent the contextual environment required for the optimization of all the processes while the management of human and budgetary resources, as well as of students and learning, involves the central aspects of any education system. In addition, according to expert opinion, they should be the starting point of any optimization process because management based on the unique identification of teaching positions, school places, budget allocations, teachers and students is the basis and transversal axis of SIGED improvement. These functionalities are key to decisively improving the use of the resources administered by the region's education ministries.

This methodology permits the classification not only of the processes and structural conditions, but also of each of the SIGEDs analyzed, according to their level of development as latent (1), incipient (2), emergent (3) or established (4). As shown in Figure 1.3, a SIGED is defined as "latent" when it does not address the central processes and sub-processes or the structural conditions that define it; as "incipient" when it partially addresses the central processes and sub-processes and the structural conditions that define it, but requires reorientation to achieve its objectives; as "emergent" when it partially addresses the central processes and structural conditions that define it and its orientation is appropriate, but it does not have the expected scope to achieve all its objectives; and, finally, as "established" when it covers more than 80% of the central processes and structural conditions that define it and its orientation is appropriate for the achievement of its objectives.

Taking the characteristics of an established SIGED (4) as a reference, the instrument, therefore, also serves to draw up a clear proposal of the actions required to strengthen a SIGED on the path to its digital transformation. An established SIGED permits adequate management of the different aspects of education systems and generates and distributes integrated, relevant, timely, reliable and easy-to-interpret information at all levels of the system. Its contribution is reflected throughout the education management process and in the formulation of policies, their implementation and the evaluation of their effectiveness. An established SIGED not only comprises a platform for the management of resources and information but also has the capacity to provide information for improving their management. Complementing this, it must also include integrated portals (applications) designed to satisfy the information needs of teachers, parents and students, guaranteeing transparent online access to this information. In

FIGURE 1.3
Levels of classification of SIGEDs



Source: Arias Ortiz et al. (2019).

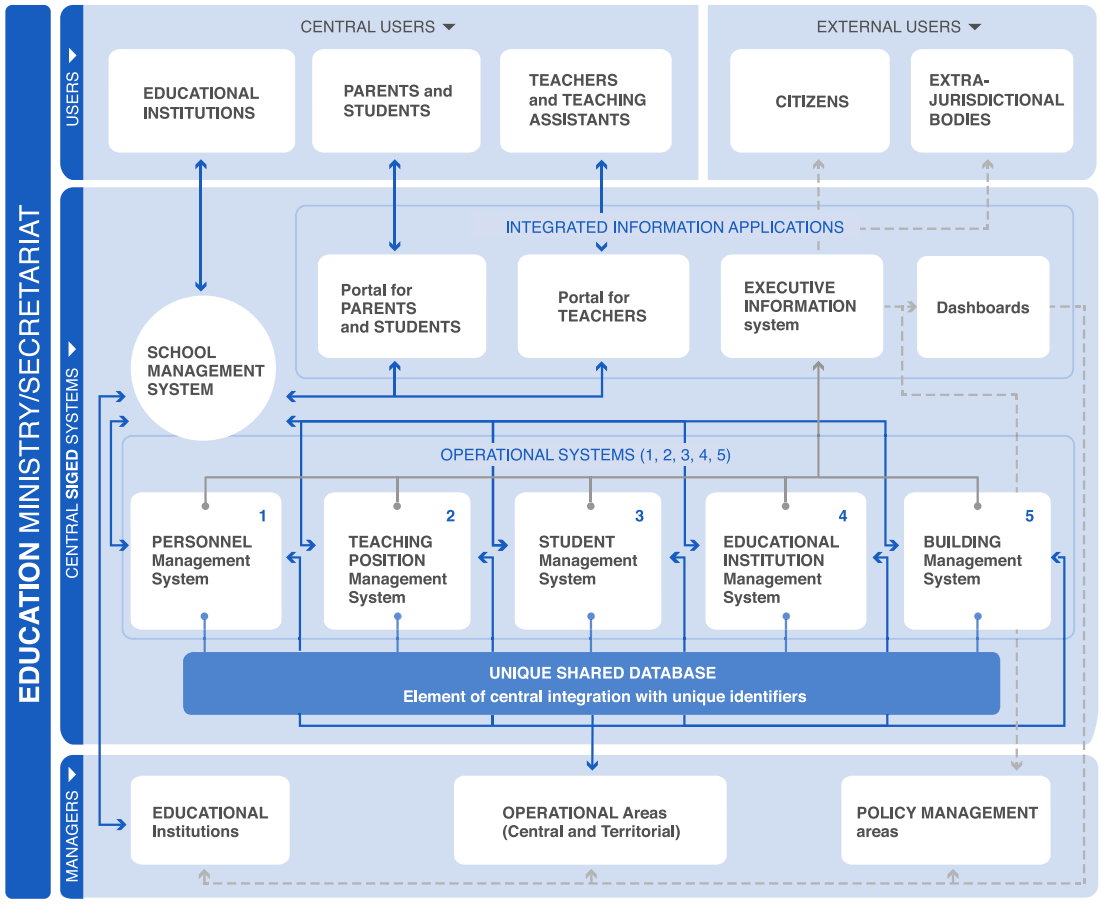
the case of students, it is useful to consider the integration of support tools for learning in the same access environment, along with management information (digital school reports, LMS tools, digital pedagogical resources, etc.).

Figure 1.4 shows the conceptual model of SIGED support systems. The central part of the diagram (SIGED Central Systems) shows the applications that support the main management models and represent the key modules for the design of an integral management platform for users of the education system.

This management platform is framed by two structural conditions. In the case of governance and institutional framework, a strategic project that includes the complete optimization of the SIGED, with the allocation of the required financial and human resources, is a necessary condition for the consolidation of an established SIGED. Similarly, there should be legal instruments (laws, decrees, resolutions, provisions, etc.) and a regulatory framework that defines responsibilities in each process along with guidelines for the operation and management of the information systems. In the case of the second structural condition (technological infrastructure), an established SIGED must have all the hardware, software and connectivity to provide adequate support for implementation of the solutions (including servers, a cloud processing service, storage devices, base software, cybersecurity measures, connectivity, etc.).

The creation of a unique database of shared and interoperable elements to which the IT support solutions for the processes are applied is the basis for creating an integral management

FIGURE 1.4
Conceptual model of SIGED support systems



Source: Compiled by authors.

platform for education ministries. From the conceptual standpoint, this platform is supported by the establishment of the following central registers:

1) Unique register of personnel (associated with the human and budgetary resources process) as a repository of all data about the characterization and performance of each teacher, applicant or other employee of the education system. This should include personal data, the positions held, medical history, details of remunerations, professional background, in-work training and external evaluations. This register should be the source for monthly payroll payments and be associated with the unique register of teaching positions which should, in turn, be linked to the budget.

2) Unique register of positions (associated with the human and budgetary resources process), with a budget for each position. It should include a unique identifier that

associates this element exclusively with the person occupying the position. In the case of replacements, the absence of the person holding the position should be verified and the replacement then associated. The sum of unique positions will be equal to the total budget of positions available and will serve as the upper spending limit.

3) Unique register of students (associated with the students and learning process) to permit management of students by name, with their personal and academic data, social benefits (if received), online enrollment, the section and division they attend, etc., all included in a single repository.

4) Unique register of schools (associated with the schools process) as a unique record of data about schools. It must include data specific to the school (name, address, contacts, etc.), the courses its offers, its organization, the shifts in which it operates and the buildings it occupies.

5) Unique register of school buildings (associated with the physical infrastructure and equipment process) as a single repository of all data about the education system's school environment, including the physical building, its movable and immovable goods, its equipment and the services available. It should also include an inventory of interventions in the building.

These information modules, which should always be integrated with a management platform, will be used by the internal areas of education ministries[12] from the central level through to the school level. Users will be able to work on the data online, with the security levels that correspond to each role and always guaranteeing the integrity of the information processed.

In addition, an established SIGED includes solutions for the analysis of integrated information repositories (data warehouses) and the creation of dashboards. These dashboards should be geared to all central and decentralized decision-making levels and, particularly, schools, including online analytical reports for presentation to leadership teams, focused on their schools, as a key element in strengthening decision-making. Under this conceptual model, schools, with their directors and teachers, will be able to address pedagogical as well as administrative demands digitally. They will, for example, be able to identify students at risk of dropping out (through patterns of absence), students who are falling behind (through timely visualization of test results) or group dynamics, making informed and timely decisions about their teaching-learning scheme.

For implementation, it is essential to have a unique user authentication mechanism, with specific roles in the system, associated with the functions of each role (teachers, students, administrative personnel, directors, etc.). An established SIGED must guarantee the traceability of access to sensitive data and its modification and must, therefore, implement access and modification auditing mechanisms, with historical back-ups.

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12 These areas include, for example, those for the management of personnel, students, buildings, schools, budget, payroll, curriculum, digital content, teacher training, job application processes, educational planning and statistics.

CHAPTER 2

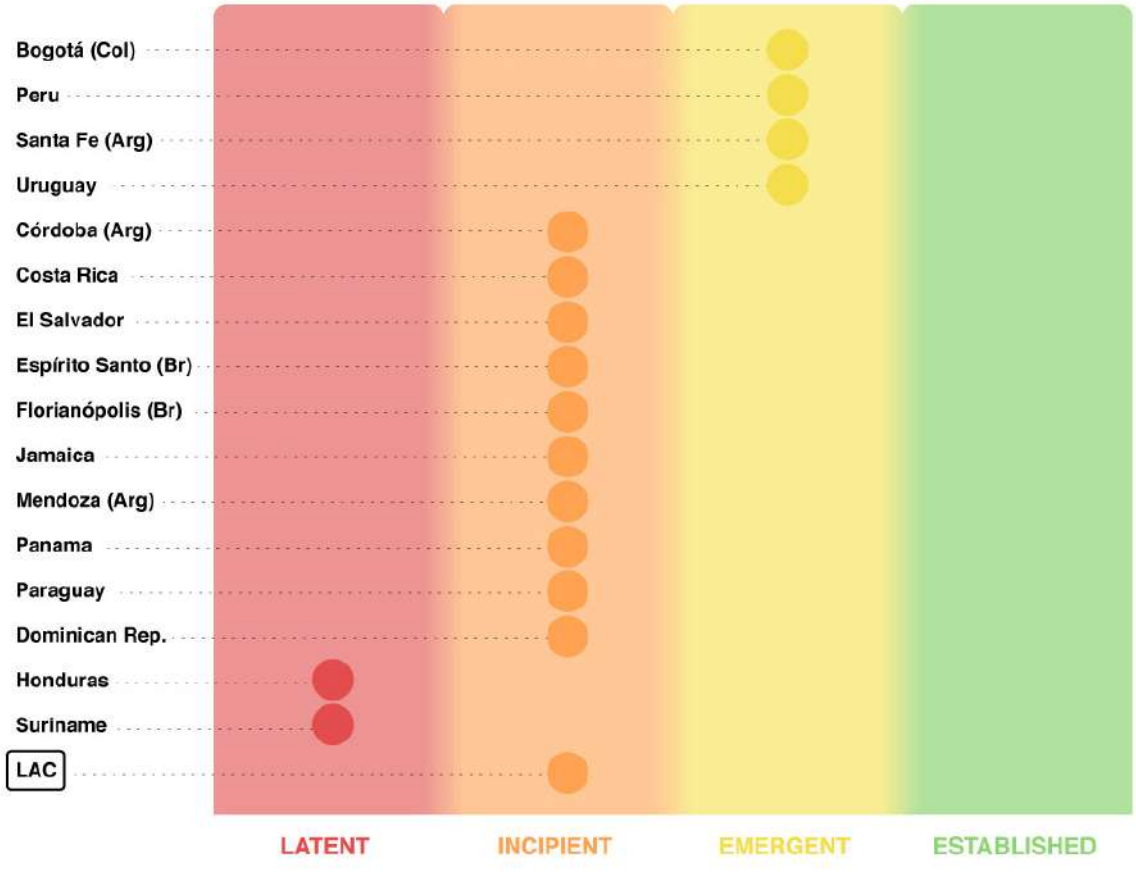
Is Latin America and the Caribbean ready for the digital transformation of education management? Principal findings

This chapter describes the main results of the analysis of the digital transformation of the region's SIGEDs, based on data for the cases of 16 education systems in 13 countries. Figure 2.1 shows the level of global SIGED development for each case. In line with the methodology used, the results are shown on a color scale from the "latent" level (red) to the "established" level (green).

No education system has achieved an established level of development and, out of the 16 systems, ten are at the incipient level (level 2 out of 4). The most advanced systems, which have reached the "emergent" level (level 3 out of 4), are those of the city of Bogotá, Peru, the province of Santa Fe and Uruguay.

FIGURE 2.1

Level of global SIGED development by education system, selected Latin American and the Caribbean countries and jurisdictions



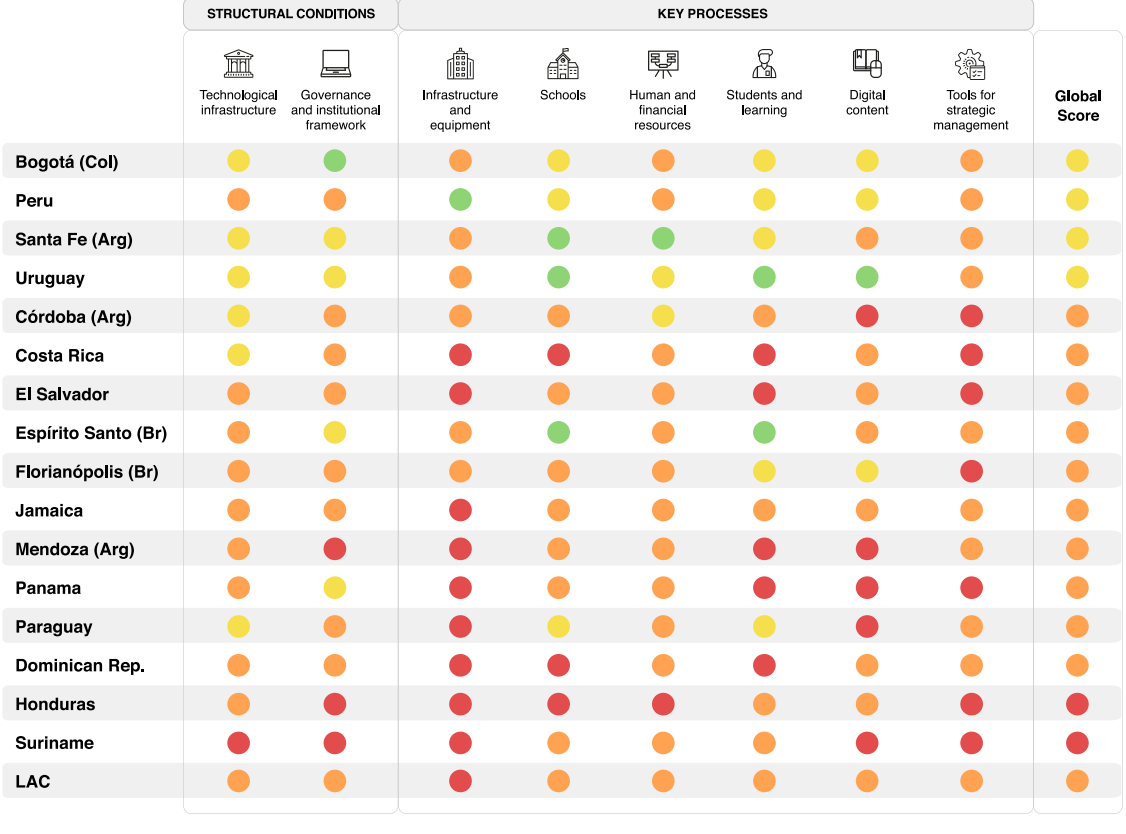
Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

The results show that the education systems of Latin America and the Caribbean (LAC) have made some progress in the digital transformation of their management, for example, by equipping schools technologically and consolidating online digital content. However, there are challenges and opportunities for improvement in terms of the interoperability of systems and the development of systems through which to monitor students and avoid dropout as well as in the management of school buildings and school materials in such a way as to increase the efficiency of maintenance.

Figure 2.2 shows the level of development for each key process and structural condition analyzed in the 16 education systems. At the regional level, all the key processes and structural conditions have an incipient development (level 2 out of 4), except for the infrastructure and equipment process, which has a latent level of development (level 1 out of 4). As seen in the figure, the countries or jurisdictions where at least one process or structural condition has reached an established level (green) are the city of Bogotá, the state of Espírito Santo, Peru, the province of Santa Fe and Uruguay.

FIGURE 2.2

Level of global SIGED development by process and structural condition



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

The main findings and results for each key process and structural condition can be summarized as follows:

SC1: Technological infrastructure

Although the situation is positive in terms of connectivity, technological infrastructure and arrangements for technological enterprises, one of the greatest challenges is the lack of interoperability of the systems that support SIGEDs.

Across all the countries analyzed, little progress has been achieved on interoperability in either education ministries or the systems of other public bodies. The systems that are in place were not designed to address management of the education system in an integral manner but were created in a fragmented way with specific needs and demands in mind. This has resulted in disperse and isolated IT systems with, in many cases, outdated architecture. In addition, the absence of protocols and security standards undermines trust in the systems and, among other difficulties, limits the use of new technologies such as big data and artificial intelligence.

Internationally, the countries that have been able to integrate the different systems are those, like Estonia, that have made a real leap in the adoption of technology. Its eKool school management platform can interoperate with other applications (Smith, 2019b). At the central government level, Estonia also has X-ROAD, a secure data exchange layer for the different state information systems, including education.

SC2: Governance and institutional framework

In general, the countries analyzed have developed some type of basic legal framework for the operation of the SIGED. Limited plans exist to address specific aspects of different areas of education ministries, but no strategic vision of how all the IT systems should interoperate as a platform for managing the education system. Limited availability of human and financial resources for SIGED development is a feature of most of the education systems analyzed.

Internationally, one example of good practices is France where the Ministry of National Education defines the strategic approach of the Digital Work Spaces (ENT), the equivalent of a SIGED (Smith, 2019c). This provides a framework for the definition and implementation of the ENTs and guides the offer of the available solutions.

P1. Management of physical infrastructure and equipment

There are good experiences in the region of the use of unique identifiers for school buildings and their geo-referencing. However, procedures are still lacking for the permanent update of information about infrastructure and equipment for use in planning its availability in line with demand.

Similarly, there is, in general, a lack of systematized plans for preventive maintenance and response to infrastructure emergencies at physical facilities. In the case of inventories, centralized and updated information about the goods in each school building, with details of the furniture, equipment and laboratories, is, in general, not available.

Internationally, Andalusia (Spain) is an example of good practices. Its Educational Information and Management System (Séneca) has a specific module with updated information about infrastructure, including buildings, laboratories and information and communications technology (ICT) resources (Smith, 2019a). As well as recording information at the school level, Séneca consolidates the data with the national register of schools.

P2. Management of schools

Most of the education systems analyzed have adopted the concept of unique identification of schools, albeit with great heterogeneity in terms of its level of development and problems of conceptual definition.

Certain progress has also been achieved in establishing digital registers of the shifts in which the sections and groups of each school operate. Some challenges exist as regards syllabus systematization and the structure of teaching positions, class scheduling and the centralized management of educational services. The education systems do not have mechanisms for managing transfers and rendering accounts or records of the educational material provided to schools. The top-down approach that prevails in the region's SIGEDs means that priority has been given to the central level's information needs, with schools confined to the function of reporting information. In this sense, little progress is seen in the adoption of a SIGED as a set of tools that facilitates and provides feedback for the operation of schools and permits good management and the availability of information at the intermediate and central levels. Again, Estonia is an example of good practices.

Its eKool system is an education management tool that serves students, families, schools and government authorities (Smith, 2019b). It offers different functions for each type of user. Parents, for example, can access information about their children's performance in real time while teachers save time thanks to the digitization of administrative tasks and the authorities can access all information and monitor schools.

P3. Management of human and budgetary resources

The region's education systems have gradually been establishing unique identifiers differentiated for each person and each position in the public education system. Important challenges exist in the management of human resources, even though they account for the bulk of education budgets.

Financial and human resources systems are not duly integrated, with the result that payroll procedures tend not to be carried out automatically using up-to-date information. In addition, there is a very low

level of systematization and automation of the validation of the hiring of human resources, their assignment to schools and the management of sick and administrative leave.

Internationally, the case of England stands out. Its school management system has a specific module for personnel management (SIMS PERSONNEL) that, as well as containing personal, professional, contractual and payroll data, is integrated with the financial and budget management systems (Smith, 2019d).

In LAC, Pernambuco (Brazil) stands out. In collaboration with the IDB, it has developed a cost monitoring system that provides detailed information on expenditures and budgets at the school level and, as well as increasing transparency, has permitted the identification of inefficiencies (Elacqua, Soares and Brant, 2019).

P4. Students and learning

The management of students and learning is one of the processes to which governments have given priority. This is reflected in the existence of unique student identifiers in most of the systems analyzed. Some education systems also use a digital format for individual student reports with information about their performance. However, very few systems have a digital process for registration and enrollment or the issue of grades and certificates.

A by-student digital record of complementary services, such as school meals, transport and scholarships, remains a challenge. Communication with parents continues to be mainly through traditional channels, with only scant use of digital technologies.

An example of good practices internationally is Andalusia where the Séneca management platform has a specific sub-system for managing all a student's academic and administrative information, including pre-registration, enrollment, academic records, applications for places, absences and evaluations, through to the completion of secondary schooling (Smith, 2019a).

In LAC, the cases that stand out are Chile, Ecuador, São Paulo (Brazil) and Rio de Janeiro (Brazil), which have digital enrollment systems. Chile, in particular, has implemented a centralized system that uses an algorithm to assign students to schools. This process, which applies to all state-subsidized schools (public and privately managed), uses an online platform, administered by the Education Ministry, where families apply for places, listing schools by order of preference. In the case of schools with more applications than places, the algorithm maximizes the probability of students being assigned to one of their preferred schools and establishes priorities for low-income families, siblings of students already enrolled in the school and the children of staff (Elacqua, Iribarren and Santos, 2018).

P5. Digital content for student learning and teacher training

The countries analyzed have established departments to define guidelines on digital content and have consolidated some repositories of digital resources for students. However, they are not making full use of resources of this type to foster teachers' professional growth or, through training, equip them to create and share resources and innovative practices.

The use of digital tools, such as assessment or learning management platforms, is still limited. Some countries do use learning management systems for teacher training but, in general, not on a large scale and there is scant incorporation of these platforms in students' learning process.

Internationally, Estonia again warrants mention. Its digital tools include the e-koolikott digital resources portal, which offers materials for teachers, students and parents, as well as the Opiq learning management system (Smith, 2019b). In addition, students and teachers have access to specialized editorial resources while the interoperability of the different platforms facilitates the use of the available resources.

P6. Tools for strategic management

Very important challenges exist in the use of decision-making tools, related mainly to the quality of data and its availability. This, in turn, limits the implementation of dashboards and the use of business intelligence tools, which are low in the region, and, therefore, also restricts the generation and effective use of educational indicators.

Estonia also serves as an example of good practices in this field. Its eKool platform includes different dashboards with pedagogical data (such as enrollment, attendance, grades and discipline) and management data about the education system (such as a school's workload, list of resources or use of the cafeteria) (Smith, 2019b).

Appendix B presents a summary of the SIGED profile for each of the 16 cases analyzed, identifying strengths, opportunities for improvement, recommendations for achieving an established SIGED and the lessons learned as well as a costing and strengthening plan for each case. For each case, a summary graph is presented, detailing the percentage of functionalities according to the level of development, for each key process and structural condition.

The COVID-19 pandemic has obliged countries to close schools and, to guarantee continuity, they have had to implement emergency online learning solutions. The extent to which countries were able to deploy online platforms and resources to provide content and tools for communication between teachers and students, was determined largely by the progress of their education systems in this field and, of course, structural conditions such as digital gaps in terms of connectivity. The analysis of SIGEDs reveals that most of the education systems were poorly prepared to transition to an online education model and many countries had to resort to more analog channels such as radio and television in order to reach all students (Álvarez et al., 2020). In recent months, countries have, as a result, accelerated the use of digital technologies for education and invested to close the digital gap through the acquisition of equipment and the provision of connectivity. However, the demands that this crisis has placed on countries go beyond digital content. Management and information systems will be essential in the coming months to monitor aspects such as the incidence of dropout and the evolution of teachers' digital and pedagogical skills as they seek to address the learning gaps that will be left in the wake of the pandemic.

CHAPTER 3

Results: How developed are education management processes in Latin America and the Caribbean?

3.1 STRUCTURAL CONDITIONS

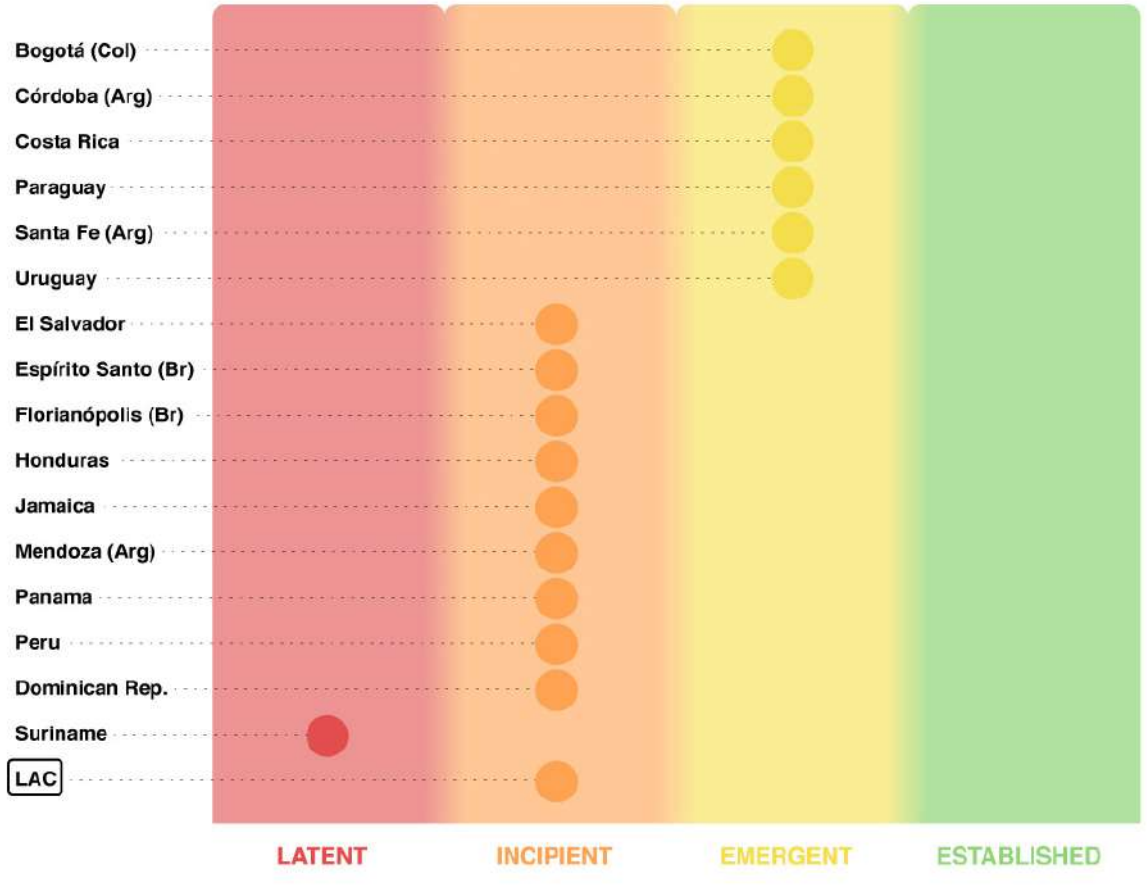
STRUCTURAL CONDITION 1:

Technological infrastructure: Incipient

The study's results show that technological infrastructure is at an incipient level of development (level 2 out of 4) in Latin America and the Caribbean (LAC). Most of the cases analyzed are at either the incipient or emergent stage (Figure 3.1). The most advanced are the city of Bogotá, the provinces of Córdoba and Santa Fe, Costa Rica and Uruguay, which have all reached an emergent level.

FIGURE 3.1

Level of development of SIGEDs: technological infrastructure



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

The case of the province of Santa Fe warrants mention. It has launched a model for the development of applications and interoperability between systems, with four centralized environments for the deployment of applications, as well as a protocol for backing up and restoring information. All its systems have unique authentication mechanisms. Although the province is on the way to improving connectivity and equipment, it needs to generate an accurate inventory of connections, goods and instruments at the individual level.

The province of Córdoba has a team trained in current technologies and uses agile methodologies to manage Education Ministry initiatives. At the central level, it has four environments for the correct deployment of applications. Back-up methodologies, information restoration and data use policies are managed centrally by the provincial government. In addition, the local government uses a unique access system for authentication through the Digital Citizen (CIDI) platform, which is also used in the sphere of education.

The structural condition of technological infrastructure refers to all the technological arrangements (hardware and software) that support a particular education system. An established SIGED must guarantee minimum levels of processing and connectivity for administrative and pedagogical purposes. This includes connectivity in education ministries' central and regional offices as well as in schools. It is important to note that the term connectivity implies that all users have not only an Internet connection, but also access to sufficient data and the data transmission speed required for their needs. To calculate education systems' minimum connectivity requirements, the factors commonly used are the number of users and network traffic in both management systems and educational platforms. Cybersecurity and information protection measures are also important. Some complementary arrangements include authentication technologies to protect identity and automatic audits of sensitive data that may be modified by the systems' users.

Interoperability is another key dimension. Education ministries tend to use different IT systems and tools, making it necessary to guarantee their interoperability and compatibility. The programming languages of the different systems may, for example, be different or a system may have been developed with technology that is now obsolete, hampering its interoperability with more modern systems. These and other barriers have been extensively documented (Chen, 2006). The availability of technical and operational information for the different systems facilitates their maintenance and update and favors better user appropriation. This is particularly important when software and digital systems are tailored to the organization (ministry or secretary) in order to ensure their sustainability in the face of personnel changes, which tend to be common in public entities. It is worth noting that, although various actors are involved in the technological arrangements for the functioning of the education system, the main responsibility generally falls to the technology departments of education ministries.

BOX 3.1

Technological infrastructure:
the cases of Estonia and Andalusia (Spain)

Internationally, the countries that have managed to integrate different systems are those, like Estonia, that have made a real leap in the adoption of technology. This country's eKool school management platform is a 100% Internet-based system and is provided in the form of software as a service. It operates through a web browser and is, therefore, accessible from mobile devices. Although it is not necessary to install the software or its components in a local server, it does require a reliable Internet connection. It should be noted that Estonia has a high penetration of household Internet connections and the country's implementation of its e-government plan is an international benchmark.

The products and services integrated into eKool include e-learning platforms, e-book stores, exam results and student inquiries and the national register of citizens. In addition, at the central government level, Estonia has developed X-ROAD, a secure Internet-based data exchange layer that enables the different state information systems to communicate with each other.

Andalusia (Spain) stands out for the high level of interoperability of its Educational Information and Management System (Séneca). The interoperability of management and information systems has been one of the Spanish government's priorities and, to this end, it has implemented a National Interoperability Strategy (ENI). From the very beginning, Séneca was conceived with the idea of interoperation and exchange of data with other external systems that intervene in educational processes. As a result, it inter-relates with: i) the Andalusian Tax Agency to verify the income of family units involved in different processes; ii) the Suppression of Paper-based Certificates platform for the verification of families' place of residence; iii) the Regional Economy and Finance Ministry for the payment

of scholarships through the Júpiter system; and iv) the Andalusian Employment Service for the verification of scholarship applications.

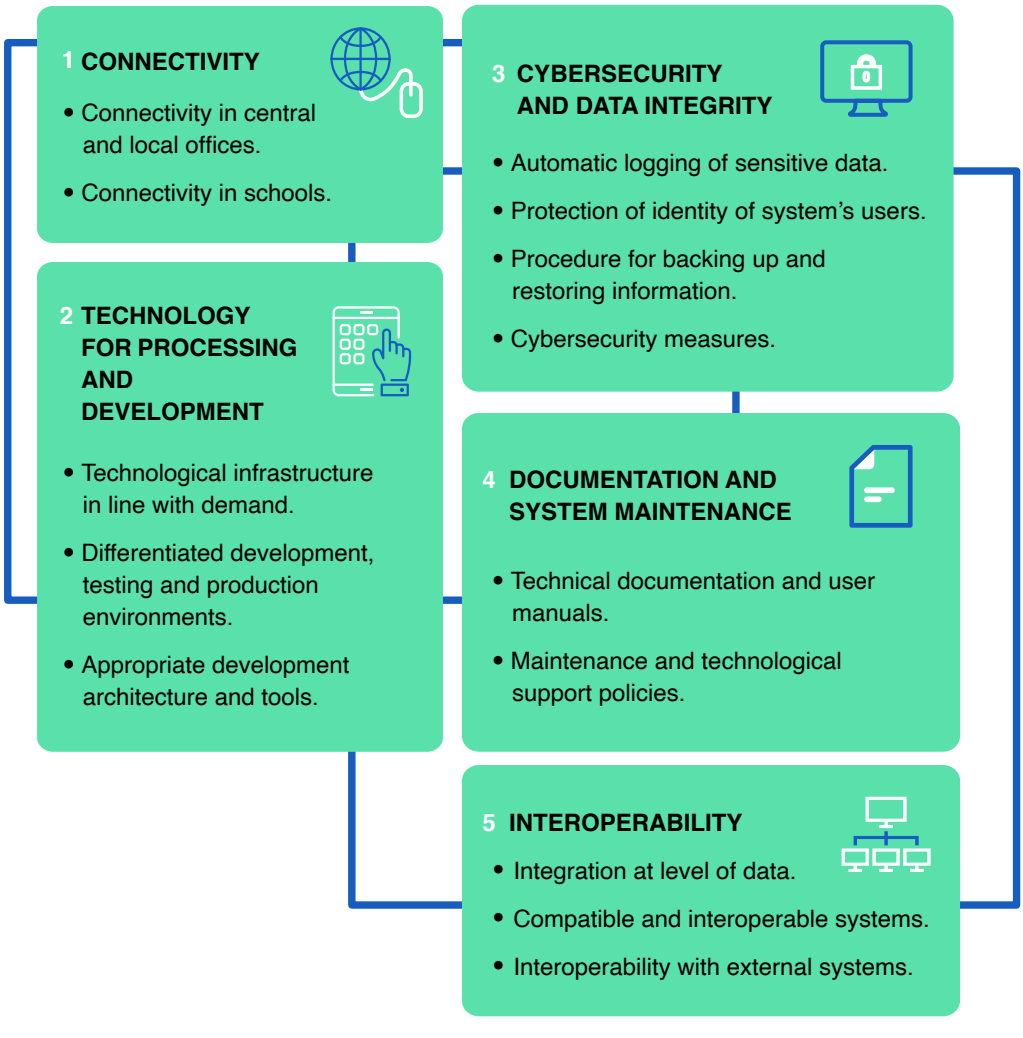
In terms of internal interoperability, Séneca is closely integrated with the Unified Human Resource Management System (SIRhUSE), the source of authorization of system users and a provider of certain telematic services for teachers through the Séneca platform itself, such as payroll details and basic data related to teachers' administrative history. Séneca is also integrated with the Official Register of the Schools Management System, the main source of basic information about schools (basic data, address, courses, services, etc.) at the regional and national levels. Another important feature of the platform is its integration with the distance training platforms (e-learning with Moodle) of the Regional Education Ministry, which are used by over 22,000 students and from which they graduate automatically based on the information available in Séneca.

Source: Compiled by authors based on Smith (2019a; 2019b).

The functionalities referred to under the structural condition of technological infrastructure are grouped into five categories: i) connectivity; ii) technology for processing and development; iii) cybersecurity and data integrity; iv) documentation and system maintenance; and v) interoperability. Each category is described below, highlighting good practices and experiences of the cases with the highest level of development. Each functionality is accompanied by a graph showing the level of development in each of the 16 cases analyzed.

INFOGRAPHIC 3.1

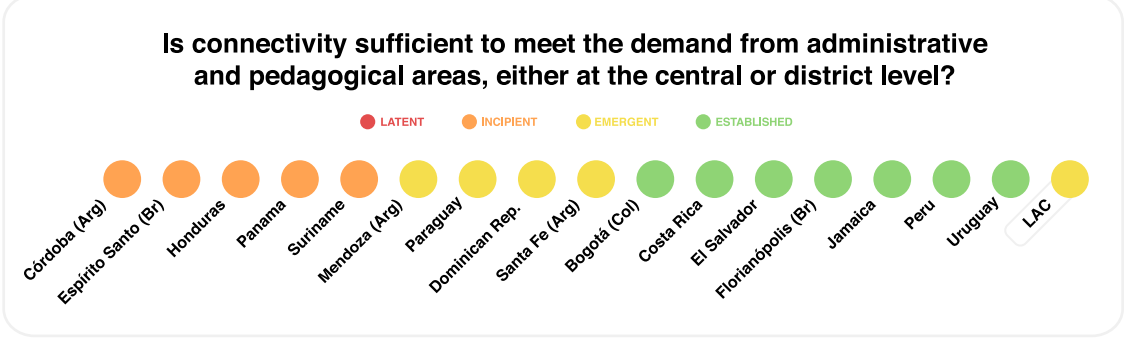
Summary of functionalities of the technological infrastructure structural condition



1 CONNECTIVITY

Connectivity in central and local offices: emergent.

At the central level and for administrative areas, minimum connectivity conditions are usually determined based on the system's number of users and network load. The highest levels of development in this field are found in the city of Bogotá, Costa Rica, El Salvador, the Florianópolis municipality, Jamaica, Peru and Uruguay. Costa Rica, for example, has a fiber ring between buildings (between 30 MB and 80 MB per building) while regional offices have 30 Mbps for Internet plus 2 Mbps for internal systems.

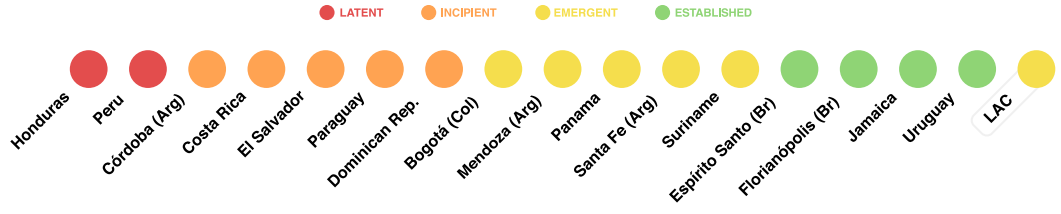


Connectivity in schools: emergent.

As well as connecting all schools, the service must allow the school director, teachers, administrative personnel and students to perform their daily management activities and use the learning platforms. This dimension, therefore, measures the coverage and quality of schools' connectivity. Ideally, they should have a minimum of 1 Mbps for every ten students. A school of 300 students, for example, should have at least a symmetrical Internet speed of 30 Mbps. Among the cases analyzed, the state of Espírito Santo, the Florianópolis municipality, Jamaica and Uruguay are the most advanced in terms of connectivity in schools.

In the state of Espírito Santo, each school receives a specific amount of money through the State Program of Direct Money to Schools (PEDDE) with which to obtain an Internet service. In addition, schools have a 2 Mbps connection through the school broadband program. In the Florianópolis municipality, all schools have a 100 Mbps connection and fiber optics. In the case of Jamaica, most schools obtain their Internet service from a telecommunications operator and use part of their budget to pay for this service. The level of connectivity is high, but schools experience bandwidth and service interruption problems, particularly in rural areas. Thanks to Uruguay's Basic IT Educational Connectivity Plan for Online Learning, known as Plan Ceibal, all this country's schools have connectivity. Schools in urban areas have a high-speed connection while those in rural areas, where a fiber optic connection is not available, use 3G. In addition, the server provides content filtering services. When the server goes down, traffic is redirected to a central site that sidesteps the lack of Internet and the school is not left without service.

Do schools have the connectivity to make use of administrative and pedagogical management systems?

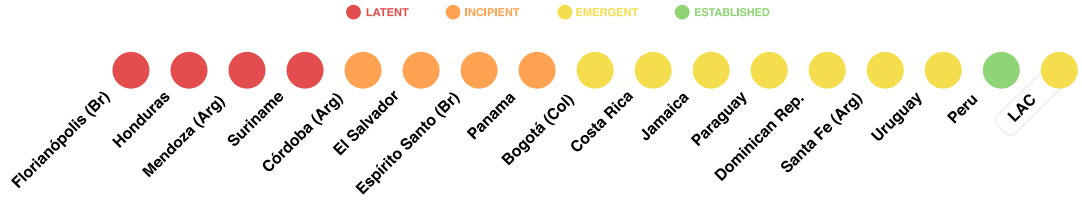


2 TECHNOLOGY FOR PROCESSING AND DEVELOPMENT

Technological infrastructure in line with demand: emergent.

The technological infrastructure (software and hardware) available in IT departments must reflect demand and the scope of the technological projects they handle, with redundancy in production environments. In this field, Peru has the highest level of development, with adequate technological infrastructure within the critical processing and storage limits for central SIGED processes. The hardware and physical installations of its data center are relatively new and sufficient for all current SIGED requirements. The city of Bogotá has its own Tier II data center[13] and also uses a specialized external storage service. However, the building where the data center is housed has structural problems. The Dominican Republic also has its own data center and housing service (own equipment), where 100% of applications and data are replicated, as well as a cloud service (Microsoft Azure). However, its existing systems do not cover all critical SIGED processes. In Jamaica, SIGED applications are hosted in a national data center and in the Education Ministry itself. The main applications are located in environments with redundancy[14] and are backed up daily.

Do you have technological infrastructure (software and hardware) for the processes handled by Educational Information and Management Systems (SIGED) that cater to demand, with redundancy in the production environment?

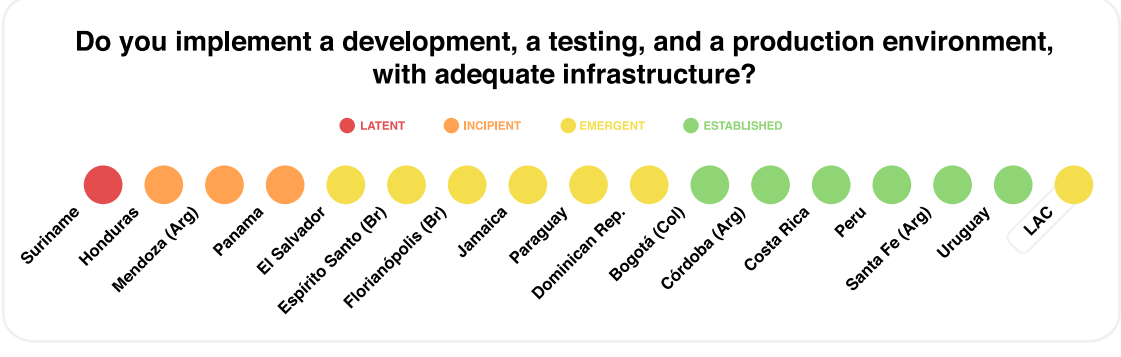


13 The Tier data center standard defines/measures the time a data center is available. It is useful for measuring data centers' performance as well as the investment or return on the investment.

14 Redundancy implies that various copies of the same content are kept in different environments, increasing security against the event that one or more back-ups cannot be read.

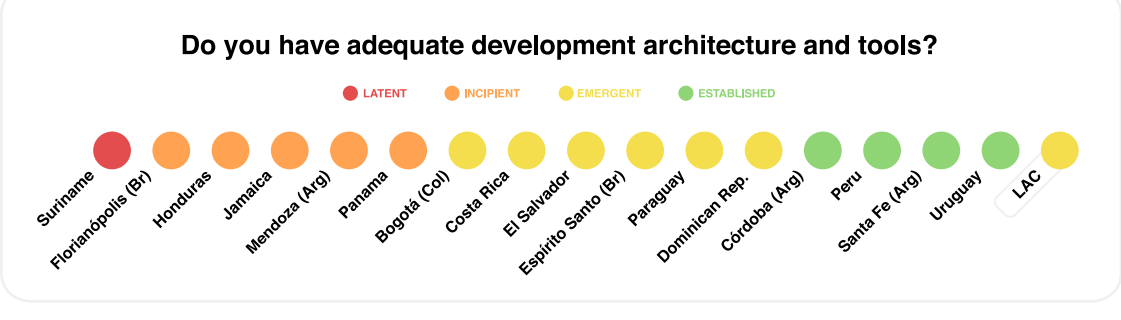
Differentiated development, testing and production environments: emergent.

A good practice for software development and implementation is to activate differentiated development, testing and production environments. The city of Bogotá, the province of Córdoba, Costa Rica, Peru, the province of Santa Fe and Uruguay have done this. In Peru, each environment has independent infrastructure to provide support for each stage of the software production cycle. It should be noted that not all developments are subject to the quality control process since this work often takes place without consulting the technology office. The province of Córdoba has a fourth pre-production environment. In the case of Uruguay, the production environment comprises 140 processors, 200 GB of RAM and a disk with a capacity of 9 TB while the development and testing environments have their own infrastructure. In El Salvador, although there are three differentiated environments, the technology is obsolete. In the Dominican Republic, the three environments are in operation, even though there are not IT systems to cover all the central SIGED processes.



Appropriate development architecture and tools: emergent.

In LAC, it is common to find inherited systems that are obsolete. However, a tendency to opt for an adequate architecture and tools has recently emerged, particularly in the case of new developments. The province of Córdoba, Peru, the province of Santa Fe and Uruguay are the most advanced in this field. Uruguay has a three-tier architecture, with high availability of servers. Costa Rica represents an average case in which only new developments have an adequate architecture. As a database, it uses SQL Server and the ASP programming language. Similarly, in the Dominican Republic, recent developments work with .NET and compile with Net Core, using SQL Server databases as well as PHP and MY SQL, especially for web applications. The province of Mendoza uses WEB architecture, with the MySQL database tool and the Apache applications server. The development language is PHP.



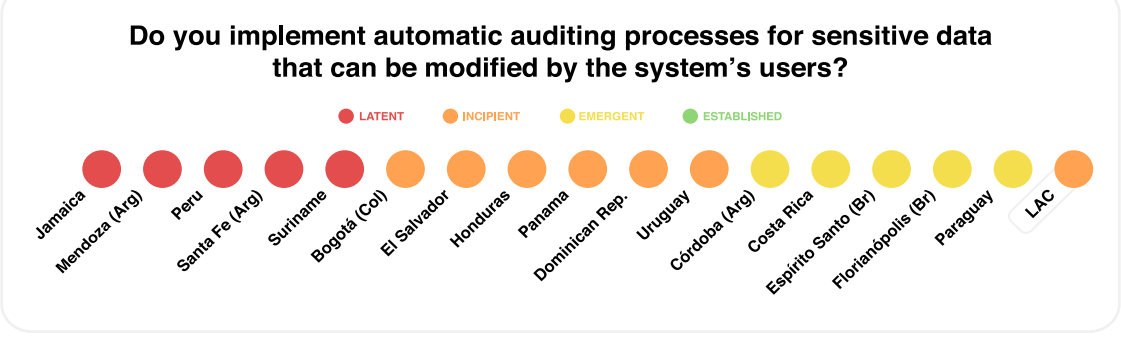
3 CYBERSECURITY AND DATA INTEGRITY

As technology advances, it is ever more imperative for education systems to have cybersecurity measures in place and to back up data online. This includes the development of automatic logging mechanisms,[15] protection of the identity of the system's users, protection of the information and specific cybersecurity measures.

Automatic logging of sensitive data: incipient.

Auditing processes should record at least information about the user making a change to the data, the location, IP address, date and time and the value of the register prior to each modification. These audits may be triggered automatically whenever data is added, modified or deleted. The logging module can be programmed to generate an alert and create a register whenever the actions that have been defined as auditable occur. In short, every screen or action button of the system should be capable of being audited (if applicable), recording who performed the action and when, and saving all the relevant information. The province of Córdoba, Costa Rica, the state of Espírito Santo, the Florianópolis municipality and Paraguay are the cases with the greatest development of automatic auditing processes.

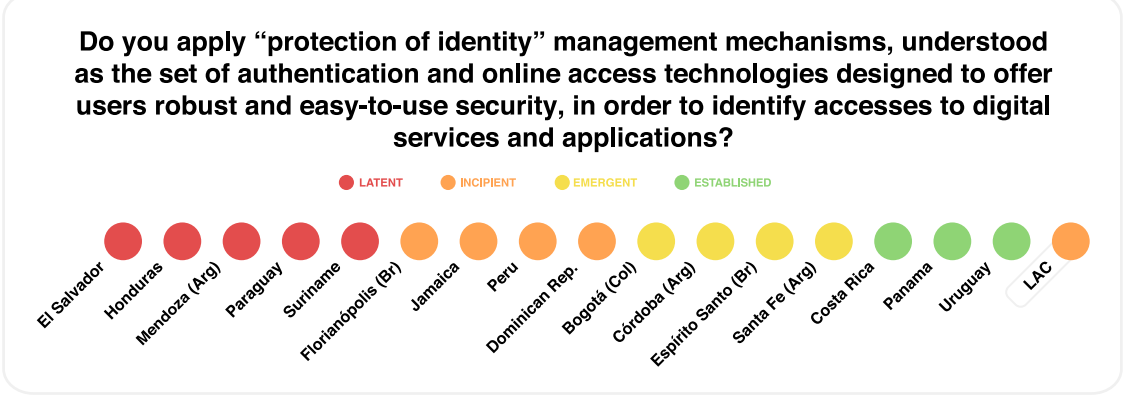
In the state of Espírito Santo, for example, the system generates a unique operation code corresponding to each parent/guardian for the registration of students and has an auditing tier. In the case of Florianópolis, the Municipal Education Secretariat has access to the activities carried out by users and can verify their accesses and the device that used the server. In Costa Rica, although auditing is not used in old systems, the capacity to register modifications of sensitive data has been incorporated into medium-age systems while new systems, such as the payments system, all have this function. In the province of Córdoba, information about who performed an operation and when is available for all systems, but regular auditing does not take place. In Paraguay, complete auditing is carried out in the Unique Student Register (RUE) while the Integrated Management System of the Ministry of Education and Sciences (SIGMEC) records the user who makes a modification. However, changes are not audited in systems that date back to before 2013.



15 Systematic registers of access to sensitive data and modifications of it, which record the previous data, the modified value and the person who made the change.

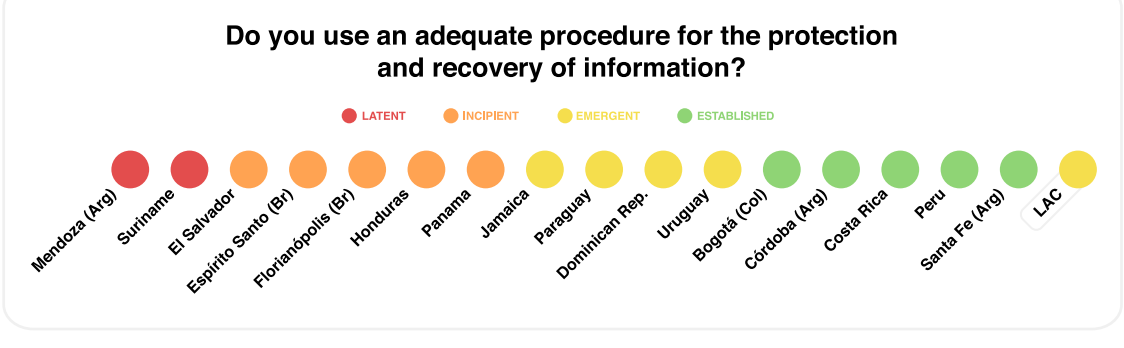
Protection of identity of system's users: incipient.

Identity protection consists in a set of online authentication and access technologies designed to provide users with robust security in a simple way. Mechanisms for identifying access to digital services and applications that guarantee reliability should be considered. The cases with the highest level of development in this field are Costa Rica, Panama and Uruguay. In Costa Rica, this aspect is regulated by Law 8.968 on "Protection of persons as regards protection of their personal data". In this country, IT systems use centralized access, with validation using Microsoft's Active Directory service, as a prior step to accessing each system. In Panama, users must present their credentials to access each of the systems. In Uruguay, access to every system is through the CAS, the unique access of the Council for Early and Primary Education (CEIP), under which each person has a unique username and password for access to all systems, with different roles and permissions. The username is each person's identity card number.



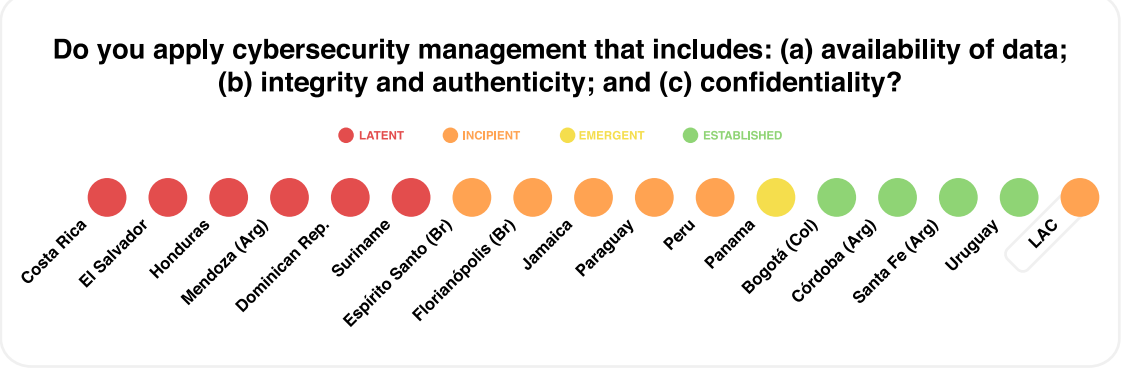
Procedure for backing up and restoring information: emergent.

The back-up of information is a process in which data is duplicated and stored for use should the main system become corrupted or the data be erased or lost. The cases with the greatest development of adequate procedures for the back-up of applications and data are the city of Bogotá, the province of Córdoba, Costa Rica, Peru and the province of Santa Fe. Costa Rica uses a Storage Area Network (SAN), with a library of disks as primary back-up, after which the data is transferred to a tape. The province of Córdoba's main data center is used for data back-up and restoration. In Uruguay, although the processes and contingency lines are not documented, a back-up process is automatically run every day and all the information is saved on an FTP server. Daily back-ups also take place, with 97% availability, and all the SQL database is backed up.



Cybersecurity measures: incipient.

Cybersecurity measures seek to protect users, the devices connected to the network, services and applications, communication systems, multimedia communications and the information transmitted and/or stored from risks in the cyber environment. They consist of tools, policies, security concepts, guidelines, risk management methods, actions, training, appropriate practices, insurance and technologies. The city of Bogotá, the provinces of Córdoba and Santa Fe and Uruguay are the most advanced in this field. In the city of Bogotá, this aspect is viewed as strategic at the district level and is governed by the norms of the Directorate of Police Intelligence (DIPOL). The city's Education Secretariat has a regulated security committee that meets every two months or in the event of an emergency. In Uruguay, the only situation in which data is not available is when a server crashes. Confidentiality is protected by National Law 18.331 on the protection of personal data.



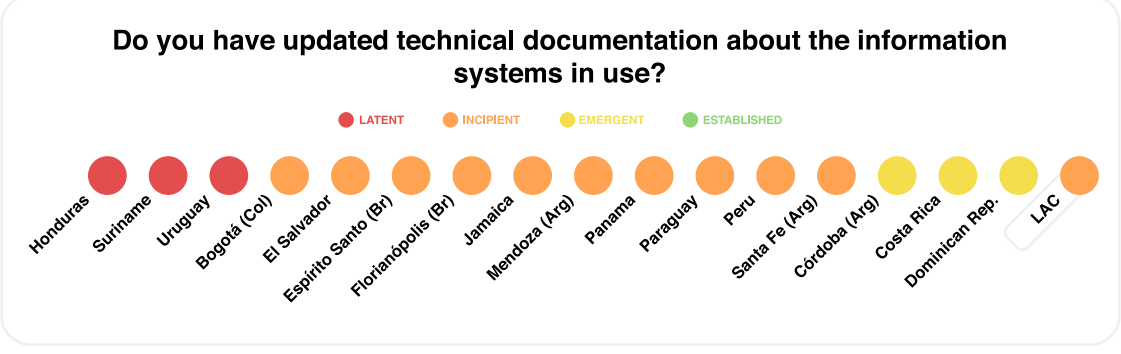
4 DOCUMENTATION AND SYSTEM MAINTENANCE

Technical documentation and user manuals: incipient.

Technology departments should have technical documentation about the design and development of IT systems as well as operational documentation or user manuals. The absence of documentation of this type hampers maintenance and updates by technical personnel, particularly in the case of obsolete systems, and limits their utilization by end-users, such as school directors, teachers and administrative personnel. The documentation of systems is particularly important for their sustainability over time to guard against factors such as staff turnover. The province of Córdoba, Costa Rica and the Dominican Republic have the highest level of development in this field.

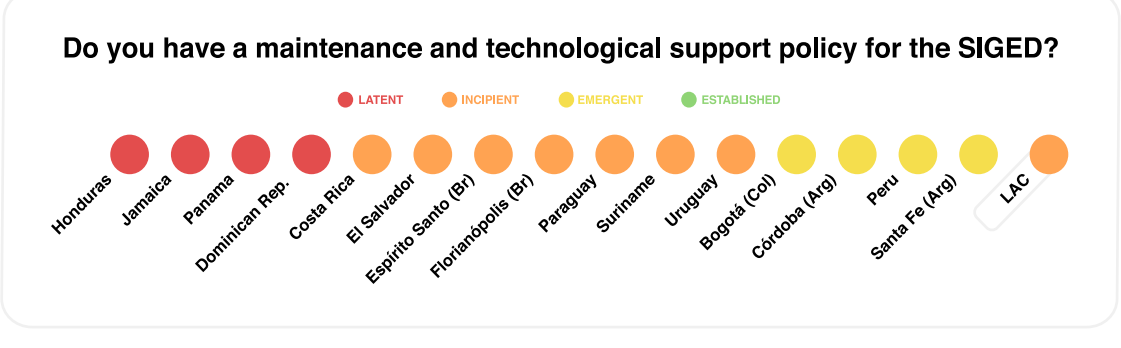
Costa Rica has technical and operational documentation for projects implemented as from 2010, which are governed by 2010 norms. Although the city of Bogotá has technical documentation for the new systems that have been developed, it lacks documentation for inherited and national systems (SIMAT and Humano). Operating manuals are not available but users can access video tutorials. Out of Peru's 136 IT systems, around 50% were inherited without proper documentation. The state of Espírito Santo does not have operating manuals for data modeling, but does have data dictionaries. Its State School Management System (SEGES) has

an operating manual that uses the step-by-step methodology, but manuals are not available for other systems. The Florianópolis municipality has updated training manuals and videos about all the system's characteristics.



Maintenance and technological support policies: incipient.[16]

Maintenance and technological support policies for IT tools can serve as a framework for SIGED governance and sustainability. These policies can define the frequency and nature of routine maintenance and technological support for the different IT systems. One of the cases with the greatest development in this field is the city of Bogotá, which has a policy or mechanism for the maintenance and technological support of IT systems. The province of Santa Fe has introduced a maintenance schedule, but has no specific policy in this field. In Paraguay, different areas, such as the Directorate of IT and Information Systems and the Directorate of Monitoring and Follow-up, each with its own criteria, develop and maintain systems. From the standpoint of schools, support for end-users is limited. In Suriname, the Education Ministry does not apply a policy on information systems. This country has launched an e-government initiative but, so far, this has focused on expanding fiber optic infrastructure in ministry offices.



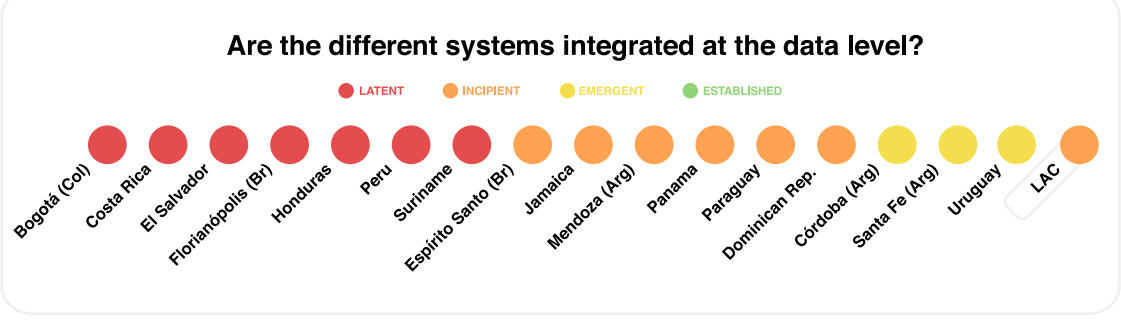
16 Data not available for the province of Mendoza.

5 INTEROPERABILITY

Although there is no single IT system for all management processes, an established SIGED achieves efficiency when the different technological tools interoperate as a management platform. However, in practice, the more systems there are, the greater the dispersion and duplication of functions between systems tend to be.

Integration at level of data: incipient.

An aspect that must be taken into account is whether the different systems are integrated at the level of data. In this field, the provinces of Córdoba and Santa Fe and Uruguay are the most advanced. The province of Córdoba has a horizontal database of all provincial agencies that uses the same technological standard. Then, according to its needs, each agency implements a vertical database with the corresponding information. Although management of this model is not simple, it has many advantages, such as unified registers, interoperability between systems and different public bodies, and the rationalization of IT resources. However, those systems at a premature stage of development that operate outside this scheme create a lag in the consolidation of information at the central level. In the province of Santa Fe, most systems are integrated but, at the data level, all the capabilities are not fully used.



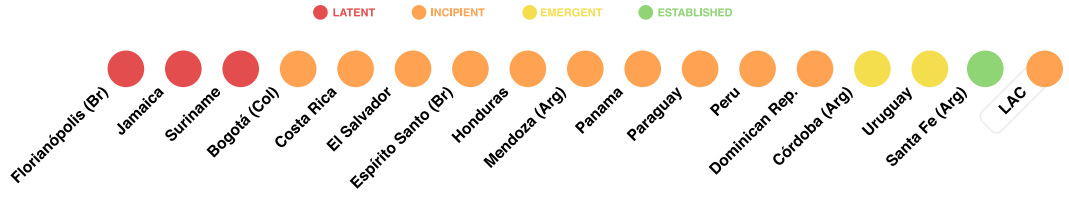
Compatible and interoperable systems: incipient.

A significant part of the IT systems used by education ministries were developed a long while ago, using technologies that are now obsolete and lack the capacity to solve the specific requirements of a certain sector or agency. Moreover, in a problem for the compatibility and interoperation of the available applications and the online provision of integrated information, the IT solutions implemented notoriously lack a transversal design. As a result, experiences with compatible and interoperable systems are scarce. The case of the province of Santa Fe, where most systems have the capacity to interoperate, stands out.

In other cases, a certain level of integration between some systems is seen. In Uruguay, for example, the GURÍ education management system and the Payroll payment system, in use at the time of this study, interoperated through batches. Some systems in the city of Bogotá, Honduras, Paraguay and the Dominican Republic implement integration through ETL or Web

Services. In the province of Mendoza, the different products implemented are not compatible in terms of development tools or architecture. The transfer of data between systems is, therefore, carried out manually by the Technology Directorate, which has maps of codes and adaptations. This process is slow, complex and prone to errors.

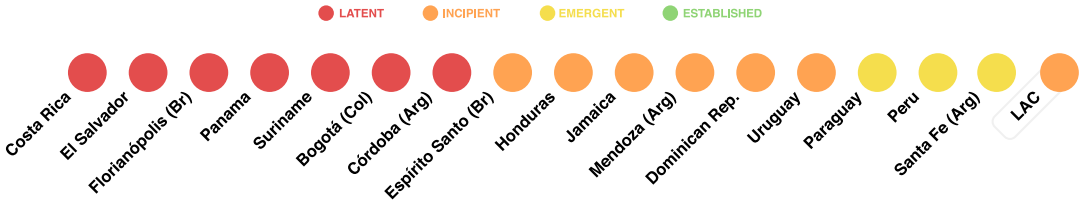
Are the systems that have been implemented compatible and interoperable?



Interoperability with external systems: incipient.

Adequate arrangements must be in place so that education ministries' IT systems can interoperate with those of other ministries and external bodies in, for example, the payment of wages when this task is carried out by an external institution. This data interaction can also be useful in the case of institutions such as social development or health ministries, credit institutions, workplace risk insurers and statistics offices. There has been very little development of interoperability with external systems. In the province of Córdoba, the Student Management System interacts in specific cases with different provincial and central government systems such as the Córdoba Integral Assistance Program (PAICor), the National Social Security Administration (ANSES), the Student Transport Ticket benefit and the Progresar scholarships. Paraguay has established a mechanism for the exchange of information and one of the goals of the Ministry of Information and Communications Technologies (MITIC) is to interconnect the databases of the different government ministries but, in practice, important challenges remain. In the Dominican Republic, certain systems interoperate through Web Service and also use ETL in which data is uploaded for the National Health Insurance (SeNaSa) system, the PROSOLI conditional cash transfer program and the Autonomous University of Santo Domingo (UASD).

Is the SIGED integrated or does it interoperate with external systems (belonging to other government agencies in the same jurisdiction, national bodies for decentralized systems, the private sector or civil society)?



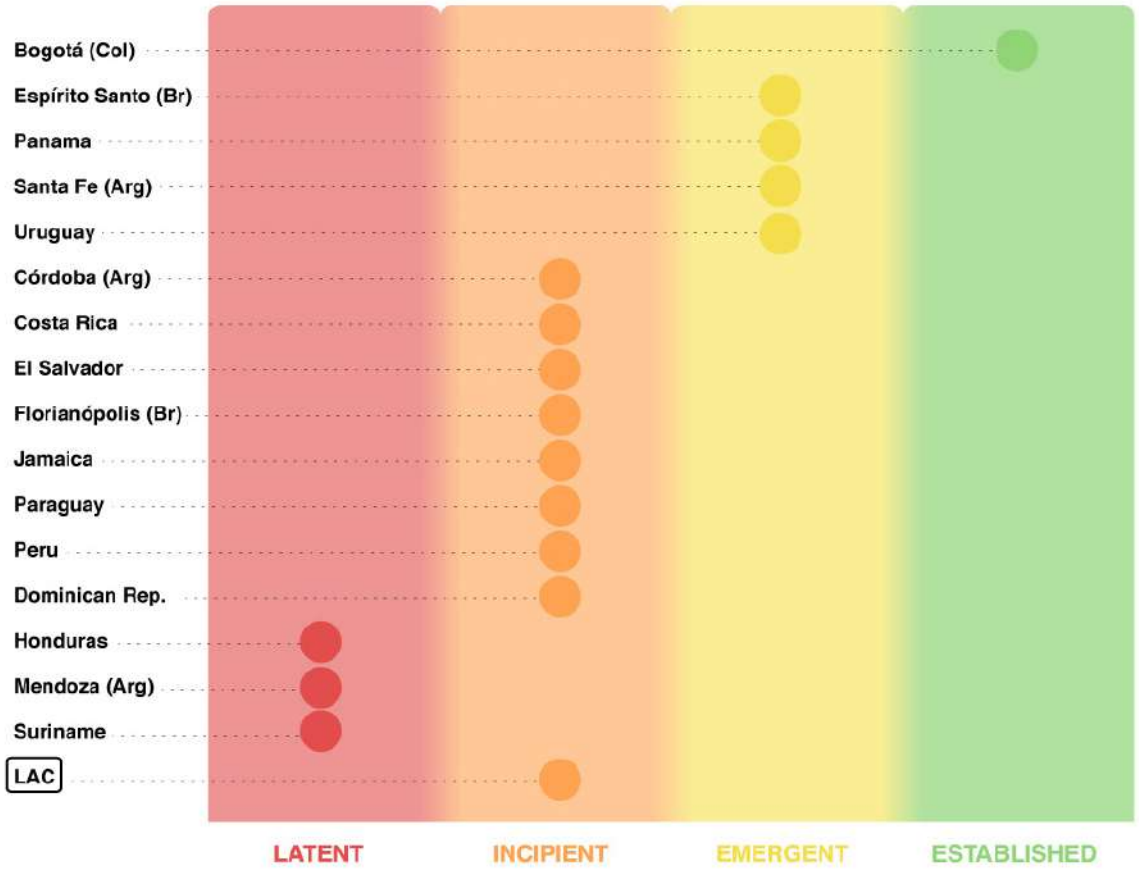
STRUCTURAL CONDITION 2:

Governance and institutional framework: Incipient

The study's results show that governance and the institutional framework are at an incipient level of development (level 2 out of 4), with most of the cases analyzed at the incipient and emergent stage (Figure 3.2). This aspect is most developed in the city of Bogotá where it has reached the established level.

FIGURE 3.2

Level of development of SIGEDs: governance and institutional framework



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

Bogotá's Education Secretariat has an Integrated Management System, approved by resolution, as an instrument to facilitate compliance with its mission and goals and create instances through which to document, implement, maintain, monitor and improve it. The clear strategic vision of the education system's authorities as regards aspects associated with the SIGED provides a framework for sustaining and promoting optimization of the Education Secretariat's processes

and information systems. Norms are also in place to regulate different aspects of the SIGED and a change management plan has been developed.

The state of Espírito Santo, Panama, the province of Santa Fe and Uruguay are at the emergent level of development. The case of Santa Fe stands out for the authorities' support for implementation of the SIGED and because it has ministerial-level norms on the use of these management and information systems. The protection of privacy and the ethical use and disclosure of SIGED information are also regulated and human and financial resources are available for the SIGED's operation and the implementation of certain improvements. It is important to note that the province's Information Technology Department has a team of 50 people working on development of the SIGED. These resources are sufficient for certain short and medium-term improvements, but the development of a long-term project may require additional resources, which are not guaranteed.

Most countries have a basic legal framework but very few have a strategic vision or human and financial resources aligned with the vision of achieving an established SIGED. The design of strategic projects for integral optimization of the SIGED, backed by a high level of consensus and approval among top authorities, is a challenge. In addition to the strategic plan, it will be necessary to develop operational plans that include a timetable of tasks, goals and the allocation of the associated resources. Limited plans, designed to solve specific issues in each area, are a typical feature of most education systems. The norms should establish responsibilities for both the recording and use of the data managed.

The structural condition of governance and institutional framework calls for a strategic vision at the highest level of political leadership of education ministries, a vision that must be reflected in an integral project for the optimization of institutional processes using new technologies. As well as detailing objectives and key actions for all areas of the institution, the strategic project must include the availability of resources for its implementation in the medium and long term, along with those financial, human and regulatory aspects that give sustainability to the optimized processes and support systems.[17]

The legal, financial and planning teams must jointly ensure that the education ministry's structural conditions are adequate for the development, implementation and maintenance of an established SIGED and guarantee its sustainability over time. In this sense, it is necessary to ensure a robust legal framework, which defines the roles and responsibilities of each department, and a strategic plan that sets out the integral vision of the SIGED as a management platform. For this, it is essential to design and implement a change management plan to support the education ministry's digital transformation and guarantee its gradual adoption at all levels of the education system.

17 The coordination of national digital strategies was not included in the instrument, although the importance they can have for the implementation of SIGEDs is highlighted.

BOX 3.2

Governance and institutional framework: the cases of France and Andalusia (Spain)

Internationally, France is an important example of good governance and institutional practices. Its Ministry of National Education defines the strategic approach of the Digital Work Spaces (ENT), the equivalent of a SIGED. The Master Scheme for Digital Spaces (SDET) is part of the set of plans that constitute the Strategic Scheme for Information Systems and Telecommunications. As a result, the norms related to the SDET are not an isolated document and are articulated with other norms that are relevant to its domain. The ENT project brings together representatives of regional authorities and the Ministry of National Education as well as authorities responsible for agricultural and maritime education.

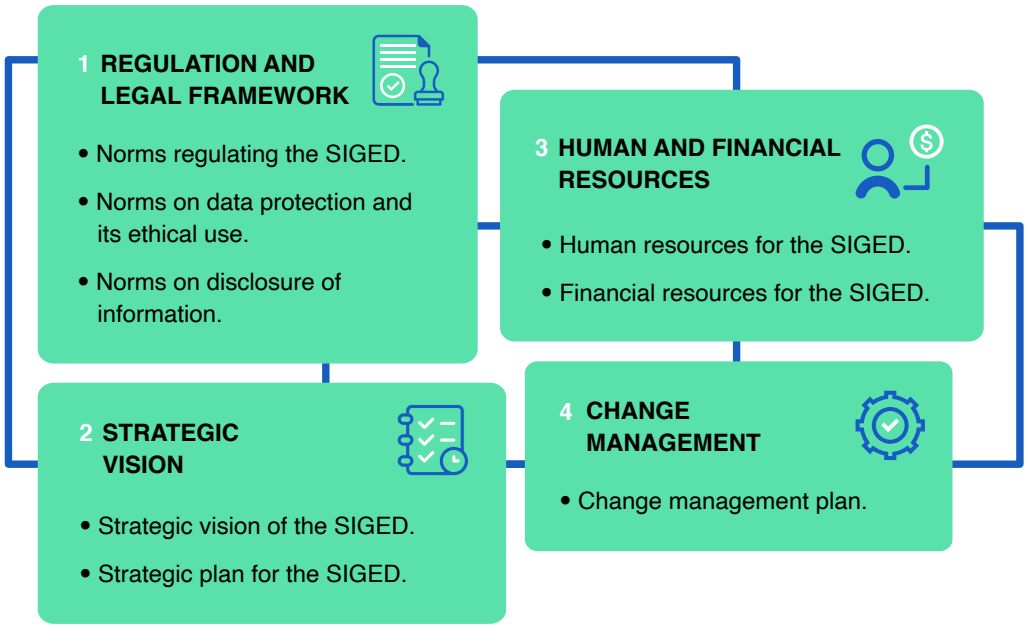
In Andalusia, the regulation of the Séneca information and management system was established by Decree 285/2010, issued by the regional government. Since its implementation, any norm issued by the Regional Education Ministry, decree, order or resolution that implies the definition of a procedure that affects schools must be implemented through and made available in Séneca in order to ensure its management as established. This is the case, for example, of the family support plan in which the management and monitoring of school meals, school transport and morning classes are Séneca modules that support this policy of the regional government.

Source: Compiled by authors based on Smith (2019a; 2019b).

The functionalities referred to under the structural condition of technological infrastructure are grouped into four broad categories: i) regulation and legal framework; ii) strategic vision; iii) human and financial resources; and iv) change management. Each category is described below, highlighting good practices and experiences of the cases with the highest level of development. Each functionality is accompanied by a graph showing the level of development in each of the 16 cases analyzed.

INFOGRAPHIC 3.2

Functionalities of governance and the institutional framework



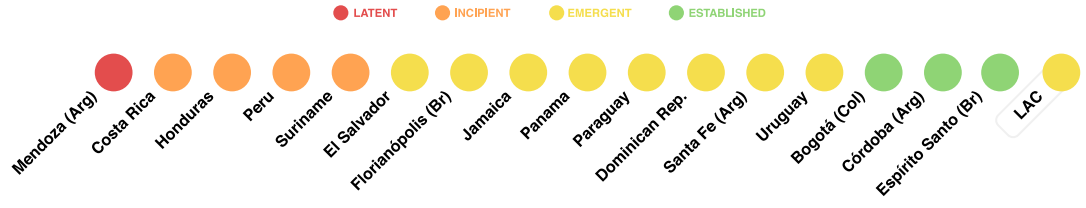
1 REGULATION AND LEGAL FRAMEWORK

Norms regulating the SIGED: emergent.

SIGED management processes and the IT systems that support them can be given sustainability through laws, decrees, resolutions or provisions and manuals for the processes. Norms can be used to define general responsibilities while manuals explain the operational implementation of the tasks assigned to each education ministry department with respect to the SIGED. The cases with the highest level of development in this field are the city of Bogotá, the province of Córdoba and the state of Espírito Santo. Bogotá has an Integrated Management System, approved through a resolution, that clearly indicates the responsibilities of the SIGED. The province of Córdoba has established norms to regulate some aspects of the SIGED, including Ministerial Resolution 275/2017 on the obligation to use the Student Management System. Jamaica has norms that, albeit general in nature, cover various aspects of the processes related to the SIGED. The Jamaican government has established the integration of information technologies (IT) into the economy as a priority. At the time of the case study, a number of

laws were being debated on matters that included e-government, access to data, privacy and cybercrime. Jamaica also has an Education Policy Law and has prepared a draft master plan for its implementation with IT systems as a transversal dimension.

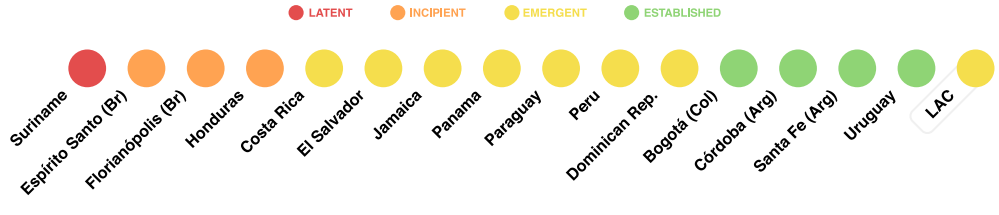
Are there established norms (laws, decrees, resolutions, provisions, manuals) that regulate key management processes and the systems that support these processes?



Norms on data protection and its ethical use: emergent.[18]

On norms to protect the privacy of the information held in the SIGED and guarantee its ethical use, the city of Bogotá, the provinces of Córdoba and Santa Fe and Uruguay are the most advanced. Colombia has a national regulatory framework on information management and the city of Bogotá has a specific committee, approved by resolution, on compliance with national and district regulations. The province of Córdoba and Uruguay have a personal data protection law. On specific aspects of the ethical use of data in education, the case of Paraguay stands out. The Education Ministry has a Code of Ethics, approved by Resolution 11.523/2007, which sets out the conduct expected of the employees of its support entities (administrative personnel) and mission entities (teachers). Users of the Unique Student Register (RUE) must sign a confidentiality letter.

Are there norms to protect the privacy of the information held by SIGED and guarantee its ethical use?



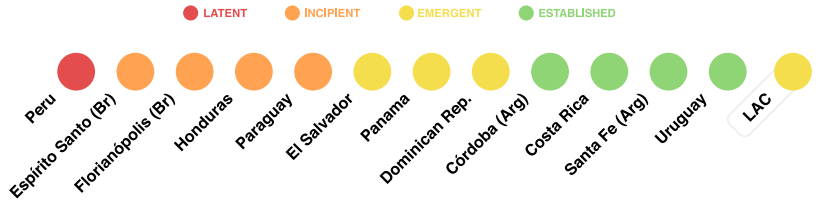
18 Data not available for the province of Mendoza.

Norms on disclosure of information: emergent.[19]

An important path has been opened on regulation of disclosure of SIGED information related to the results of the education system. The laws and norms on transparency and access to information that regulate the conditions and processes for accessing data held by the public sector are of particular importance. In general, they apply equally to all public institutions and are not specific to SIGEDs. Costa Rica, the provinces of Córdoba and Santa Fe and Uruguay have the highest level of development in this field. Costa Rica has implemented an open government initiative, defined by Law 8.968 on "Protection of persons as regards protection of their personal data". In Uruguay, all aspects of the disclosure of information in the education sector are regulated in the framework of Law 18.381 on the right of access to public information.

Other transparency and access to information norms include Panama's Law 6 on Habeas Data and the Dominican Republic's Decree 534 on the Law on Access to Public Information and its General Law on Free Access to Public Information (Law 200-04). In addition to its Law on Transparency and Access to Public Information (Legislative Decree 170/2006), Honduras has a regulatory decree on the operation, responsibilities and powers of its National System of Educational Information (SNIEH), issued on August 25, 2015. However, it was not possible to verify compliance with these norms.

Do you have and apply norms to regulate the disclosure of information from SIGED related to education system results?



2 STRATEGIC VISION

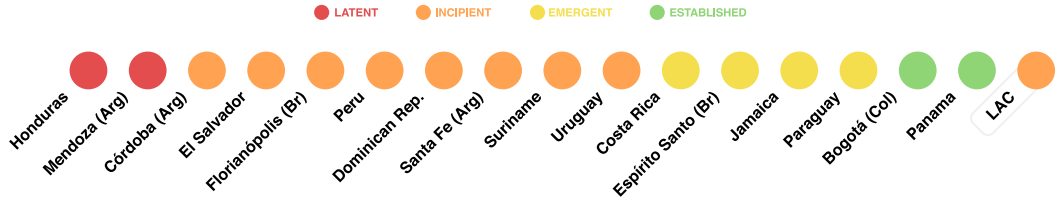
Strategic vision of the SIGED: incipient.

The transition towards a SIGED as an integral management platform calls for a clear strategic vision on the part of the education system's authorities, including concepts such as unique identifiers, the virtualization of processes, the modernization of systems and an integrated approach. The city of Bogotá and Panama show the greatest development in this field. In Panama, for example, the Education Ministry (MEDUCA) has defined a number of information system projects as key: i) strengthening of the School Administration System, SIACE (SIACE 2.0); ii) strengthening of the Human Resources Administration System, SIARHE (SIARHE 2.0); iii) implementation of an infrastructure management system; iv) implementation of the PEC

19 Data not available for the city of Bogotá, Jamaica, the province of Mendoza and Suriname.

center educational project; v) implementation of an information system and indicators; vi) implementation of a document management platform; and vii) implementation of a business process management (BPM) tool. In the case of technological infrastructure, Panama is giving priority to connecting official schools to Internet and to adapting and restructuring the MEDUCA data center. In Jamaica, the Education Ministry has a strategic vision for SIGED development, linked to its ICTs in Education Strategy, and, therefore, has documents on technical and functional requirements. In Costa Rica, the Vice-Ministry of Planning and the systems area, in particular, recognize the need to move towards an integral project, known as the Ministerial Platform.

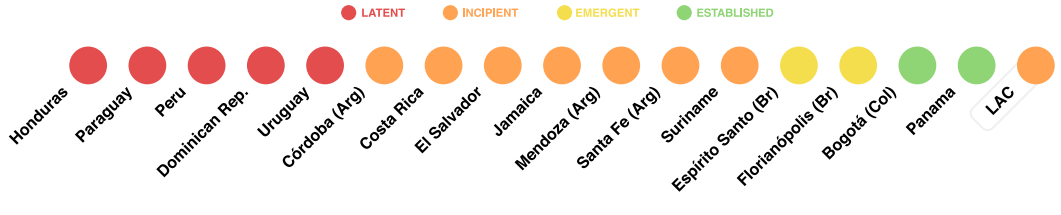
Is there a clear strategic vision for the implementation or development of the education management and information system (unique identifiers, virtualization of processes, modernization of systems, integrated approach, etc.)?



Strategic plan for the SIGED: incipient.

An integral strategic project envisages the optimization of institutional processes based on the support provided by new technologies. When these projects are formalized in documents as a strategic plan, they are validated by the approval and backing of the education system's highest authority. Very few education systems have a strategic plan. The cases with the highest level of development are the city of Bogotá and Panama. At the time of gathering information for this study, the city of Bogotá had a strategic plan approved by the Education Secretariat for the entire management period. In Panama, the National Authority for Government Innovation (AIG) has proposed an agenda that has been approved by the authorities of the Education Ministry.

Does SIGED have a strategic plan approved and backed by the educational system's top authorities?

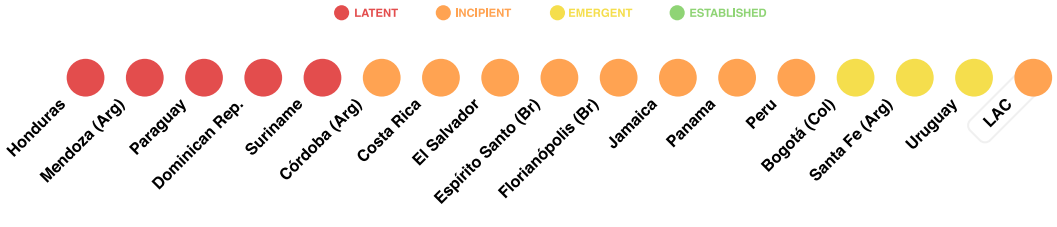


3 HUMAN AND FINANCIAL RESOURCES

Human resources for the SIGED: incipient.

A SIGED requires a stable professional structure in line with demands on it. Education ministries should have a sufficient number of trained and qualified personnel for the development, improvement and maintenance of the SIGED in the short, medium and long term. The number of professionals and roles required will depend basically on the model of development, systems maintenance and technology that each country implements. However, even in cases of extensive outsourcing of services, there should be the professional capabilities required to guarantee full governance of the available systems. Technological support for IT systems has traditionally been provided by the personnel of technology units which, by their nature, tend to have small teams and a high turnover. They often have only a few permanent employees and rely on external experts for support, depending on the availability of funds. Given the existence of obsolete IT systems, with scant technical documentation, the high turnover of technology personnel results in the loss of information about technical aspects of the systems. The city of Bogotá, the province of Santa Fe and Uruguay have the highest level of development in terms of the availability of human resources for the SIGED. In Bogotá, its human resources are determined by the strategic plan. The permanent staff is small, but numerous tasks are outsourced. In some aspects, the SIGED's work needs to be reoriented and the necessary new human resources calculated. In the province of Santa Fe, some 50 people are responsible for IT, but the operational and maintenance workload leaves little time for new initiatives.

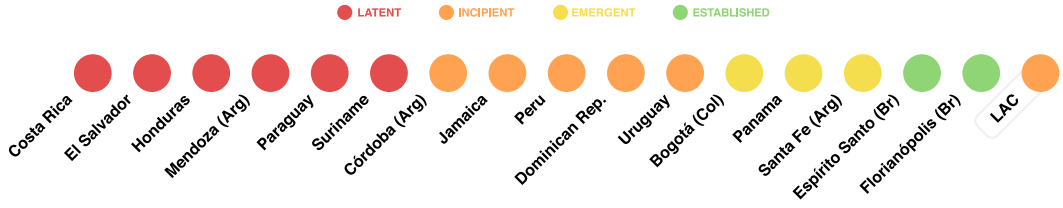
Do you have the necessary human resources to improve SIGED in the short, medium and long term?



Financial resources for the SIGED: incipient.

In the Brazilian cases, sufficient financial resources are available for the maintenance and improvement of the SIGEDs in the short, medium and long term. The state of Espírito Santo and the Florianópolis municipality have a budget for investment in schools' technological infrastructure and the development of IT systems. However, despite the availability of funds, the capacity for development of the systems is limited. In the city of Bogotá, the current needs of the SIGED and the financial resources required would have to be determined, but it does have a budget established under the SIGED strategic plan. In Panama, a number of projects are being implemented with external financing, but the availability of domestic financial resources to operate and improve the SIGED is a challenge.

Do you have the necessary financial resources to improve SIGED in the short, medium and long term?



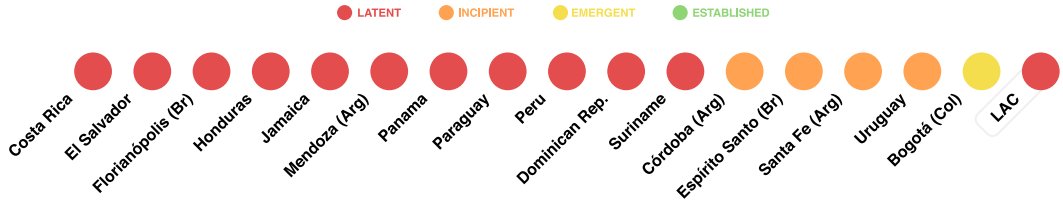
4 CHANGE MANAGEMENT

Change management plan: latent.

A SIGED digital transformation project requires transformations at all management levels. They may range from basic aspects, such as the transition from paper to computers or mobile devices, to more complex matters, such as re-engineering, but will affect all the SIGED's users. A change management plan that takes into account their needs during the digital transformation process is, therefore, key (see Box 3.3). Training is central to a change management plan and should include not only initial aspects (such as office applications) but also, importantly, aspects requiring continuity that have arisen as a result of changes in demand, performance evaluations and feedback from the SIGED itself. In this continuous process of adaptation to change, awareness-raising among decentralized management personnel (schools, departments, regions) also plays an important role in creating an environment of trust and empowerment that favors the detection of local needs, which should be taken into account and integrated into the SIGED.

In certain cases, some type of legal framework or strategic vision exists and resources may even be available but, in general, the absence of a change management plan is a feature of the region. Only the city of Bogotá has a plan of this nature and it still lacks an official norm. The province of Córdoba has a small change management team that covers some SIGED processes. Some countries have opted to establish units responsible for leading the digital transformation of their education systems. For example, El Salvador has a Digital Transformation Unit and Uruguay has Plan Ceibal as an agency for educational innovation and digital transformation.

Do you have a change management plan for SIGED?



BOX 3.3

How to promote adoption of existing technologies?
The importance of change management

In Panama, school syllabuses and the structure of positions have historically been managed on paper and, although the Education Ministry has incorporated a module into the school management system that can be accessed by 90% of schools, it was used by only four of the 2,800 schools in 2018. This failure may have been due to a lack of efforts to increase awareness of the new initiative, educational actors' ingrained habit of using paper or a lack of training in use of the new module. In any transition, there is a learning process and this takes time, but these initial results are not positive.

Although the gap in access to devices and connectivity is the main barrier to the digital transformation of education systems, it is not the only one. As progress is achieved in narrowing the digital divide, the question arises of how to ensure that technology is adopted and incorporated into schools' daily management. The different actors in the region's education systems, such as teachers, school directors or administrative personnel at the central level, are accustomed to carrying out many processes on paper or manually. Although the time and effort they involve mean they are not the most efficient management models, they do enable the actors to meet their immediate needs. In the short term, the incentives for incorporating new technologies into everyday processes may not be apparent and change management is essential. Information must be provided about the benefits of new technologies and personnel must be trained in their use and gradually start to incorporate them. Change management is not cheap, but it is much cheaper than installing IT systems or technological infrastructure and is as or more important than these two other aspects that are normally envisaged in all digitization programs.

Source: Compiled by authors based on Ithurralde (2019b).

3.2 KEY MANAGEMENT PROCESSES

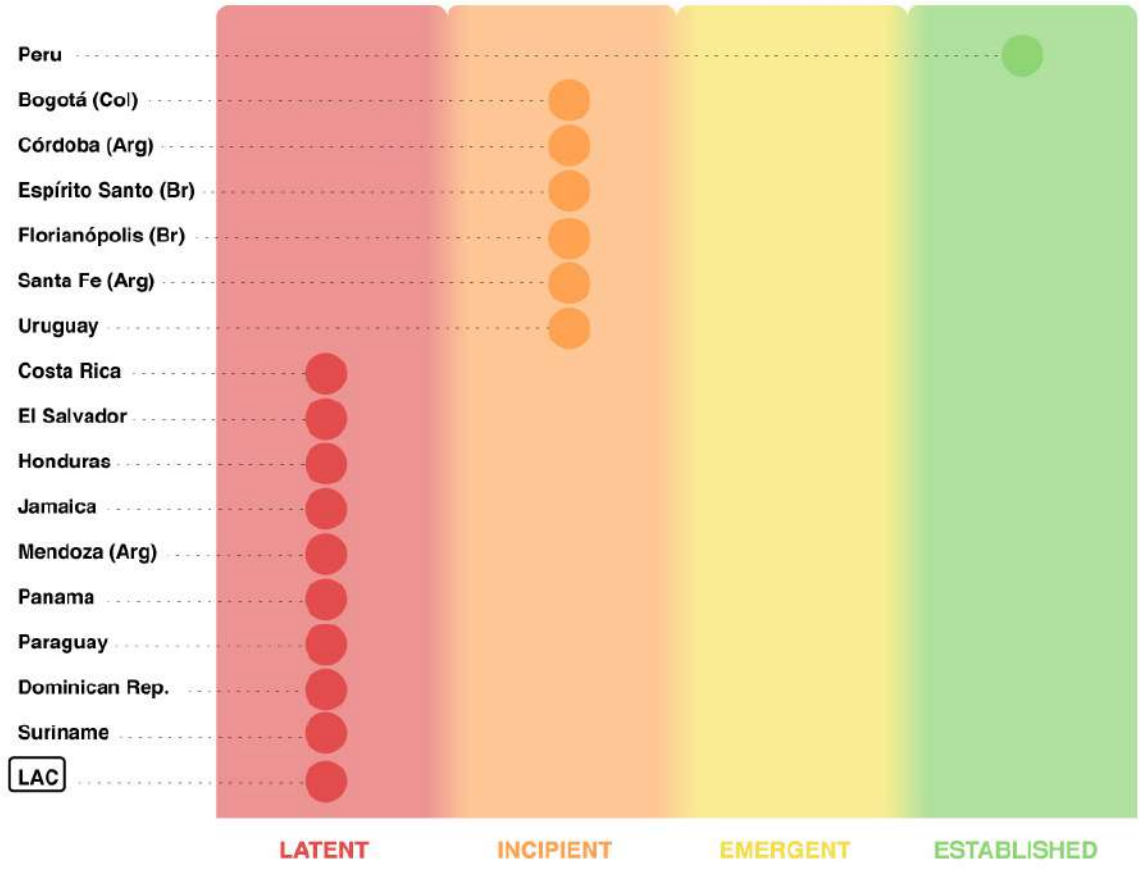
PROCESS 1:

Physical infrastructure and equipment: Latent

According to the results of this study, management of physical infrastructure and equipment has a latent level of development (level 1 out of 4) and most of the cases analyzed are at this or the incipient level of development (Figure 3.3).

FIGURE 3.3

Level of development of SIGEDs: management of physical infrastructure and equipment



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

In Peru's education system, management of physical infrastructure and equipment has reached the established level of development, positioning it as the most advanced in this field. Although Peru does not have a transactional system, it has implemented a model that provides it with data that is updated annually. Under its model, information from the Educational Infrastructure Census (CIE), carried out in 2013, is updated each year using information from the annual Education Census, which must be completed by all the country's schools. This register includes information about the utilities available in the school, occupation, furniture and equipment, state of conservation and geo-referencing.

Broadly speaking, the region's education systems manage infrastructure and equipment using isolated databases and IT systems, most of which are the result of specific initiatives, such as infrastructure censuses, which quickly become out-of-date. Rather than transversal arrangements, there are multiple parallel arrangements, developed by each of the internal areas of the ministries responsible for school infrastructure. In fact, no case was found of an efficient infrastructure management system, used for the daily handling of the sector's needs and able to monitor the characteristics and state of conservation of buildings individually and process requests related to emergencies and maintenance.

The physical infrastructure and equipment process involves all the physical spaces, facilities, furniture and buildings that make up a school. In this sense, school architecture must respond to pedagogical requirements, rationalizing and optimizing the use of the available resources. The planning, construction, maintenance and management of the buildings where schools operate is, in general, the responsibility of infrastructure departments while the public works ministry intervenes, to a greater or lesser extent, mostly in the construction of new buildings. If school infrastructure is to be managed efficiently, it is very important to have unique identifiers and geo-referencing for each of the buildings, a categorization of the types of environments and the dimensions of the structure of the buildings, information about the services available and an inventory of all the movable and immovable property. Geo-referencing makes it easier to take full advantage of the available physical spaces.

Based on a unique identifier for each school building, the information system should operate as a unique register of buildings in which all the elements necessary for their management are recorded and inter-related. The system should also have functionalities for carrying out transactions, such as requesting the replacement of equipment, and then record the answer received so that, if the equipment is replaced, there is updated information about its state of use. The system can also be used as a vehicle for reporting and following up infrastructure emergencies in schools. This can, in addition, serve as a procedure for the permanent update of information and the state of school infrastructure and equipment, facilitating the planning of expansions or rearrangements of the infrastructure and the creation of preventive maintenance mechanisms.

BOX 3.4

Physical infrastructure and equipment: the cases of Andalusia (Spain) and England

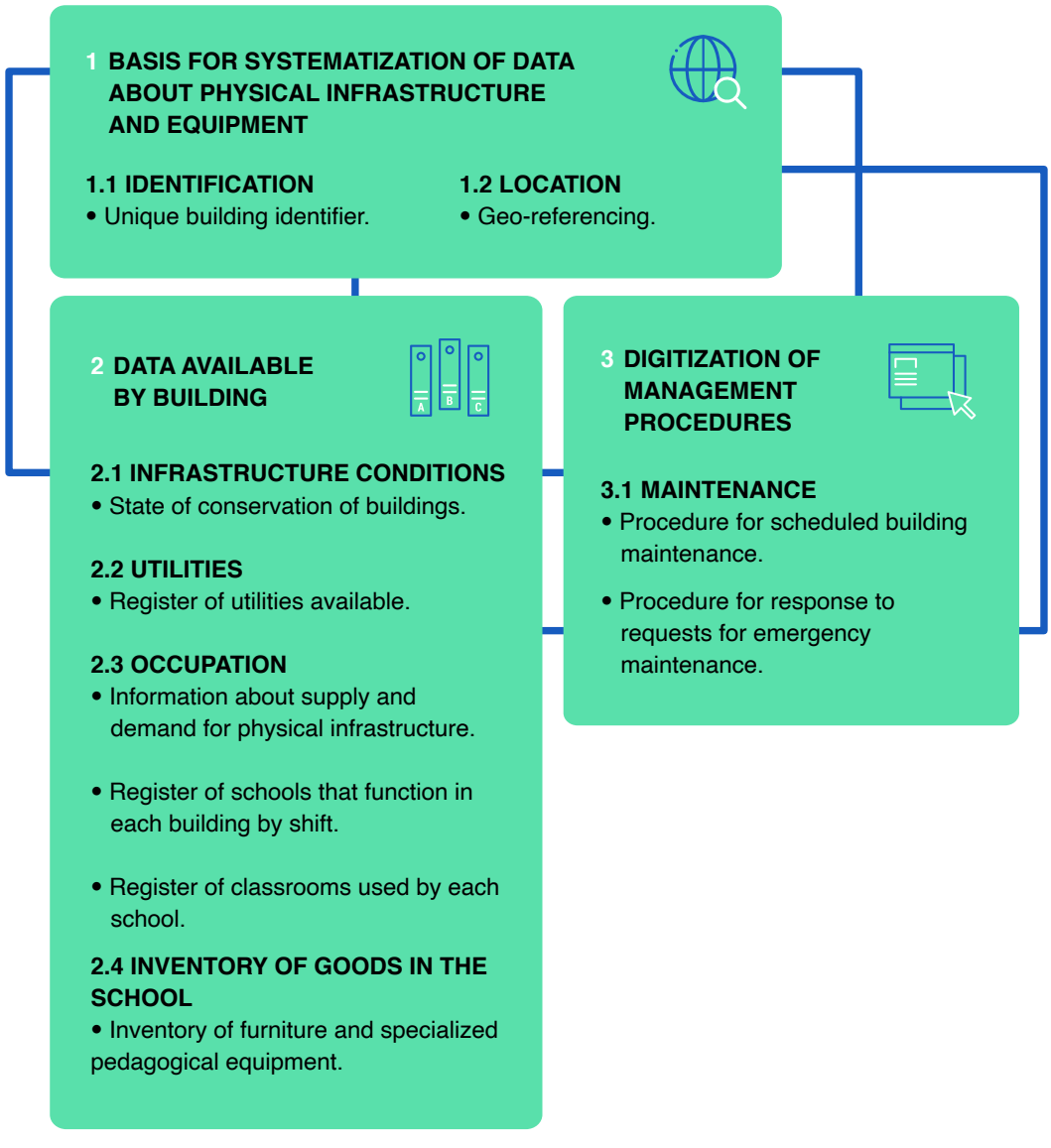
Internationally, Andalusia (Spain) serves as an example of good practices. Its Séneca school management platform has a specific module with updated information about infrastructure, including buildings, laboratories and resources related to information and communications technologies (ICT). The system consolidates school-level data with the national register of schools.

In England, physical infrastructure and equipment are managed using SIMS SIGED. This process is based on a main module, which can be complemented with additional modules for the management of the school's resources, such as equipment, classrooms and other infrastructure. There is a system of permissions that, in some cases, requires central authorization and, for the booking of equipment, classrooms and other resources, there is a calendar, which shows the resources available by date. The system also includes the management of resources that temporarily become available (classrooms that are free because the class is traveling or taking exams) and notifies users if they try to book rooms that are closed for repairs of other similar work.

Source: Compiled by authors based on Smith (2019a; 2019d).

For analysis of the management of physical infrastructure and equipment, functionalities are divided into three broad categories: i) basis for systematization; ii) data available by building; and iii) digitization of management procedures. The results for each category are presented below and a brief description of each functionality is provided, along with a graph with a score, corresponding to the median of the 16 education systems studied that reflects the level of development, and a review of good practices and the experiences of the cases with the highest levels of development.

INFOGRAPHIC 3.3
Summary of the functionalities of the physical infrastructure and equipment process



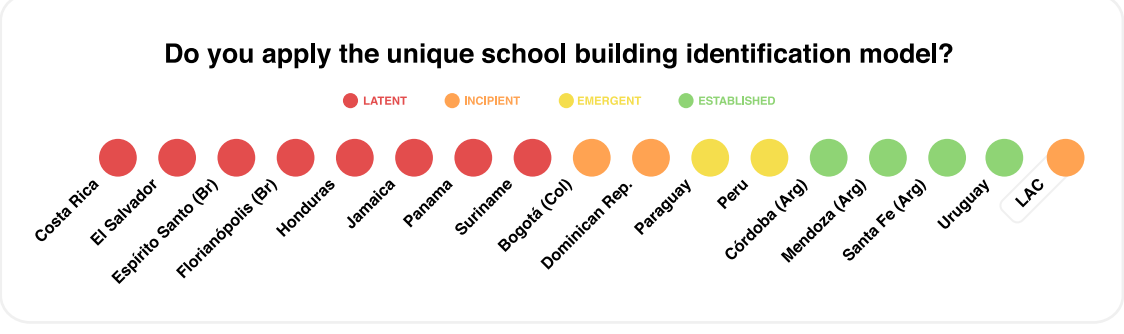
1 BASIS FOR SYSTEMATIZATION OF DATA ABOUT PHYSICAL INFRASTRUCTURE AND EQUIPMENT

1.1. IDENTIFICATION

Unique building identifier: incipient.

The identification of school buildings is particularly important because a building may house more than one school or a school may operate in more than one building. This is a key variable when assigning students and teachers to schools. The cases that have achieved the greatest

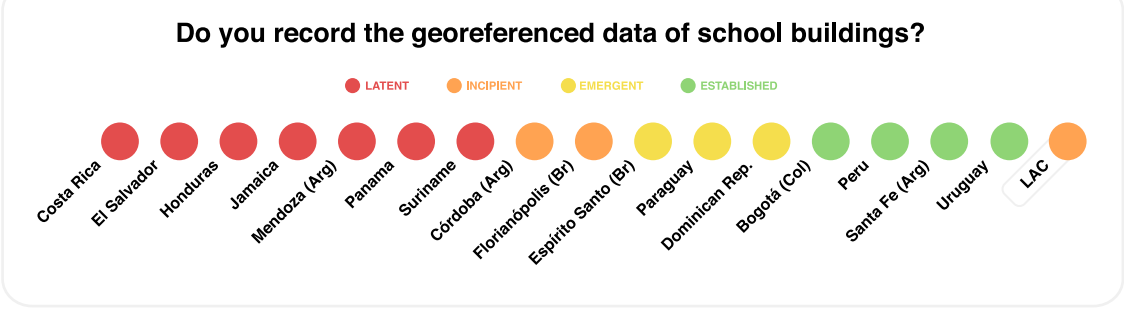
development in this field among the education systems studied are the provinces of Córdoba, Mendoza and Santa Fe and Uruguay. The three Argentine provinces use a unique building identifier and, at the national level, each school building has a Unique Infrastructure Code (CUI). In Uruguay, the unique identifier of school buildings is known as the RULE code, which is a 15-position numeric field comprising the following concatenated information: i) owner of the establishment; ii) department in which it is located; iii) number of the establishment; iv) type of administration; v) type of function; vi) Education Council that uses the building and is responsible for its use; vii) department where the institute/office is located; and viii) identification number of the institute/office.



1.2. LOCATION

Geo-referencing: incipient.

Although the concept of school is related to the organization of the provision of the educational service, a school building has specific cadastral geo-referenced coordinates that facilitate the planning of the supply of educational services as regards both the construction or closure of buildings and the optimal allocation of teachers and students to schools. In addition, geo-referencing serves to analyze equity in education and access to it (see Box 3.5). The cases analyzed with the highest level of development in this field are the city of Bogotá, Peru, the province of Santa Fe and Uruguay. Using geo-referencing, Uruguay opted to create GURÍ Maps on which it is possible to search for schools, locate them in the territory and obtain some basic data about the services offered. Although geo-referencing in Uruguay is at the school level, not the level of buildings, the school/building association can be made by crossing with information from RULE.



BOX 3.5

What are the advantages of geo-referencing?

Geo-referencing provides information about the distance to health centers, the police, fire services and nearby educational establishments, which can serve as an input for educational planning. With the location, it is also possible to determine the population density of the school's catchment area and relate it to the inhabitants' socioeconomic conditions. Information can also be obtained about the types of access to the building (paved, sand, gravel or dirt roads). Another important use of geo-referencing is to obtain information about public transport services in the area of the school, which can be particularly useful when planning school transport. Information about security incidents, provided they are geo-referenced, serves to classify buildings in terms of the level of conflict and define preventive actions. In addition, geo-referencing can be used to build more dynamic systems for assigning students and teachers by, for example, enabling parents and teachers to know how far a school is from their home before choosing it.

2 DATA AVAILABLE BY BUILDING

2.1. INFRASTRUCTURE CONDITIONS

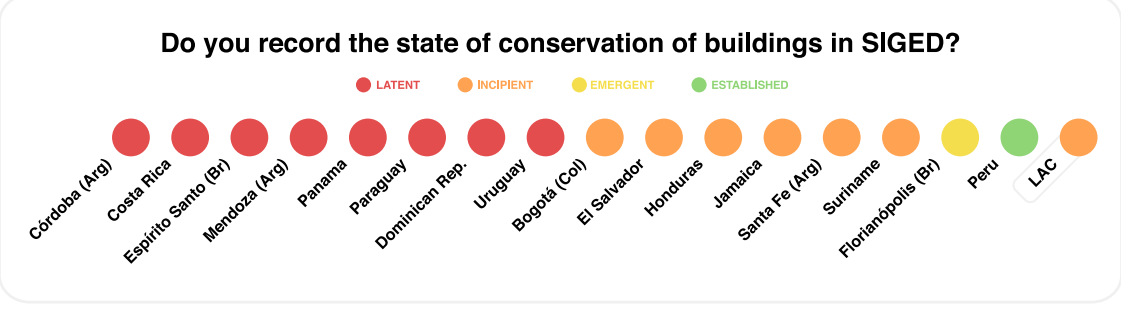
Register of state of conservation of buildings: incipient.

To determine the state of conservation of buildings, it is important to have a standardized technical categorization defined by professionals (numerical or of the bad-average-good type) to enable specialized personnel to identify the state of each building. The areas responsible for this procedure should create mechanisms for the constant update of this information to use as a guide when planning future interventions.

With regards to recording information about the condition or state of conservation of buildings, Peru's education system is the most developed. It has a National Infrastructure Plan and has determined that, in 40% of schools, the infrastructure needs to be completely replaced.[20] It is

20 It is estimated that a minimum investment of S/68,000 million (approximately US$20,000 million) is required.

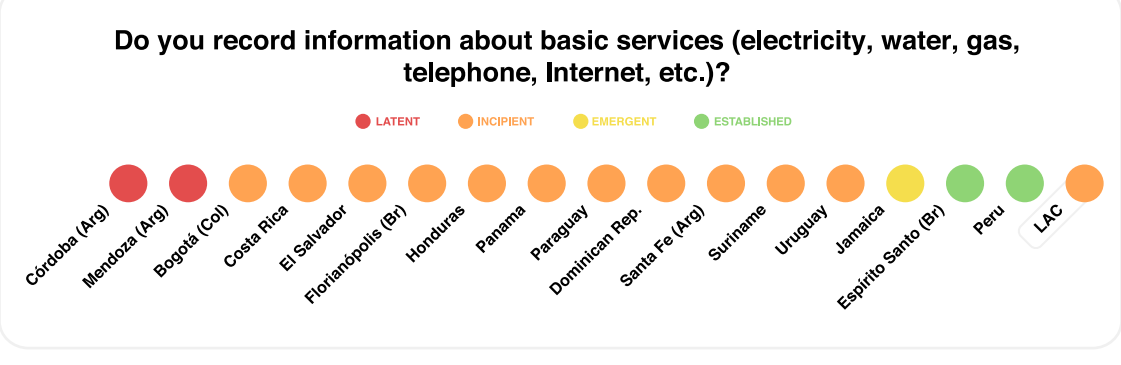
important to note that this information has been collected only recently. Before 2017, no planning related to the state of conservation of school buildings was undertaken. In the Florianópolis municipality, the Municipal Works Secretariat (SMO) system is used to measure the execution of work and is in the process of incorporating indicators of the state of conservation of schools and their verification.



2.2. UTILITIES

Register of utilities available: incipient.

The utilities available in each school, such as water, electricity, telephone and Internet, should be registered as part of the information about each individual school building. Depending on the type of school and the type of access route, the availability of gas can also be recorded. Education ministries must guarantee and monitor the provision of these services, either directly or indirectly. The education systems of the state of Espírito Santo and Peru are the most advanced in this field. In Espírito Santo, Educacenso, the computerized data collection system of the School Census, includes information about utilities such as water, electricity and telephone. Peru's Education Census also collects this information: each year, school directors must complete the census form, including the utilities available at the school. This information can be accessed through the Educational Quality Statistics system (ESCALE). In Jamaica, coverage of the private sector is low, but access to utilities is also recorded by the annual Education Census.

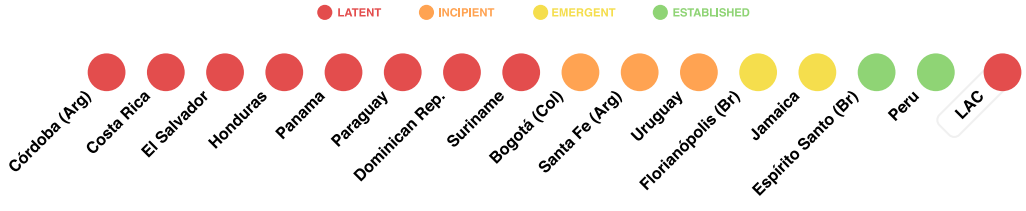


2.3. OCCUPATION

Information about supply and demand for physical infrastructure: latent.[21]

An education policy generally determines a maximum number of students per physical space in order to avoid overcrowding and guarantee students the minimum space required for their learning process. Demand for educational services is determined by enrollment and/or the school-age population while supply is defined by the space available (distribution of spaces within the building, including the size of classrooms). The education systems of the state of Espírito Santo and Peru are the most developed in terms of the availability of information for measuring the match between supply and demand. In Espírito Santo, this is evaluated in the State School Management System (SEGES) as regards both infrastructure and educational services. For this purpose, Peru uses its Educational Quality Statistics system (ESCALE), which is updated annually based on the Education Census that each school director must answer.

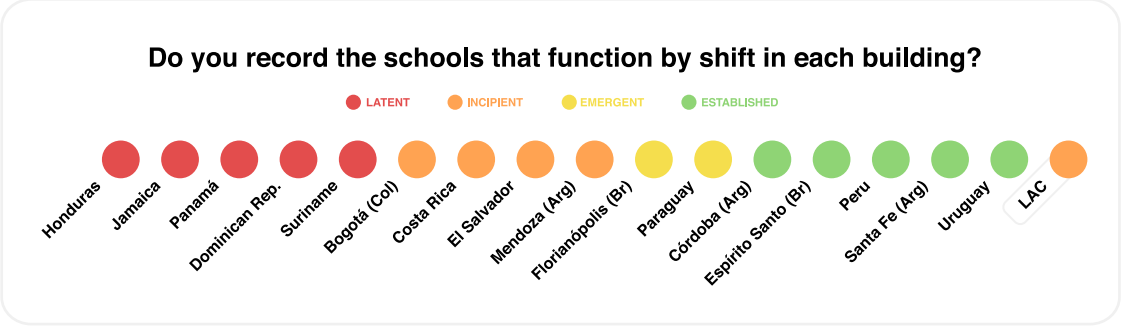
Does SIGED have the necessary and timely information to assess the match between supply of physical infrastructure and demand for educational services?



Register of schools that function in each building by shift: incipient.

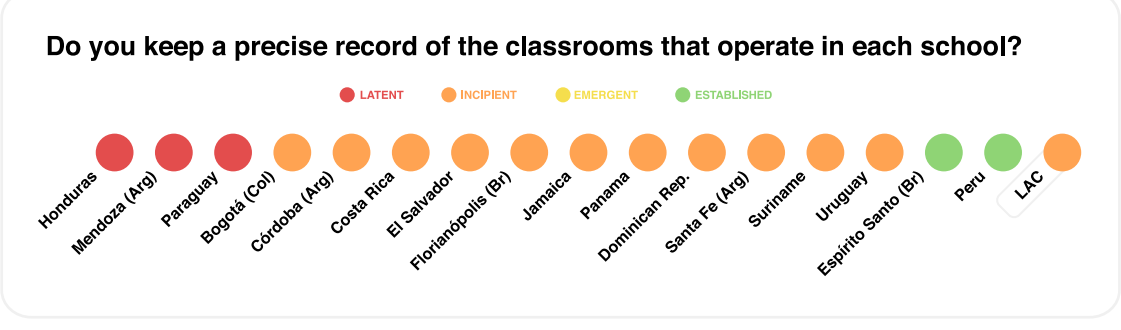
The school infrastructure module should be linked to information about schools through an association between the unique school building identifier and the unique school identifier (for more details, see Process 2: Management of schools). In this way, the schools that operate by shift in each building can be identified. The province of Córdoba, the state of Espírito Santo, Peru, the province of Santa Fe and Uruguay have the highest level of development in this field. Both the province of Córdoba and the province of Santa Fe have a register of the relationship between the Unique School Code (CUE) and the Unique Infrastructure Code (CUI), as well as of the shifts for using the building. In Uruguay, this information is systematized in GURÍ: the link between school and shift is direct while association with the building involves cross-referencing with the RULE code.

21 Data not available for the province of Mendoza.



Register of classrooms used by each school: incipient.

Each of the spaces in school buildings should be uniquely identified, indicating their dimensions and the type of space in question (classroom, office, bathroom, etc.). This information can then be associated to data about the sections or groups of students that occupy these spaces (and their students) in order to obtain information about occupation of the buildings in each shift. The education systems of the state of Espírito Santo and Peru are the most developed in terms of registering the classrooms used by each school. For this purpose, Peru uses its Education Census.

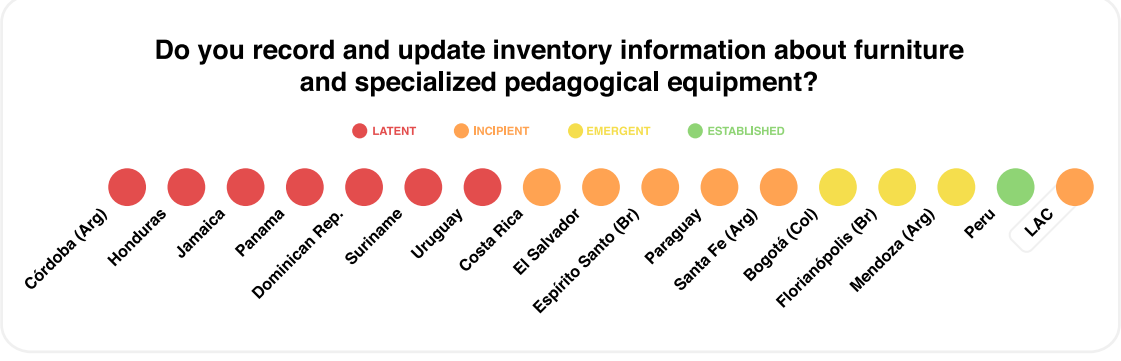


2.4. INVENTORY OF GOODS IN THE SCHOOL

Inventory of furniture and specialized pedagogical equipment: incipient.

An optimized procedure and a support module are required for a school's inventory so that all the goods of each school building (furniture, equipment and laboratories) are correctly recorded and this information is available for consultation. To update this data, an established procedure should be used that allows for the integration of data from the central areas of the ministry, departmental offices, districts and schools. An updated digital inventory is essential for the efficient allocation of state resources in national or territorial programs for the provision of equipment. Peru's education system is the most advanced in this field. Through the Education Census, it captures information about movable property (such as benches, chairs, blackboards and canteen equipment) and specialized pedagogical equipment (such as physics, chemistry, biology and computer laboratories). The city of Bogotá records the incorporation of goods (purchases, donations, local development plans) and their decommissioning. Inventory information is recorded at the school level, not the building level. Similarly, the province of Mendoza has a school-level register that

consists of a general inventory of furniture and equipment for each school registered in the SIDICO system. The information is uploaded by the Inventory Sub-Directorate, which forms part of the General Directorate of Administration at the central level.

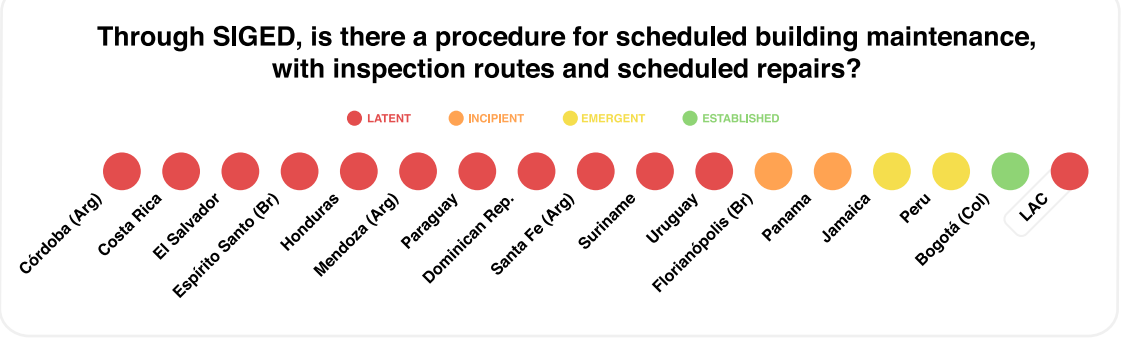


3. DIGITIZATION OF PROCEDURES FOR MANAGING EDUCATIONAL INFRASTRUCTURE

3.1 MAINTENANCE

Procedure for scheduled building maintenance: latent.

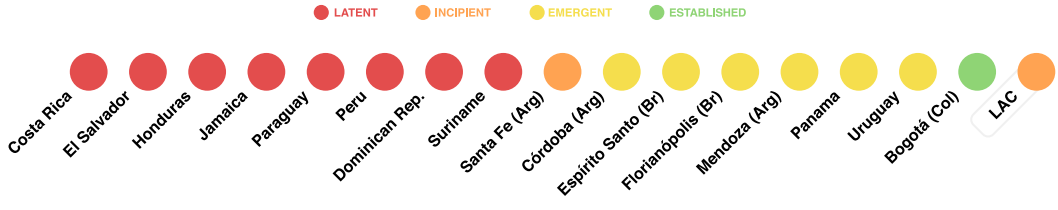
The infrastructure management system should have a module for monitoring scheduled maintenance of school buildings, including a minimum description of the scope of the project, the company hired to implement it, the implementation period, guarantees, the amount invested and the type of intervention. This module should be updated by the agencies responsible for infrastructure in order to have complete records of all interventions and be able to access online information about progress of the work. The education system with the highest level of development in this field is that of the city of Bogotá. It has norms defining the maintenance that schools must carry out each year in the first and second semesters. In Peru, the funds distributed annually to all school directors through the Wasichay System are monitored digitally. However, digital monitoring of the stages of implementation of these budgets is not possible. In Jamaica, regional officials visit schools, generally every five years, to assess maintenance needs. There is a procedure for schools to submit maintenance requests, albeit using physical forms rather than digitally. However, these procedures are not registered in the SIGED.



Procedure for response to requests for emergency maintenance: incipient.

The infrastructure management system should establish a procedure for managing requests for emergency maintenance of buildings. This should be similar to the one for scheduled maintenance. This enables schools to obtain the necessary repairs in a timely manner in the case of unexpected events that compromise the infrastructure and its safe use. The education system of the city of Bogotá is the most developed in this field since it has a database of repairs typified by category, in which there is also a list of pre-selected companies that can be called on for each type of repairs. These companies are selected through a tender at the beginning of the school year and are hired to attend any emergency (they must go to the school within 24 hours of the incident). In addition, school buildings in the city of Bogotá are insured. In an emergency, the principal calls the local director, who then contacts the headquarters and verifies the information.

Through SIGED, do you implement a procedure for managing demand for urgent building maintenance?



The state of Espírito Santo's emergency maintenance procedure does not use the SEGES. Instead, it has a control process in Excel, known as the Integrated Maintenance System (SIM), that comprises three steps: i) the school reports the problem to the Education Secretariat by email; ii) a designated engineer contacts the school by telephone to classify the problem in a risk matrix; iii) the coordinator establishes the routes for the technician to visit the school. To manage these requests, the Education Secretariat has a maintenance contract. Minor repairs are carried out through a service order under this contract while, for larger-scale work, a tender is issued. Uruguay has an established procedure that operates through a telephone service (0800) and receives requests from the different actors (resident architects, councils, decentralized commissions by department). Incidents are registered in the Infrastructure section of the National Public Education Administration (ANEP) system where it is possible to view the status of requests (attended or not) and alerts are issued in the case of a prolonged delay.

Transversal aspects of the management of physical infrastructure and equipment

• Lack of provision of information in real time:

In general, the 16 education systems analyzed have achieved little development in terms of using the data contained in the unique register of buildings to provide accurate information in real time. This should be available with viewing rights and privileges for the different actors in the education system (director, supervisor, level director, administrative areas, central and decentralized political authorities). In the case of Peru, the information available about infrastructure can be accessed through the Statistical Information Management System (SIGIED), ESCALE and the Integrated Information System (SIDI). In ESCALE, the data can be disaggregated to the level of Regional Directorate of Education (DRE) and Local Education Management Unit (UGEL). Most of the information is collected through the country's annual Education Census.

• Low level of articulation with other SIGED processes:

In most of the education systems analyzed, there is little articulation of this process with the rest of the SIGED. The lack of a unique building identifier prevents articulation with the other SIGED processes. Similarly, the use of a support application with outdated information and that is not integrated with the student and human resources system impedes immediate response to requests for basic information, such as a school building's occupancy rate by shift or the interventions in the building carried out during a certain period, and the relationship of this information with the academic performance of the students who use the building.

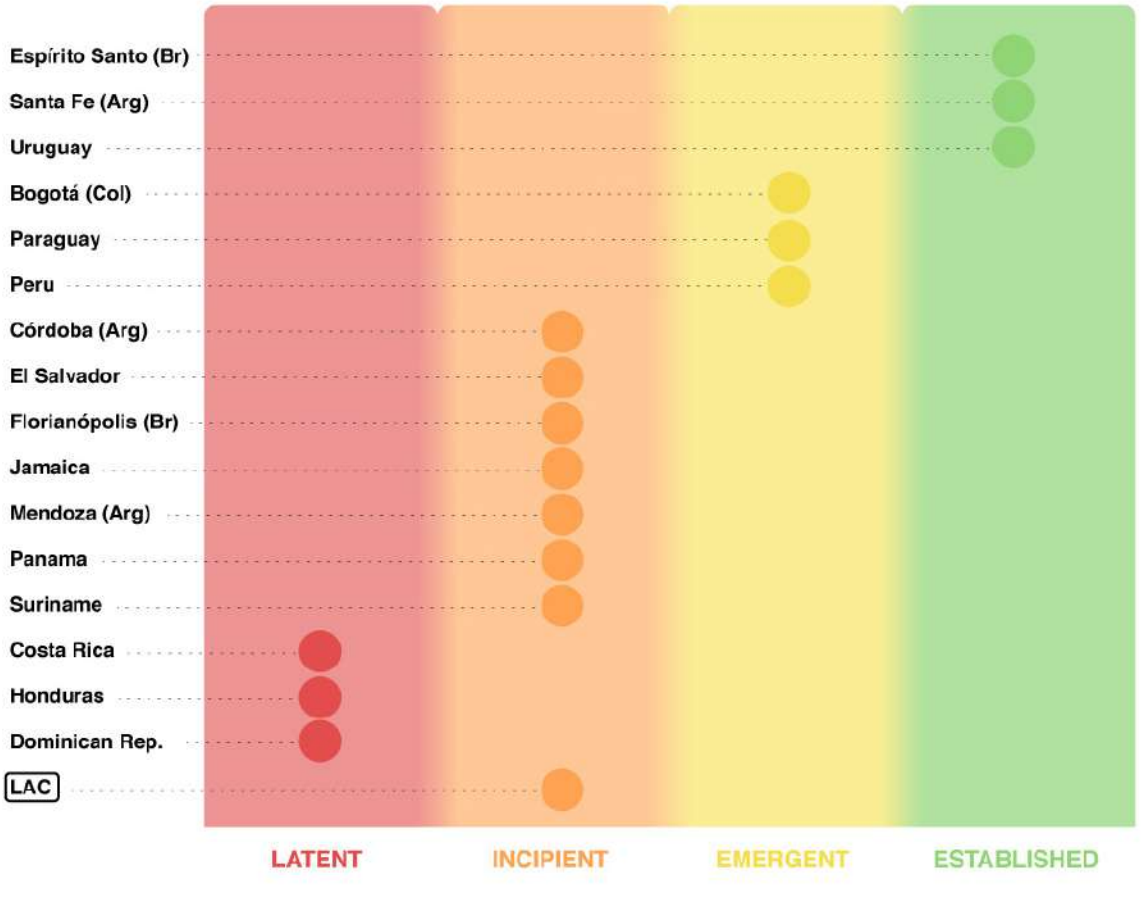
PROCESS 2:

Management of schools: Incipient

According to the results of this regional study, school management is at an incipient level of development (level 2 out of 4), with most of the cases analyzed corresponding to this level of development (Figure 3.4). The state of Espírito Santo, the province of Santa Fe and Uruguay, which have reached an established level of school management, are the most advanced in this field.

FIGURE 3.4

Level of development of SIGEDs: school management



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

In the state of Espírito Santo, schools are managed mainly through the SEGES system, in which all procedures have a digital data "input" and "output". The most frequent procedures, such as student attendance, grades and enrollment, are carried out through the SEGES. The education sector systems are integrated with the main national systems and a unique code for schools and

classes/school shifts is used for all information traffic. Systems for managing school meals and transport interoperate with the SEGES, permitting full and timely access to this information and its management. The SEGES enables online student registration and enrollment and has a student grouping module.

In Uruguay, the GURÍ system is designed for the integral management of schools, human resources, students and learning. All early and primary education management and information systems use a unique school identifier. GURÍ has systematized the places available at schools, the structures of positions and the criteria for assigning students by school.

Broadly speaking, the management of education systems has taken a top-down approach, giving priority to the information needs of the central level. So far, schools have, therefore, acted primarily as providers of information for management and planning at the central level. This implies that, with a few exceptions, management systems have not been designed to meet the needs of schools, which have had to develop their own management tools, mostly on paper or using Excel spreadsheets. The coexistence of individual records at the school level and a reporting system for the central level has meant a heavy workload for schools' directors, teachers and administrative staff who, in addition to their usual tasks of provision of educational services, have to devote time to recording the same information several times, both in their records and in the reports they must provide for the central level.

The school management process covers all that the operation of the school organization at the territorial level requires for the development of the teaching and learning process. School directors are responsible for the efficient management of the resources available to them and for guaranteeing the effective provision of educational services. This includes managing syllabuses, curricular structures, and administrative and teaching positions. Using a single repository of data, they must plan timetables and the allocation of students and teachers to the different sections. In addition, they must implement policies for grouping students in shifts in line with norms on minimum classroom space per student. Schools must also keep a digital register of the educational material they receive from the central and regional levels and update this dynamically. The systematization of transfers to schools and funds for emergencies facilitates the rendering of accounts whilst permitting the definition of cost centers, regardless of the systems' level of decentralization.

In an ideal scenario, the school should be the nucleus of any management system. An established SIGED must serve as a tool for schools to perform their daily activities, functioning as a transactional system. In this way, the director can use it to assign teachers and students to each section and record student and teacher absences. In turn, these transactions are recorded as data, which can be accessed by the different levels of education management, with restrictions according to their role in the system, and they are able to view the data with the necessary level of disaggregation. In this situation, data is input only once at the time the transaction occurs.

BOX 3.6

School management: the cases of Estonia and England

In Estonia, the eKool system manages all the information related to the operation of a school (school agenda, enrollment and allocation of students to school) as well as the transfer of state repository data. In interface with eKool, the UNITIS platform manages the school calendar and timetable. The interoperability of eKool with other state systems is key since this data is used as an input for online registration processes. The experience of the Tallinn local authority schools, where eKool uses data from the census and register of households for registration in first-year primary education, is noteworthy. Based on this data, children of the age to start primary school are identified and parents are contacted by email to confirm enrollment and enquire about their preferences as regards the school. Subsequently, the data sent by parents is updated in eKool, the children are assigned to a school and the parents are notified of the result.

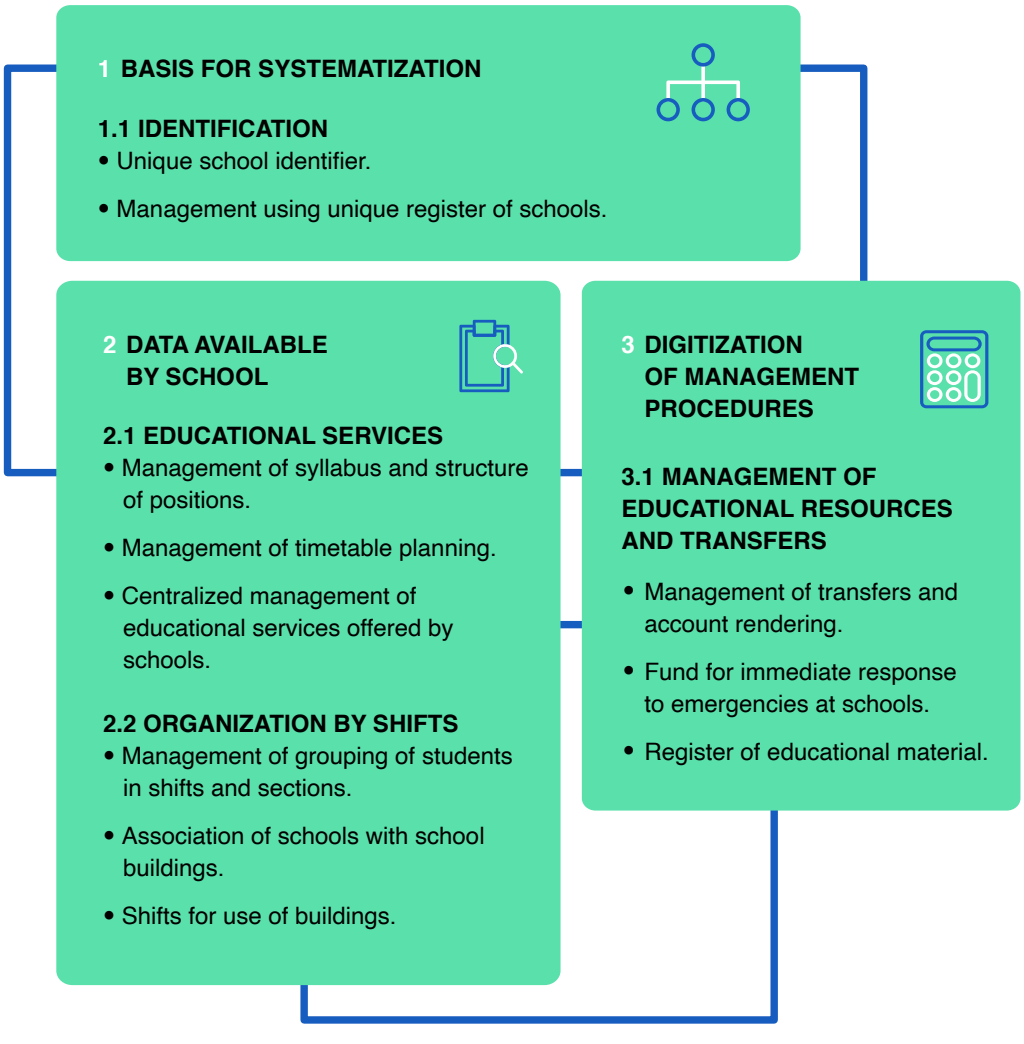
In England, schools are managed using the SIMS Core Suite, which has different complementary modules, according to the needs of each school or group of schools. SIMS Registration & Admissions allows schools to import data, requests and enrollments directly from the school's website, easily capturing the data and streamlining the enrollment process. SIMS also includes tools for analyzing enrollment data that, in turn, is used to generate data about budgets and, in the case of subsidized or private schools, the income generated by enrollment. Once the enrollment data has been captured, it is also used to complement the student's file and other modules integrated into the solution. The SIMS Curriculum Management Suite, which supports syllabus management, permits the automatic or manual creation of the calendar and syllabus, the grouping of students by school level, age and abilities, if desired, and the automatic calculation of the number of students per class to ensure an optimal size. In addition, it can be used to identify and manage the teaching staff available to cover classes in cases of absences or in any other situation where this is necessary.

Source: Compiled by authors based on Smith (2019a; 2019d).

For the analysis of arrangements related to school management, the functionalities are divided into three broad categories: i) basis for systematization; ii) data available by school; and iii) digitization of management procedures. The study's results for each category are presented below and a brief description of each functionality is provided, along with a graph with a score, corresponding to the median of the 16 education systems analyzed that reflects the level of development, and a review of good practices and the experiences of the cases with the highest levels of development.

INFOGRAPHIC 3.4

Summary of the functionalities of the school management process



1. BASIS FOR SYSTEMATIZATION OF DATA ABOUT SCHOOLS

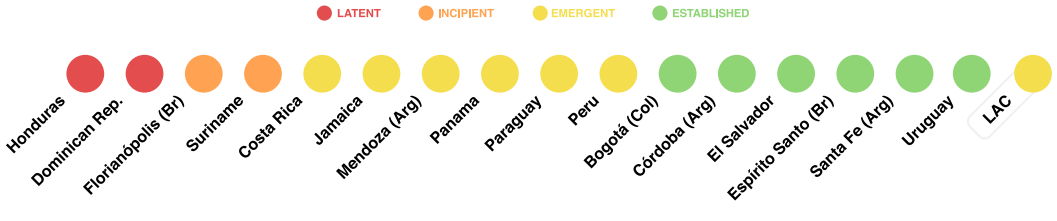
1.1 IDENTIFICATION

Unique school identifier: emergent.

Education systems need to be able to identify each school individually. This is necessary for micro-planning and management of the educational services offered at the different levels of the education system. In this way, teachers can be allocated and students enrolled in each school, establishing different groups of students with their corresponding syllabus. Each school must have its unique identifier and no duplicates must exist. The education systems with the highest level of development in this field are those of the city of Bogotá, El Salvador, the state of Espírito Santo and Uruguay as well as that of the province of Córdoba, where the unique school identifier is used in all management and information systems or, at least, in most of them.

In Jamaica, the Ministry of Education, Young People and Information (MOEYI) assigns a five-digit identifier to primary, secondary and tertiary educational establishments. One of the digits distinguishes between public and private schools. When an establishment closes, the code is blocked to avoid historical duplication. The country's Early Childhood Commission (ECC) is responsible for registering nursery schools and assigning them a unique identifier. This leads to some overlapping of the MOEYI and ECC codes in establishments such as primary schools that have an early education program.

Do you implement a management system that relies on the use of a unique school identification code?



BOX 3.7

The unique school identifier in Peru

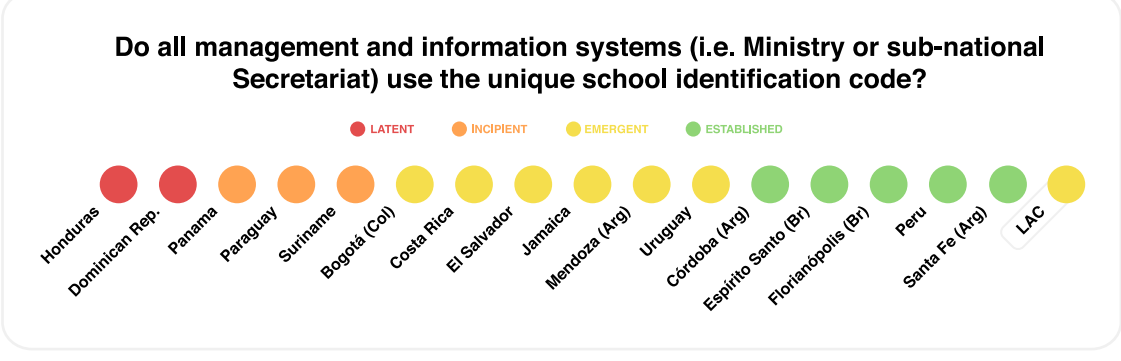
In 2017, Peru's Education Ministry, faced with the need to be able to identify schools unequivocally, created the Register of Educational Institutions (RIE) under resolution RSG-096-2017-MINEDU of the General Secretariat. Historically, Peru has had two types of identifiers at the school level: the local code, which refers to the building, and the modular service code, in which each of the modalities of educational services (early, primary, secondary, etc.) is identified as a different educational service. The same school may, therefore, have up to four or five different modular codes (for example: early, primary, secondary, alternative, technical-productive, etc.). Similarly, the same educational service may operate in more than one school building. This complicates the registration, processing and interpretation of the information and makes it difficult to trace the educational establishment over time. The aim of the RIE is to consolidate the two types of information by integrating the school building code with the corresponding modular educational service code(s) into a single identity, thus facilitating day-to-day management of the process. Since its creation in 2017, the General Directorate of School Management Quality has been leading this process and, as of December 2020, the RIE had been implemented for 62% of educational services.

Source: Compiled by authors based on Marcone (2019).

Management using unique register of schools: emergent.

The unique school register is the repository of all data related to schools. It is common for information about schools to be dispersed across different registers, implying additional consolidation efforts. The duplication of records and the implementation of databases without interoperability undermine the information's usefulness for management purposes. The importance of a unique register of schools lies precisely in that it can be used in a dynamic manner for management and decision-making.

Out of the education systems analyzed, only the Uruguayan system has a unique register of schools. The GURÍ system, which is this country's main tool for school management, contains all the data about schools and the students, teachers and other personnel who have attended or worked at a school since 2013. The Florianópolis municipality uses a national system for managing educational establishments, students and academic procedures, and also has a unified register with the main information about schools. However, this system is not interoperable and is not integrated with other key systems, such as Educacenso (which registers school meals and transport) or the Florianópolis Joaquina Municipal Prefecture System (which manages data related to human resources).



2. DATA AVAILABLE BY SCHOOL

2.1. EDUCATIONAL SERVICES

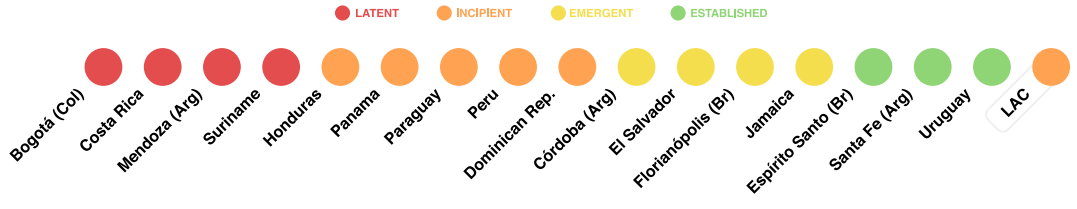
In general, the educational services offered are defined at the central level. The education ministry designs the syllabus for each school year and the different modalities (regular, technical-vocational, special). The syllabuses are then assigned to schools which, in turn, organize the classes by groups or sections and teach the corresponding content. In its analysis of the SIGED, this section focuses on the arrangements for assigning and dynamically managing the offer of educational services.

Management of syllabus and structure of positions: incipient.

It is important to record and manage the schools' offer of educational services in a centralized manner in terms of syllabus and curriculum. Based on how each of the services is assigned

to schools, each school administers the groups/sections in which the students and teachers will be distributed according to a curriculum predefined for the entire education system. The data related to the syllabus and curricular structure that is used in managing schools should come from a unique shared database that is also a source of information for the management of human resources and monthly payment of the payroll. Shared data facilitates the digital use of records. The state of Espírito Santo's education system is one of the most advanced in this field since the SEGES has a specific module for the management of syllabuses and the structure of positions, with complete and updated information.

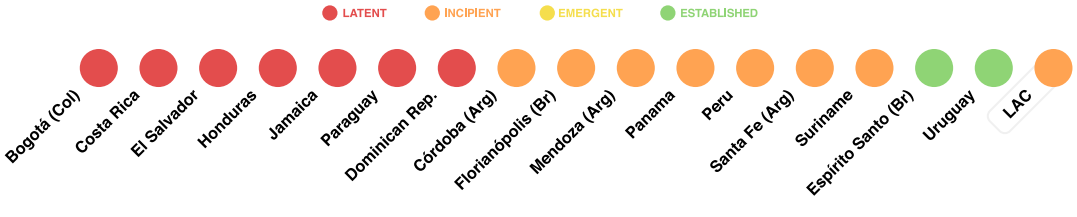
Does the system implement and manage study plans and the structure of teaching positions and reflect their changing dynamics, linking them to the different sections or groups of students?



Management of timetable planning: incipient.

Based on the educational services assigned to each school, the director must plan class timetables and teaching positions, defining teachers and students for each section. The most developed education systems in this field are those of the state of Espírito Santo and Uruguay where, it should be noted, the case study examined only early and primary education in which teachers have only one group of students to which they devote all their hours. In GURÍ, the teacher in charge of each group of students is identified.

Based on the allocation of the educational offer for each school, do you record the scheduling of each subject/teaching position, with the allocation of teachers and students?



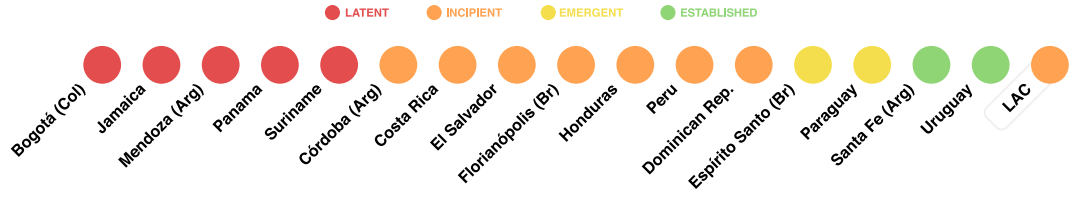
Centralized management of educational services offered by schools: incipient.

The centralized management of the educational services offered by schools means that it is possible to have information about the history of the structure of positions, syllabuses and the services provided over time. The most developed education systems in this field are those of

the province of Santa Fe and Uruguay. Only Uruguay has a centralized system, managed by the Technical Inspection Service, with data from GURÍ. In El Salvador, centralized management began in 2008, but only for secondary education, while, in Peru, it is used only at the primary level through the Information System for Support of the Management of Educational Institutions (SIAGIE) and the NEXUS system of control of teaching positions, which contains the register of hours. Decentralized education management entities can access reports, but not the database.

In the state of Espírito Santo and the Florianópolis municipality, Honduras and Panama, the human resource and school management systems operate in isolation so a history of the offer of educational services associated with positions, syllabuses and the services provided is not available. One of the main obstacles is the use of different codes to identify schools in the human resource and school management systems. In other words, there is not an identifier that unequivocally differentiates each school across the entire education system. In this case, recourse to dictionaries of equivalents or intermediate tables with code mappings is necessary, complicating the maintenance of the different IT solutions and interaction between them.

Do you manage educational offer in schools in a centralized way, systematizing the evolutive history of the structure of teaching positions, study plans and the educational services that are provided and eventually withdrawn?



2.2. ORGANIZATION BY SHIFTS

Schools often operate in more than one shift (morning, afternoon, evening, Saturday) with a regular or extended school day. School directors must group students into different shifts and assign teachers to the different groups. This organization, which is based on norms about minimum space per student, determines the number of places available at each school.

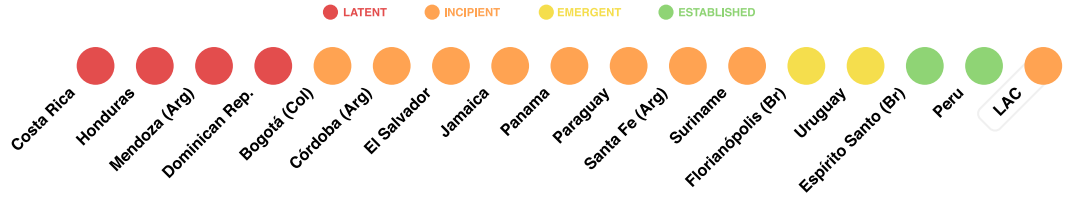
Management of grouping of students in shifts and sections: incipient.

Management of the grouping of students is important in order not to exceed the limits established on the number of students per classroom and guarantee optimal occupation of the space available by avoiding the creation of very small classes. In other words, the parameters for the creation of classes define the distribution of students into different groups. In the state of Espírito Santo and Peru, students are grouped using parameters for the creation of classes and, in both countries, the process is parameterized in their IT systems. Peruvian norms set only a maximum number of students per section. This prevents more than the permitted number of students

per classroom, but not the creation of sections that are too small. The state of Espírito Santo has an online student enrollment process, with a platform through which users request a place in the state public network and select up to three schools, depending on their preferences. The system then establishes the number of places per class according to the capacity of the classroom and the creation of a new group of students is conditioned by the maximum number of students in the groups already established as a result of re-enrollment, internal transfer or a new enrollment. The allocation criteria are geo-referenced. In Uruguay, GURÍ Familia allows 6th year primary students to enroll in advance for lower secondary education as part of a strategy to protect their educational paths. They can indicate their preference for three schools and, in nine out of 10 cases, obtain a place in one of their preferred schools.

In the Dominican Republic, the norms stipulate an upper limit of 45 students per classroom but, in practice, some classes have up to 75 students. Because these norms are not parameterized in a management system, no alerts are generated when they are breached. In other cases, registration systems do not establish a maximum number of students that can be assigned to each school depending on its capacity. This explains why it is common to find crowded classrooms and schools, a situation that can be to the detriment of educational quality. It can also mean that some schools have idle capacity that could be used to relieve pressure on the schools with most students. The importance of this type of systems is that demand can be monitored and the offer of educational services be planned in terms of infrastructure and teacher allocation.

Does SIGED have digitalized information for managing the grouping of students in shifts (morning, evening, weekend, etc.) and sections, the criteria for categorization of schools and regulation about the minimum space required per student per classroom?

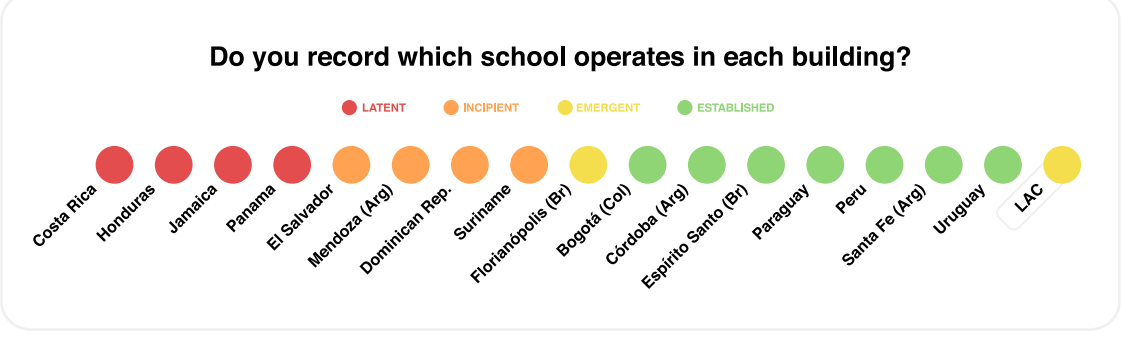


Association of schools with school buildings: emergent.

For planning and management purposes, it is important to differentiate school buildings from schools and establish links between them. A school may function in one or more school buildings or, conversely, one or more schools may function in the same building. Accurate identification about how schools and school buildings are related is possible only when both schools and the buildings have their own unique identifier and there is a register of the schools that function in each building. The most advanced education systems in this field are those of the city of Bogotá, the province of Córdoba, the state of Espírito Santo, Paraguay, Peru, the province of Santa Fe and Uruguay. In these cases, the association between schools and

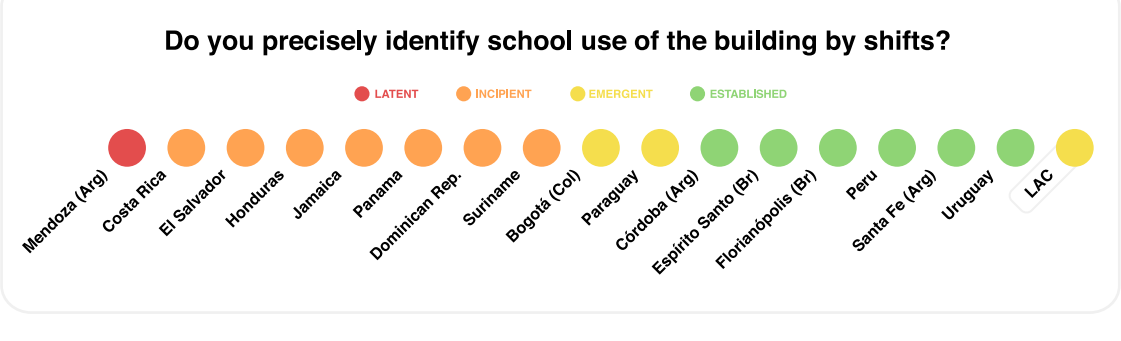
buildings is clearly identified. In the city of Bogotá, for example, this information is contained in the Unique Directory of Educational Establishments.

In some cases, there is more than one register of the association between schools and buildings and these registers may even be inconsistent with each other. In the Dominican Republic, for example, there are two different registers of the schools that function in each building: an Excel file, used by the Infrastructure Office, and the Information System for School Management of the Dominican Republic (SIGERD). None of the registers is updated dynamically. In general, this situation occurs when systems were not designed taking into account all the needs of the managers of the education system, but rather consist of a series of tools and mechanisms that each department or area has established with its own goals in mind.



Shifts for use of buildings: emergent.

Another useful input for planning and management is the register of the shifts in which each school operates in each school building. The education systems of the province of Córdoba, the state of Espírito Santo, the Florianópolis municipality, Peru, the province of Santa Fe and Uruguay keep a record of this information. In some cases, such as the Dominican Republic, no explicit record is kept, but the shifts can be inferred by cross-referencing data. In Jamaica, information about shifts is captured in the annual School Census. However, because this country does not use a unique school building identifier, precise identification of the shifts in which schools use buildings is not possible. The registration of shifts is an example of how different management processes are closely linked - in this case, the management of physical infrastructure and the management of schools - and underscores the importance of their interoperability.



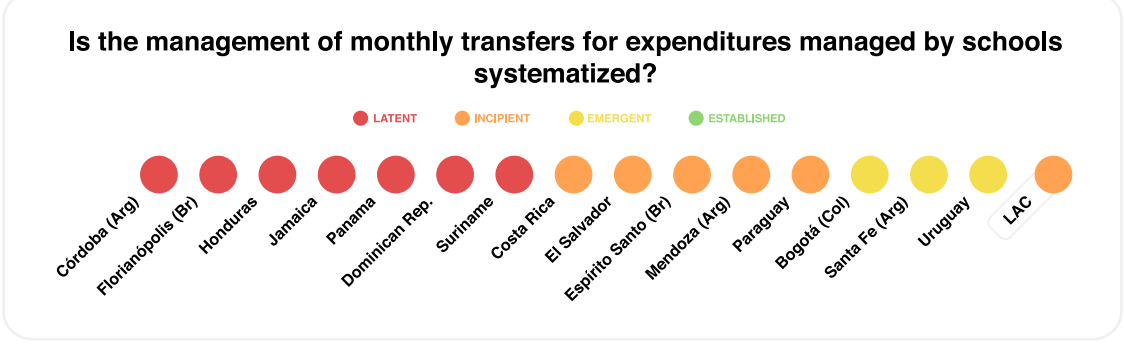
3. DIGITIZATION OF PROCEDURES FOR DAILY SCHOOL MANAGEMENT

3.1. MANAGEMENT OF EDUCATIONAL RESOURCES AND TRANSFERS

The central administration and sub-national management need to monitor spending and the rendering of the corresponding accounts and foster the efficient allocation of educational resources. This calls for standardized digital procedures for managing and accounting for transfers received from central and/or decentralized agencies and the allocation of educational materials to each school. Monetary transfers include both those for current expenses and those associated with funds for emergency assistance.

Management of transfers and account rendering: incipient.[22]

The management of transfers to schools and the rendering of accounts are not systematized in any of the cases analyzed. In the city of Bogotá, which has one of the highest levels of development in this field, transfers are systematized but schools do not have access to any system of online information about transfers and payments for public services. At the time of conducting this study, transfers in Uruguay were organized through an AS/400 system[23] that provides information about how much money a school has received and returned (rendering of accounts) for each item: school meals, didactic material, cleaning and minor repairs. However, it does not provide information about spending other than the item to which it corresponds.



One of the challenges faced by the education systems that were analyzed has to do with the resources schools receive from sources other than the education ministry. Schools commonly receive funding from local governments and families. In some cases, this is small compared to their total spending but, in others, may be significant, depending usually on a school's level of autonomy and sector regulation. The systematization and recording of schools' own income are extremely important for monitoring and the rendering of accounts, particularly in schools that have the autonomy to make large expenditures, such as the hiring of teachers or administrative staff. Although the management of human resources tends to be centralized, the free use of resources by schools and the lack of a management system that facilitates monitoring at the central level leave room for the hiring of personnel outside official procedures.

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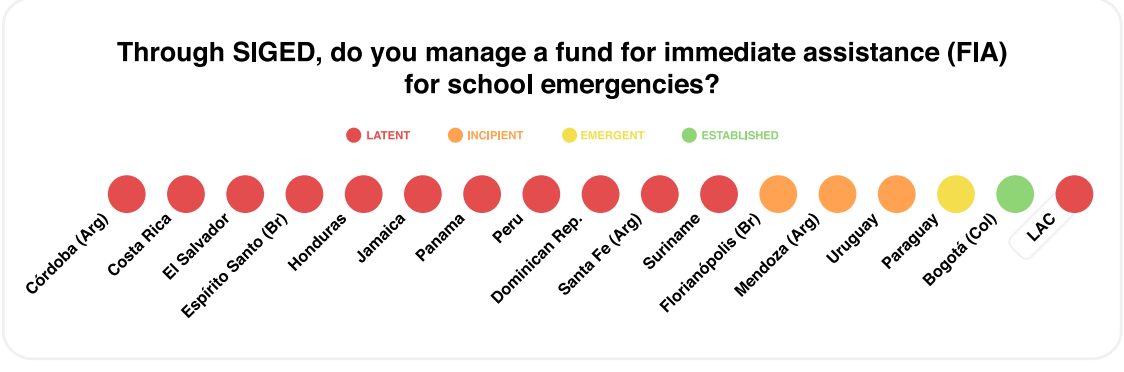
22 Data not available for Peru.

23 Rather than a system per se, it is a set of libraries in AS/400. In 2019, the Council for Early and Primary Education (CEIP), now the General Directorate of Early and Primary Education, began to use the Odoo system for government resource planning (GRP).

Fund for immediate response to emergencies at schools: latent.

The transfer of assistance for emergencies is used in the case of extraordinary demands that cannot be met through regular procedures. One example would be the repair of pedagogical equipment damaged by a storm. These exceptional expenditures may exceed the resources available in the form of current transfers and, therefore, warrant special attention. Out of the education systems analyzed, only the city of Bogotá has a fund for immediate response to emergencies at schools.

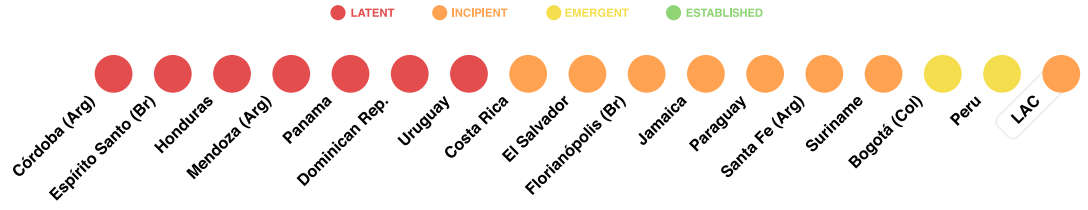


Register of educational material: incipient.

Although education systems vary significantly regarding the volume of educational material transferred to schools, this can account for a significant proportion of the budget. However, it is one of the least developed aspects of the education systems analyzed: none has an updated digital register of the educational material such as school supplies, textbooks, teaching materials and school uniforms, received by schools from the central or sub-national administrations. In general, records are dispersed, in Excel or on paper, and indicate only aggregate amounts at the regional or school level. There is no case in which the central administration has information about the materials received by each student. In other words, it is unable to identify the students who received a school kit or specific educational material. For planning purposes, this implies that educational materials are distributed with little knowledge about the items with which students have already been provided.

In Jamaica and the province of Mendoza, schools tend to organize records according to the school's dominant criterion. In Peru, the Directorate for the Management of Educational Resources (DIGERE) uses the Materials Management System (SIGEMA) to keep an updated register of the distribution of resources down to the level of the Local Education Management Unit (UGEL). It is also developing an Information System for the Distribution of Materials in Educational Institutions (SIDMAT) to monitor the reception of educational materials and their status down to the level of educational service.

Do you record and update information related to the educational material a school receives from the provincial or national government such as school materials, textbooks, teaching materials (pencils, exercise books, etc.) and school uniforms?



Transversal aspects of school management

• Lack of provision of information in real time:

In general, the 16 education systems analyzed have achieved little development in terms of using the data contained in the unique register of schools to provide accurate information in real time. This should be available with viewing rights and privileges for the different actors in the education system (director, supervisor, level director, administrative areas, central and decentralized political authorities). In the case of the state of Espírito Santo, the SEGES does not have a specific module for this purpose, but information is available in real time to the different actors through auxiliary systems. The situation is similar in the Florianópolis municipality where accesses are validated periodically and users' access profiles are audited annually. In Uruguay, information about enrollment, grade repetition rate, dropout or attendance can be viewed, although its availability in real time is greater at the central level than for schools. The system also permits the creation of access roles (as teachers, directors, inspectors or Council), adjusting the information available according to the role: for teachers, about the groups assigned to them; for directors, about the school; for inspectors, about the jurisdiction; and, for the Education Council, all the information.

• Low level of articulation between systems and a heavy administrative workload for schools:

Although the education systems analyzed have adopted unique school identifiers, articulation of all the relevant data about each school remains a challenge. The absence of a transversal technological solution for all management processes results in an important administrative workload for schools and complicates their management. The lack of interoperability between the tools used to manage schools and for other SIGED processes, such as human resources, makes it impossible to obtain an overall view of data about schools.

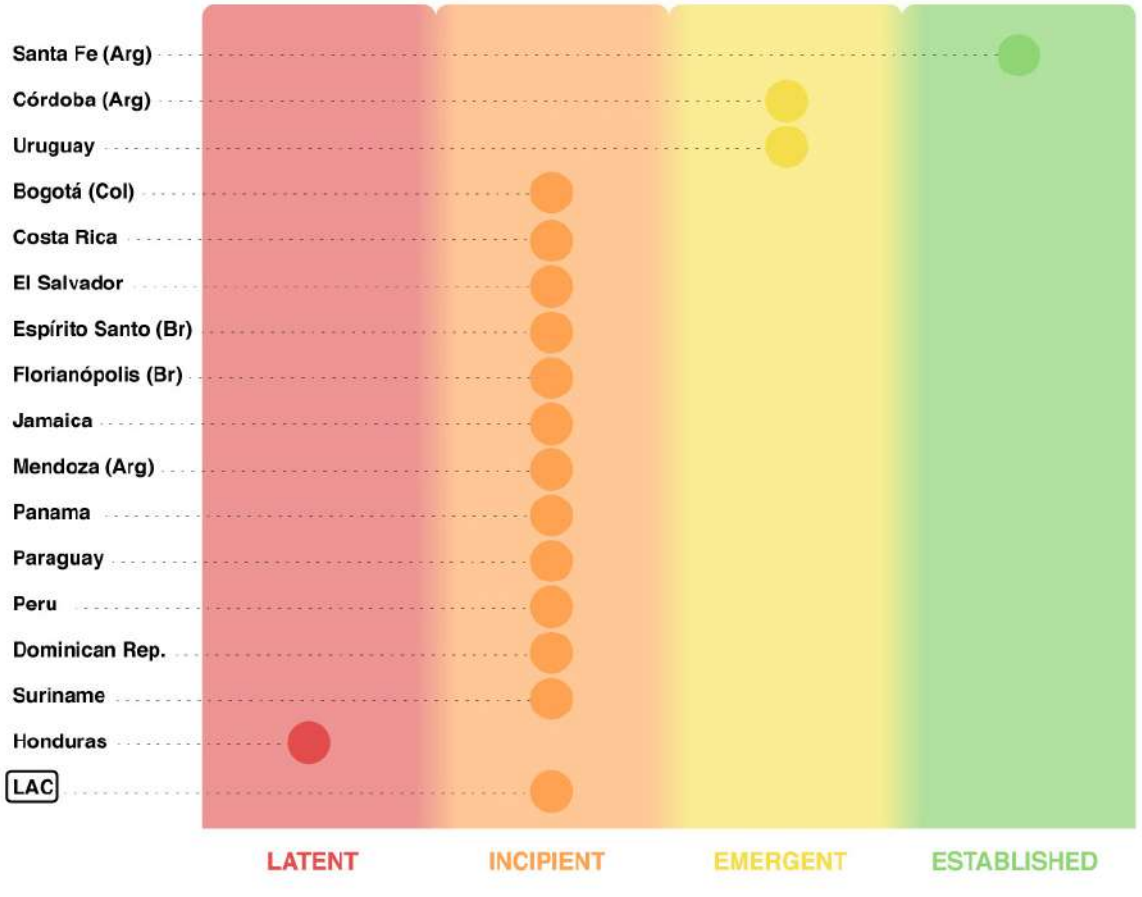
PROCESS 3:

Management of human and budgetary resources: Incipient

The study shows that management of human and budgetary resources is at an incipient level of development (level 2 out of 4) and, accordingly, many of the education systems correspond to this level (Figure 3.5).

FIGURE 3.5

Level of development of SIGEDs: management of human and budgetary resources



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

The province of Santa Fe, which has an established level of development in this field, is the most advanced. To manage positions, it uses a unique identifier and a register of all the agents in the education system according to their national identity document (DNI). This register includes complete information about remunerations, the tasks performed and bonuses. In addition, the province has a centralized register of attendance and sick leave. The human resources and school management systems interoperate, providing access to reliable data. Teachers and administrative personnel can consult all the information about their employment situation and carry out procedures with the central administration.

The education system of the province of Córdoba and that of Uruguay have an emergent level of development (level 3 of 4). Uruguay has a unique register of human resources and unique identifiers of people and positions. In addition, teachers can check their register online through the GURÍ system. Remunerations are paid using the Payroll solution based on the position held by each person, taking into account the profile of employees and the attendance data registered in the GURÍ system. Adjustments for errors in previous payments of remunerations can also be made.[24]

The management of human resources includes all the workforce hired in the education systems administered by the public sector that are directly or indirectly involved in the teaching and learning process. Human resources account for 71% of the region's education budgets (CIMA, 2017), making their management fundamental for the efficiency of investment in education. Even slight improvements in the efficiency of human resource management systems can produce savings that are significant in absolute terms. At the central level, budgets must be administered using optimal systematized processes that permit both the definition of budgets for schools and the establishment of items and limits for the control of spending. At the same time, budget items must permit the introduction and elimination of positions in the education system. In other words, it should not be possible to create a new position unless there is a budget item to which it can be assigned. Similarly, the budget item associated with a position should only be freed for reallocation if the related position is eliminated (for example, due to the completion of an activity). In this model, the budget always acts as a regulatory framework for the administration of positions, guaranteeing the availability of financial resources for their creation and subsequent payment of the corresponding payroll.

Human resources are managed at the central level, with different areas or departments of education ministries intervening in the process. The division of responsibilities varies across the different education systems but there is generally an area that handles the entire selection process and manages the teachers' pay scale, an area that is responsible for teachers' professional development and in-service training and an area that manages finances and the payroll. Using a unique repository of data about the workforce, these areas must coordinate with each other in the daily management of human resources. In turn, remunerations are usually paid by finance ministries or other similar bodies. The human resources of public education systems are government employees and, therefore, come under the public-sector payment system. Arrangements for the exchange of information between the education ministry and the finance/economy ministry about the payroll and the associated payments will largely determine the efficiency of payroll management. It is in this process where there is most interaction between public financial and budgeting management and the specific management of human resources for education. In many cases, their coordination is more complex than for other key SIGED processes.

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24 In January 2019, with financing from the Inter-American Development Bank (IDB) and support from the Ministry of Economy and Finance (MEF), the Council for Early and Primary Education (CEIP) began to use the Integrated Personnel Administration System (SIAP), also used by all the National Public Education Administration (ANEP), and the Odoo system as GRP. The Uruguayan case study does not take the resulting improvements into account since the information for it was gathered before they came into operation.

The efficient management of an education system's human resources should center around a repository of the related data and updates. All procedures related to the management of human resources, such as the transfer of a teacher from one school to another, should be immediately recorded digitally and reflected in the unique repository of data. In turn, this repository should integrate the IT systems used by the different departments involved in the management of human resources. In this way, data will be input only once when the procedure is recorded. The different IT solutions should serve as a tool for all procedures related to human resources whilst, at the same time, storing updated information that is available to all users, with the due access permissions. However, in the region's education systems, different human resource management applications often coexist, with databases that are not integrated and are, to different extents, outdated, resulting in a heavy workload in the form of manual data validation. The greatest challenge is in the payment of salaries where, in addition to the different validations and consolidations that must be carried out within the education ministry, it is necessary to interact with the finance ministry's IT systems. In a common issue, the IT solutions of these two ministries were often not designed in an integrated manner, a situation that significantly affects their inoperability when processing payroll payments.

BOX 3.8

Management of human and budgetary resources: the cases of England and France

In England, the school management system includes SIMS Personnel, a specific module for the management of human resources that stores all the personal, professional, contractual and payroll data about schools' teaching and non-teaching employees. This module is integrated with the other complementary modules for personnel management, such as the management of absences and the financial and budget management systems. In addition, the SIMS Staff Performance module manages all the information related to the evaluation and performance of personnel. It also guides the creation of personal goals, such as the management of professional development, in-service training, teacher evaluation from the standpoint of student performance, and development and career plans (Smith, 2019d). The SIMS Financial Management System module manages financial and budgetary resources. For those levels of users who control their own budgets, the module offers direct access for recording spending, viewing the state of costs and the budget and generating reports. In addition, it includes a module through which to create reports for preparing budgets and financial statements in real time with annotations and projections. This module is also interoperable with other key modules for the management of budgetary resources such as that for the management of canteens.

In France, the Ministry of National Education has made the I-Prof portal available to teachers and school directors, who can view and modify their profile and personal/professional information (personal details, curriculum vitae, etc.). Each teacher is in contact with an agent responsible for their affairs so they can benefit from advice and information tailored to their profile. The platform offers the following services: access to personal information available to the public administration; library of all services related to the management of teaching personnel, education and guidance

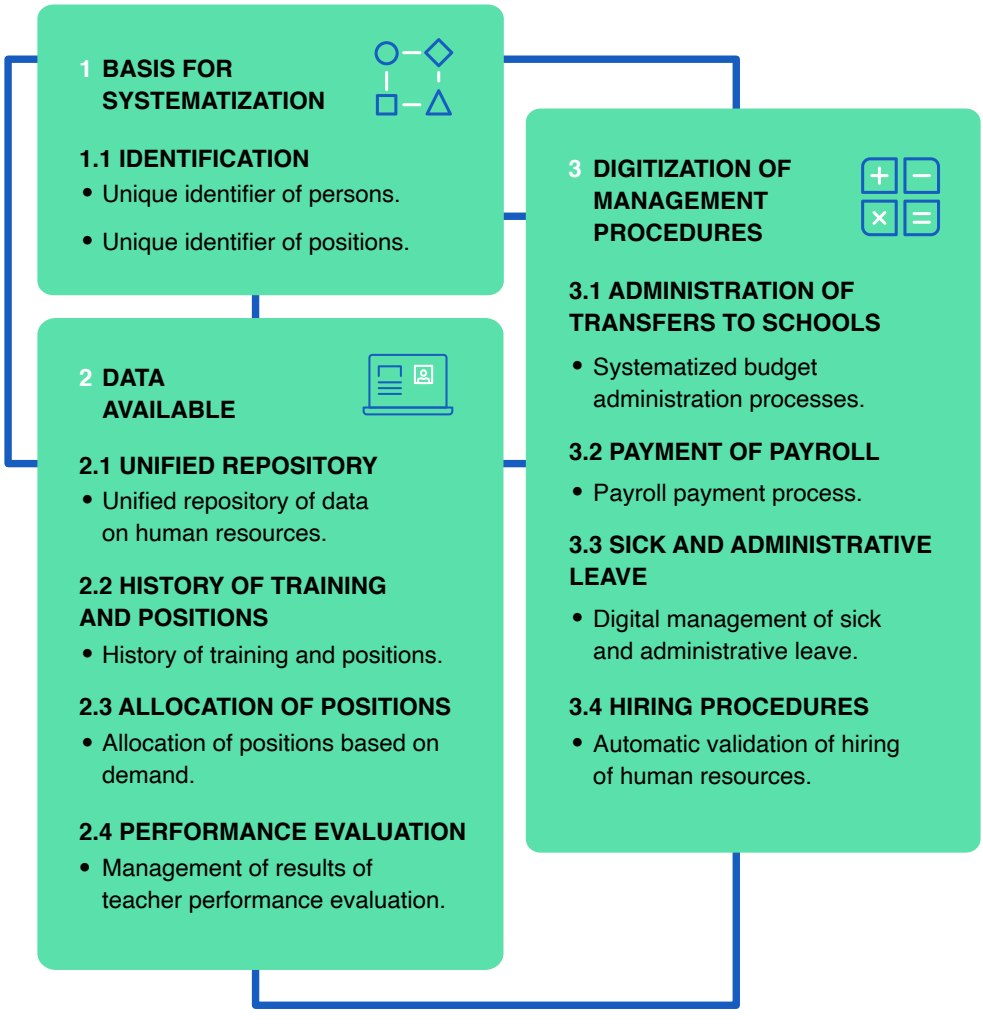
(changes, promotions, applications for positions, positions, training, e-administration); input of complementary information (other diplomas, experience, etc. that can add value to a teacher's professional career); single point of access for managing working life and careers; guides to management processes; communication of personalized information about career prospects; and rapid communication (via messaging) on the status of processes underway.

Source: Compiled by authors based on Smith (2019d; 2019c).

For the analysis of arrangements related to the management of human and budgetary resources, the functionalities are divided into three broad categories: i) basis for systematization; ii) data available; and iii) digitization of management procedures. The study's results for each category are presented below and a brief description of each functionality is provided, along with a graph with a score, corresponding to the median of the 16 education systems studied that reflects the level of development, and a review of good practices and the experiences of the cases with the highest levels of development.

INFOGRAPHIC 3.5

Summary of functionalities of the process of management of human and budgetary resources



1. BASIS FOR SYSTEMATIZATION OF HUMAN RESOURCE AND BUDGETARY DATA

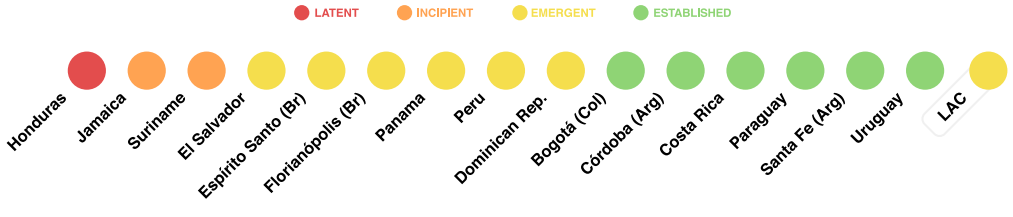
1.1 IDENTIFICATION

All human resource management should be centered around two unique identifiers: one for people and the other for positions. In an established SIGED, each position will have, throughout its history, numerous relations with the people who have held it, each in a unique period, considering the employment situation corresponding to the position (holder of position, replacement, substitute, etc.). It is the relationship between the unique identifier of persons and the unique identifier of positions that allows the identification of the history of the positions a person has held in the system and the different people who hold or have held the same position.

Unique identifier of persons: emergent.[25]

The different education systems tend to use people's national identity number as their unique identifier. In this way, each member of the system's workforce can be unequivocally identified. The most advanced education systems in this regard are those of the city of Bogotá, the province of Córdoba, Costa Rica, Paraguay, the province of Santa Fe and Uruguay. All of these, as well as Panama and the Dominican Republic, use the national identity card or document. Peru uses the modular census of persons[26] and Jamaica, the person's tax number. Honduras generates a "pay-scale password" that changes with the position that a teacher holds, implying that the same teacher can have up to three passwords for the system.

Do you use a model of unique identification of persons in the educational system and their relationship with the budget?



Unique identifier of positions: emergent.

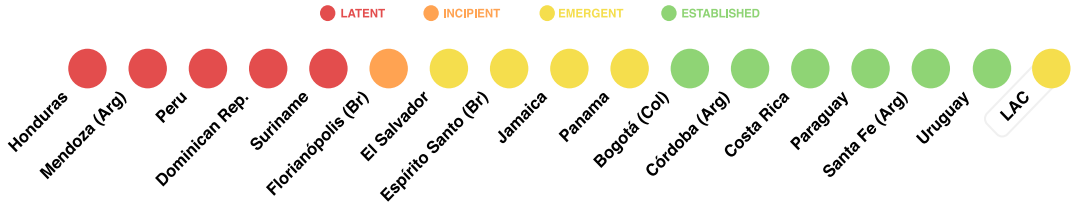
Positions are uniquely identified jobs within the education system. The creation and elimination of positions are always associated with the budget through their function, type and/or allocation. In this way, the position a person occupies is related to the budget from which payroll payments are disbursed. The most advanced education systems in this field are also those of the city of Bogotá, the province of Córdoba, Costa Rica, Paraguay, the province of Santa Fe and

25 Não há dados disponíveis para a província de Mendoza.

26 The Integrated System for Management of Education Sector Personnel (AYNI) was launched on December 18, 2020. It permits the integration of different platforms (including NEXUS and SIRA). It uses the national identity number for identification and access.

Uruguay, which all have unique identifiers of positions associated with the budget. In Panama, the Ministry of Economy and Finance (MEF) provides the Education Ministry with the structure of positions. For each position in this structure, posts are assigned, with their creation approved by the MEF. Both the post and the position have an identification code. The budget item is assigned to the position, the position is associated with some of the posts in the structure and it is the post that is held by each person. The creation of positions is not systematized and a request must be submitted to the MEF for this and for the creation of new posts.

Do you use a unique model of identification for teaching positions in the educational system and are they included into the budget?



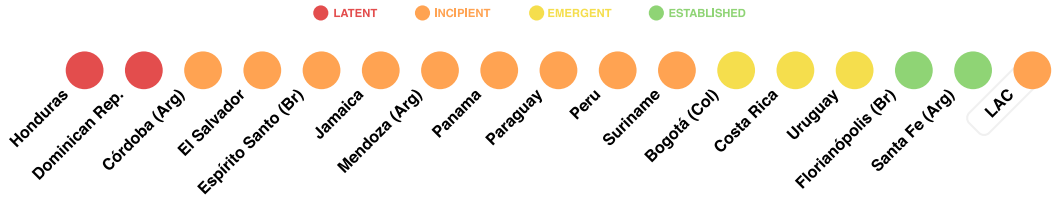
2. DATA AVAILABLE ON HUMAN RESOURCES

2.1. UNIFIED REPOSITORY

Unified repository of data on human resources: incipient.

The region's education systems tend to have a number of repositories of human resource data, which are, moreover, often incomplete and/or outdated. The Florianópolis municipality and the province of Santa Fe are the cases with the highest level of development in this field. In the former, information on human resources is held in the Traceability System. In the event of changes in contract or curriculum information, each person must first register them in the system, attaching the corresponding documents. The new information must then be presented to the Education Secretariat, which enters the update. The province of Santa Fe holds all the updated information on human resources in the Human Resources Administration System (SARH). Although Uruguay has an updated register in the GURÍ system, this does not contain information about teachers' training or their medical history.

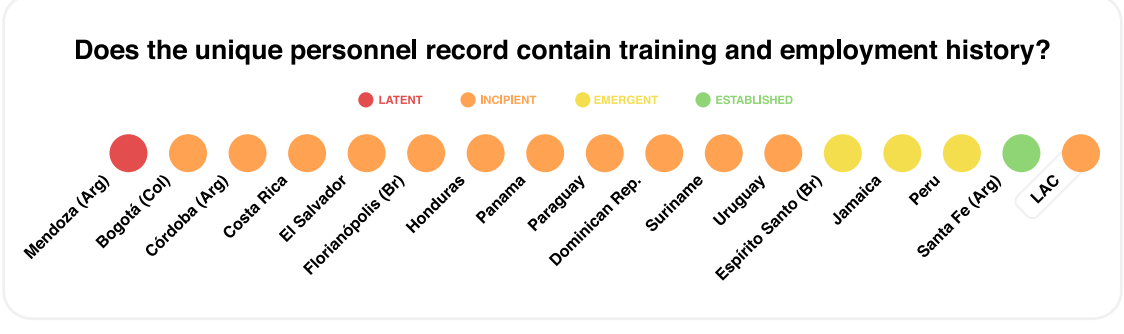
Do you have a unique human resource record in digital format to use in the daily management of these resources?



2.2. HISTORY OF TRAINING AND POSITIONS

History of training and positions: incipient.

The repository of data on human resources must include information about teachers' training history and the positions they have occupied in the system. In general, in the region's education systems, there has been little development of this aspect. The greatest progress has been on the history of positions, which the different systems usually record as teachers move up the career ladder. In Peru, the record of teachers' history includes information about previous positions, the duration of each one and the training courses completed. However, this data is not complete for all teachers. In Jamaica, information about the history of positions is stored in the OrangeHR system and training history in the database of the Jamaica Teaching Council (JTC). Both systems use people's tax number as the unique identifier for all human resources. However, the JTC database does not yet cover all teachers. The history of permanent non-teaching positions is managed in the OrangeHR system, albeit not systematically.



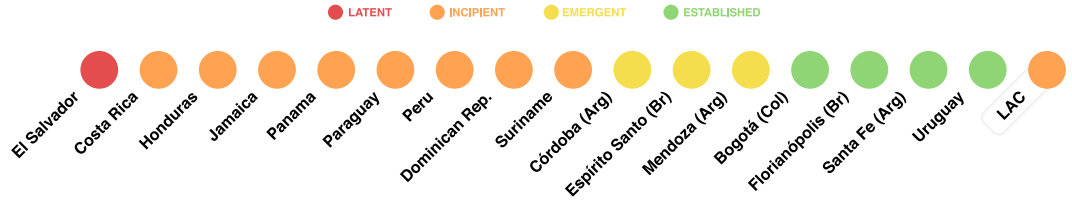
2.3. ALLOCATION OF POSITIONS

Allocation of positions based on demand: incipient.

Positions should be allocated strictly in accordance with demand in terms of students enrolled and their characteristics. An established SIGED must determine demand and parameterize the corresponding national or local norms. In the systems observed in LAC, this criterion is used mainly for the creation of new positions and rarely for their elimination. In the education systems of the city of Bogotá, the Florianópolis municipality and Uruguay, the creation of positions is based strictly on enrollment. In the city of Bogotá, it is managed at the central level, but it is not possible to know in real time the year or student to which each new position is associated.

Regulation in the Dominican Republic stipulates that positions should be allocated based on enrollment. In practice, the director reports a school's needs to the district, which then refers it to the central level. A commission, formed by the Planning Directorate and other central areas, decides on the positions to be created. Enrollment information is obtained from the Information System for School Management of the Dominican Republic (SIGERD). Costa Rica and Honduras have a similar process in which schools submit requests. However, little attention is paid to these requests and not all the demand is covered. Peru has a regulated process and has not created organic positions since 2015. Infrastructure and models of service provision are taken into account as well as enrollment.

Do you estimate a school's teaching and non-teaching positions based strictly on demand in the form of enrolled students?

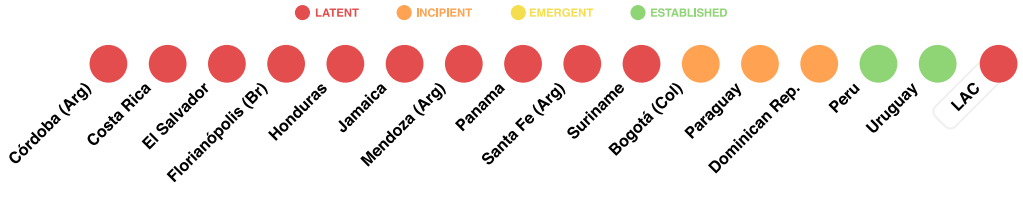


2.4. PERFORMANCE EVALUATION

Management of results of teacher performance evaluation: latent.[27]

The region's education systems generally implement some type of teacher performance evaluation, carried out directly by education ministries or by independent bodies. The results are not systematized or related to data from human resources systems and their use in drawing up teacher training plans is infrequent. The education systems of Peru and Uruguay are the most advanced in this field. In Peru, evaluations are carried out at the national level and there is a complete digital record of the results. In Uruguay, the inspector records the teacher's evaluation. Reports on the evaluations, which take place at least three times a year, are held in the GURÍ system. In addition, the Qualifying Board conducts an evaluation at the end of the year. In the city of Bogotá, evaluation takes the form of a survey carried out every two years, but the results are not recorded in the Humano system. Costa Rica, the province of Córdoba, El Salvador, the state of Espírito Santo, the Florianópolis municipality, Jamaica and the province of Mendoza do not evaluate teacher performance.

Do you record and manage the results of external teacher assessments, whether regional or national?



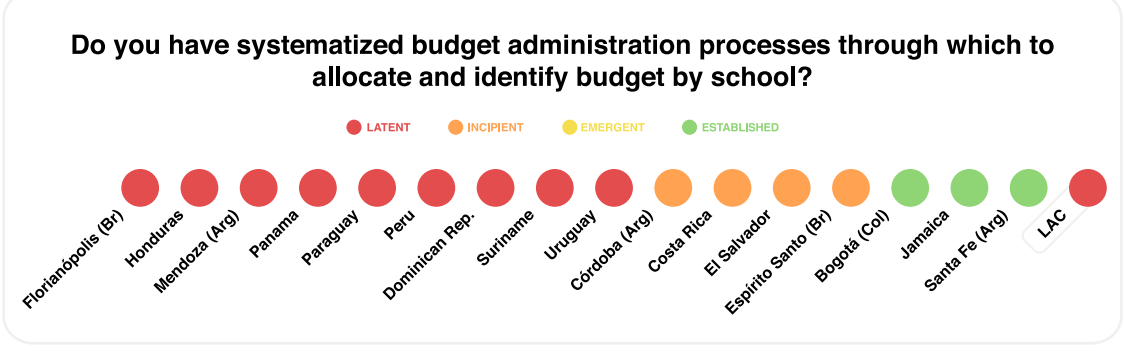
27 Data not available for the state of Espírito Santo.

3. DIGITIZATION OF PROCEDURES FOR THE MANAGEMENT OF HUMAN AND BUDGETARY RESOURCES

3.1. ADMINISTRATION OF TRANSFERS TO SCHOOLS

Systematized budget administration processes: latent.

Budget administration must permit the definition of budgets by school and establish items and limits as a means of controlling spending. This should, in turn, enable other functionalities in the SIGED such as the creation of positions. A specific module in the SIGED should provide tools for controlling transfers to schools and the corresponding rendering of accounts. Systematized budgeting procedures at the central level, particularly those related to human resources, permit the creation of cost centers which, in turn, facilitate analysis of the financing of education for the purpose of measuring the efficiency with which resources are being used and identifying gaps and inequities in their distribution at the territorial level. Only the city of Bogotá and Jamaica reported the existence of cost centers at the school level. Under Bogotá's management model, Colombia's Ministry of National Education regulates positions, allocating them as a function of the number of students at each institution. The number of positions per school is recorded in the Humano system and serves as an upper limit. In addition, the Bogotá District approves additional positions at schools, which are financed out of the local budget. The other education systems analyzed manage budgets at a more aggregate level, such as by program or educational level, or have to cross-reference information from different databases in order to arrive at an approximation of budgets at the school level.



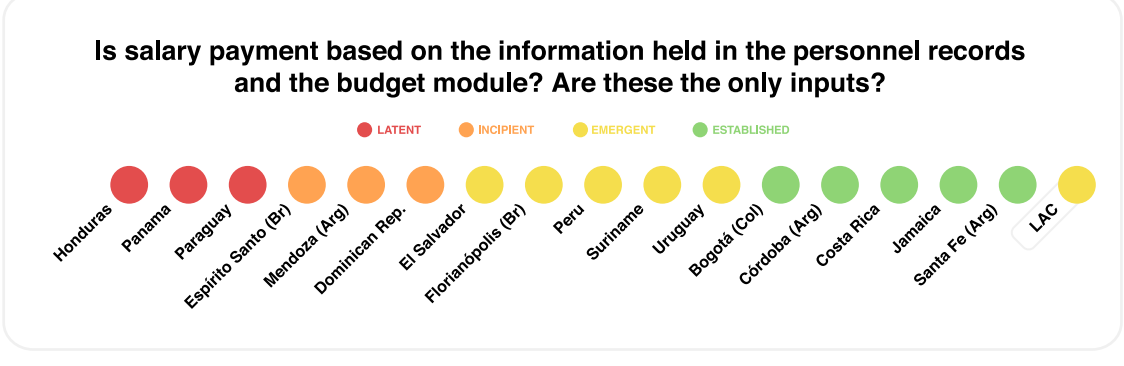
3.2. PAYROLL PAYMENT

Payroll payment procedure: emergent.

A prevalent feature of payroll payment in the region's education systems is that it takes place in the framework of the process for public employees in general for which the finance ministry is usually responsible. The education ministry has to generate a fortnightly or monthly payroll using its human resource systems. Ideally, this should be automatic and based on up-to-date information but, in practice, is usually a manual process. The most advanced systems are those of the city of Bogotá, Costa Rica, the province of Córdoba, Jamaica and the province of Santa

Fe. In Jamaica, the only input for generating the payroll is the repository of human resource data while the city of Bogotá uses the information on positions, people and performance contained in the Humano system, which is also used for the complementary elements required for calculating remunerations, such as family allowances, embargoes[28] and seniority. In El Salvador, payroll payment is based solely on the Human Resources Information System (SIRH), which only records positions that are financed by the Education Ministry.

In Panama, the payroll is generated manually. The Payroll Department of the National Directorate of Human Resources prepares the fortnightly payroll: it controls and verifies the resolutions or decrees it receives in physical form with modifications to the service sheets of administrative personnel and teachers and then enters the changes in Excel spreadsheets that are sent to the Comptroller General's Office, which is responsible for updating the information in the Structure, Payroll and Discount System (EPD) and making payments by transfer or check. The manual process and the high volume of changes that occur each fortnight imply room for errors. Although the Payroll Department has access to the EPD system, it does not perform systematic validations. As a result, aspects that affect the payroll, such as absences, incidents of tardiness and teacher training, are reported to the corresponding departments on paper and, because of the manual nature of the process, the incorporation of this information into the payroll takes time.



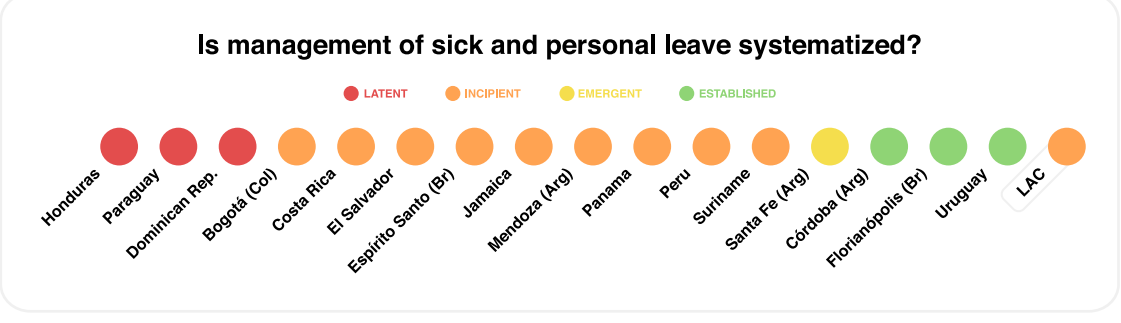
3.3. SICK AND ADMINISTRATIVE LEAVE

Digital management of sick and administrative leave: incipient.

Information such as sick or administrative leave must be automatically recorded and validated in accordance with the regulation in force. The statute for the teaching profession and the different complementary decrees and resolutions should be parameterized in the system, with the parameters serving to automatically approve or reject any modification and update the data accordingly in the unique register of the human resource management system. For example, if a request is received for administrative leave longer than permitted under national or local regulation, the system should automatically issue a notification of its rejection. The education systems of the province of Córdoba, the Florianópolis municipality, the province of Santa Fe and Uruguay are the most advanced in this field.

28 An embargo occurs when the courts order an employer – in this case, the state – to retain part of an employee's (teacher's) remunerations due, for example, to a delay in repaying a debt of some type.

In Uruguay, sick and administrative leave are managed through an AS/400 system.[29] Healthcare providers inform the Banco de Previsión Social (BPS), Uruguay's social security institute, about the certificates of leave issued and the system collects this information the next day. By contrast, in the Dominican Republic, the management of leave involves a great deal of bureaucracy and is not optimized or systematized efficiently. Although there is a partial record of certain absences, such as those related to maternity, there is no application process and, consequently, no notification of the approval or rejection of an application. In some cases, absences are not reported by schools or recorded in any system.



3.4. HIRING PROCEDURES

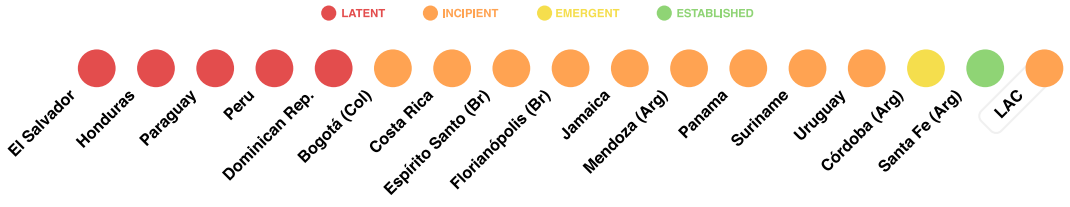
Automatic validation of hiring of human resources: incipient.

Like sick and administrative leave, the hiring of human resources must be automatically registered and validated under the regulatory regime in force. The different norms, such as the statute for the teaching profession and complementary decrees and resolutions, should be parameterized in the human resource management system, with the parameters serving to automatically approve or reject any modification and update the data accordingly in the unique register of the human resource management system. In this way, it is possible to verify if the profile of a teacher to be hired corresponds to the requirements for the position. The education systems analyzed have a low level of development in this field.

In Peru, hiring processes are managed in a decentralized manner in each region. The Regional Directorates of Education (DREs) and even the different Local Education Management Units (UGELs) may have their own system. The Education Ministry does not consolidate the information in a systematic way. In the Florianópolis municipality, the Municipal Education Secretariat delegates the simplified hiring process, which involves written tests and verification of grades, to the Federal University of Santa Catarina. Hiring is recorded in the Joaquina system, which is used for the city council's human resource management, and are then entered manually into the SIG Educação education management system. There is no data portability or interoperability between systems.

29 A set of libraries in AS/400.

Do you automatically record and validate the hiring of human resources?



Transversal aspects of the management of human and budgetary resources

• Low level of provision of information in real time:

Few of the 16 education systems analyzed use the unique register of human resources to provide accurate information in real time. This should be available with viewing rights and privileges for the different actors in the education system (director, supervisor, level director, administrative areas, central and decentralized political authorities). In Uruguay, the GURÍ system provides information in real time, with the option of creating differentiated access roles for teachers, directors, inspectors or the central level.

• Low level of articulation of unique identifiers of positions with the budget and monthly payroll:

In general, the human resources systems of the 16 education systems analyzed are closed and do not permit adjustments or integration with the other complementary systems used for the management of human resources. In addition, a low level of articulation with the systems used for the other SIGED processes hampers immediate response to elementary requirements such as an integral view of the register of teachers or information about the teachers of each student (or group of students). This is important when monitoring educational quality.

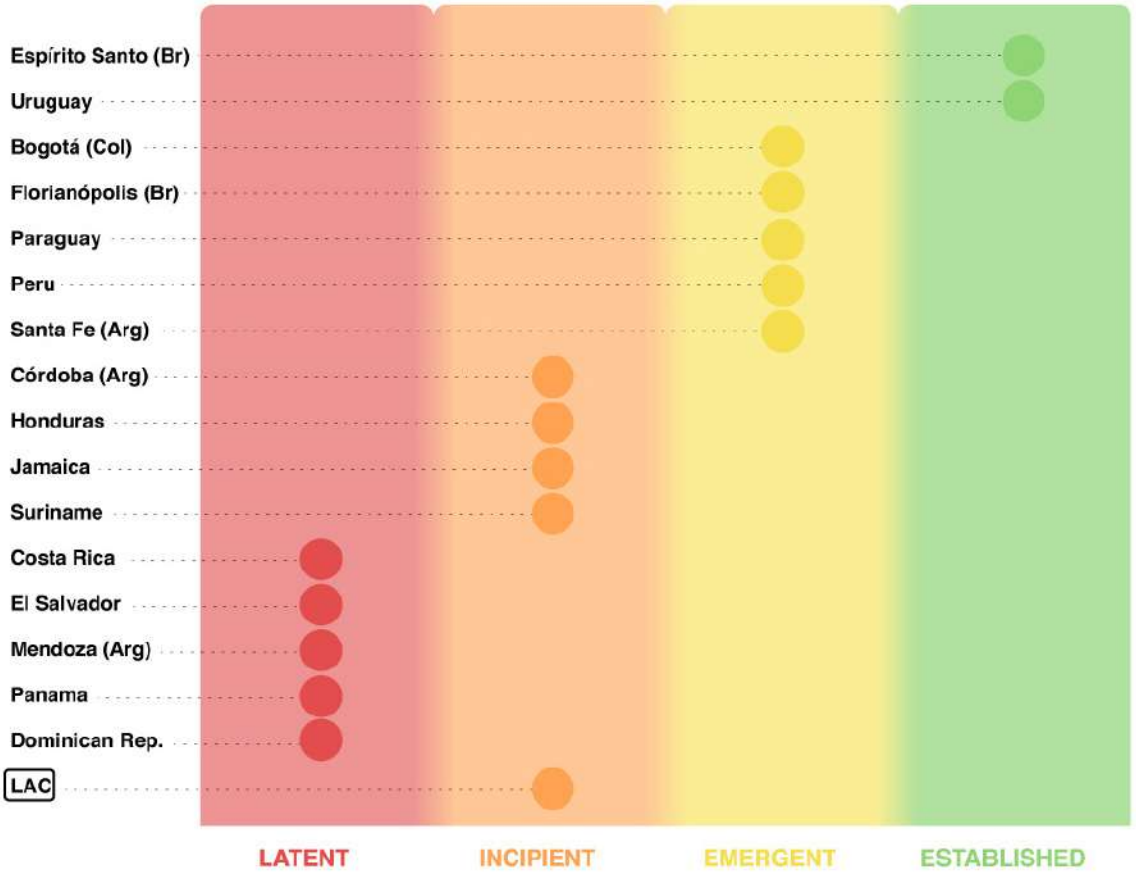
PROCESS 4:

Management of students and learning: Incipient

The study shows that the management of students and learning is on average at an incipient level of development (level 2 out of 4), with some dispersion across the latent, incipient and emergent levels (Figure 3.6). The most advanced systems are those of the state of Espírito Santo and Uruguay, which have reached an established level.

FIGURE 3.6

Level of development of SIGEDs: management of students and learning



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

In the state of Espírito Santo, the unique student registration code, known as RA1, remains with them throughout their school life and is used by all government systems. The online student registration procedure allows users to select up to three schools according to their preferences. Reports and data are updated in real time and parents and guardians can access students' information through an Internet portal. To support teachers in the classroom, an application that works online and offline records students' attendance, performance and approval or repetition

of the year. Through the Quarterly Espírito Santo Primary Education Evaluation Program (PAEBES TRI), a module available in the SEGES, data from external evaluations can be used to measure students' performance.

In Uruguay, a model with a unique identifier for students means they can be related to the school they attend, the group to which they belong and the teacher responsible. The unique student register is in digital format and very complete. GURÍ has a digital file for each individual student with information on attendance, grades, conduct and approval/repetition of the year. Through GURÍ Familia, students' parents or guardians have access to this same information and receive communications from the Council, the school or the teacher.

The management of students and learning is also affected by the top-down approach prevalent in the region's SIGEDs. The responsibility falls mainly to schools, which often lack the necessary tools. As a result, it is common for public schools to develop their own management mechanisms, mostly on paper or using Excel. The management of students should be based on a transactional system that begins with their registration and continues through to the issue of the different certificates over the course of their school life. Procedures, such as the register of absences, should be stored as data that can be accessed by the different actors in the education system, including those at the central and sub-national levels. In practice, these registers are often kept on paper in the classroom and are later consolidated in a register of some type that is used by the school. In many cases, it is necessary to record the same data twice to comply with the requirements of the central level and regional office. The lack or absence of connectivity can also compound this problem.

The management of students and learning comprises all aspects directly related to the unique identification of students through their name and its association with their educational trajectory. Regulation and parameters for the allocation of students to different schools are defined at the central level. Then, during a typical school year, parents must enroll their children at a school and directors must have a complete nominal record of the students who were ultimately sent to the school they head. Teachers must monitor and record the absences and performance of the students allocated, a task that can currently occupy up to 39% of their time (Bruns and Luque, 2014).[30] At the end of the different years and educational levels, certificates and diplomas must be issued to testify to students' learning. Continuous communication with parents must also be maintained to inform them about their children's performance and any other relevant matter. Some education systems that have school meal, transport and scholarship programs also manage these services. The central and sub-national levels must, therefore, be able to identify the school attended by each student, their teacher, absences, incidents of tardiness, daily grades and the educational services and social programs they receive as well as their academic record.

30 In LAC, classroom management activities, such as calling the register, correcting homework or handing out printed materials account for between 24% and 39% of total class time, well above the 15% that is considered appropriate internationally (Bruns and Luque, 2014).

BOX 3.9

Students and learning: the cases of Andalusia (Spain) and England

The Séneca management platform used in Andalusia was designed based on three sub-systems that constitute its functional core: student, school and personnel. In the case of students, the platform permits management of their academic and administrative life cycle, from their pre-registration at a school through to the completion of their secondary studies, including enrollments, academic files, applications for places, absences and evaluations.

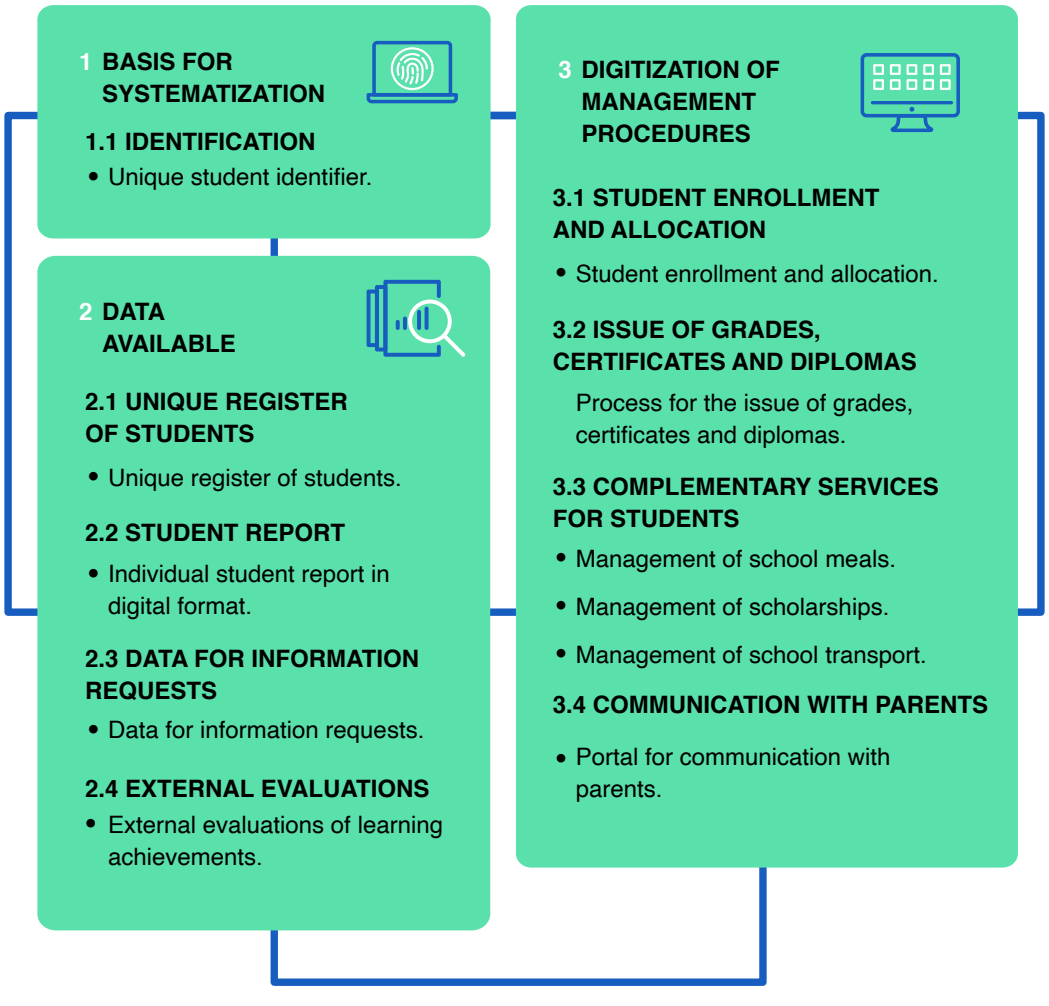
In England, the management of students and learning is based on the SIMS system and the SIMS Primary system (a new integrated solution for primary schools). At the center of these two systems is the student's file. The SIMS system provides a complete overview of all a student's data: personal, social welfare and academic information, including educational history and progress. Additional modules are integrated into the main solution: SIMS Interventions, which is used to manage the extraordinary support for students that seeks to provide real-time answers to problems in their educational progress, behavior or well-being; the SIMS Lesson Monitor, which manages each student's absences, tardiness and behavior at the class level; and the SIMS IEP Writer, which allows educational plans to be tailored to each student. The SIMS system also includes third-party solutions, such as Century Tech, which uses artificial intelligence to create personalized learning paths for each student and offers a complete view of their progress and performance, and the MyConcern application, which manages everything related to the safety and well-being of students, physically, emotionally and digitally. The SIMS SIGED also has integrated complementary modules for managing other aspects of students' school life such as benefits under the Online Free School Meals system as well as communication with parents through SIMS InTouch, which provides access to all the information about the student's learning process and school life, enabling families to verify whether their child has arrived at school, obtain information about homework and keep abreast of news about the school, etc. In addition, through EntrySign, associated with the SIMS Core modules, it provides schools with a safe visitor management system.

Source: Compiled by authors based on Smith (2019a; 2019d).

For the analysis of arrangements related to the management of students and learning, the functionalities are divided into three broad categories: i) basis for systematization; ii) data available; and iii) digitization of management procedures. The study's results for each category are presented below and a brief description of each functionality is provided, along with a graph with a score, corresponding to the median of the 16 education systems studied that reflects the level of development, and a review of good practices and the experiences of the cases with the highest levels of development.

INFOGRAPHIC 3.6

Summary of the functionalities of the process of management of students and learning



1. BASIS FOR SYSTEMATIZATION OF DATA ABOUT STUDENTS AND LEARNING

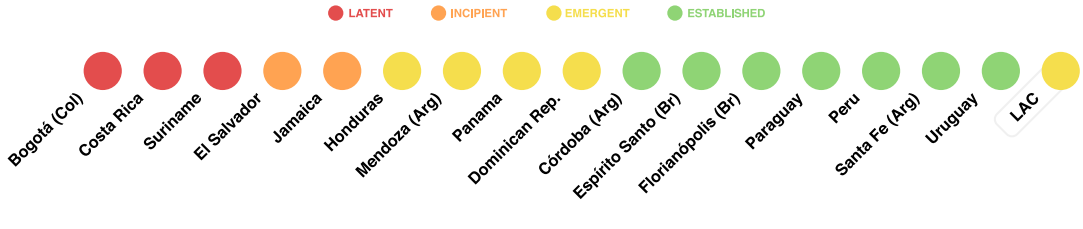
1.1 IDENTIFICATION

Unique student identifier: emergent.

Education systems need to be able to identify each student individually. With a unique student identifier, it is possible to micro-plan and monitor students' educational trajectories from the different management levels of the education system, detecting deviations in learning indicators and tailoring educational services to current needs. All students must have a unique identifier, without duplicates. Out of the 16 education systems analyzed, only Costa Rica does not have unique indicators or some other type of nominal student register. Jamaica has a nominal register only for students for grades 1 to 6. Similarly, the province of Mendoza does not have a nominal register of all students. The Dominican Republic's Information System for School Management (SIGERD) uses unique student identifiers, with a nominal register, but there are some duplicates in the system. In addition, the SIGERD and the evaluation and grading system use different student identifiers. The other education systems analyzed have unique identifiers and a nominal register of students.

Although almost all the education systems use unique identifiers, only the province of Córdoba, the state of Espírito Santo, the Florianópolis municipality, Paraguay, Peru, province of Santa Fe and Uruguay use a model that permits identification of each student's school, syllabus and section. In the city of Bogotá, syllabuses are not managed at the central level. In Suriname, each bureau and inspection of the Education Ministry collects this information using paper forms. This country's Education Information System (OIS) generates a unique indicator for each student, used only in this system, which includes information about educational level, year and section. The OIS is updated once a year.

Do you use the unique School-Study Plan-Section-Student model to identify the school, study plan, and section corresponding to each student?

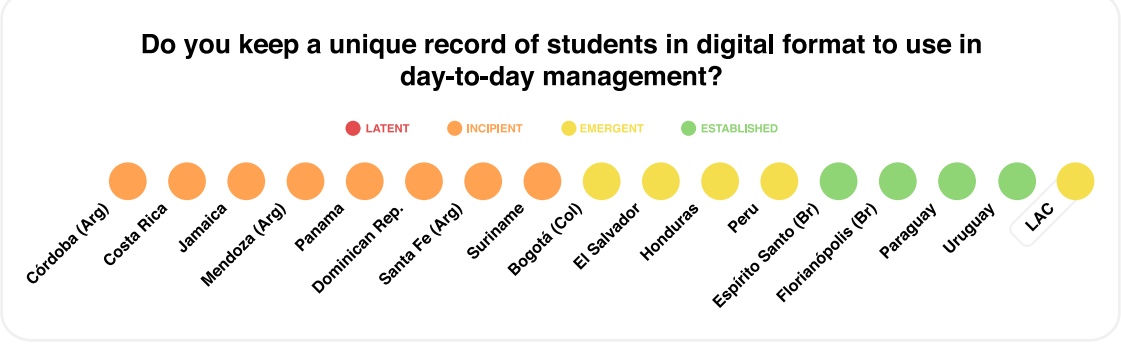


2. DATA AVAILABLE ABOUT STUDENTS AND LEARNING

2.1. UNIQUE STUDENT REGISTER

Unique student register: emergent.

The creation of a unique register where all student information is stored enables decision-makers not only to access information in real time but also to manage it efficiently. It serves, for example, to certify studies and process information about the approval or repetition of courses. As well as personal data, it should include at least information about attendance, grades, conduct and repetition. The education systems of the state of Espírito Santo, the Florianópolis municipality, Paraguay and Uruguay are the most advanced in terms of unique student registers. In Honduras, a nominal register of students forms part of the Schools Administration System (SACE) and contains some data about students. However, this system fulfills an information-storage, rather than management, function and is not widely used for decision-making by the central administration. Similarly, in El Salvador, some data about primary and secondary students at public and private schools is recorded in the Academic and Institutional Register System (SIRAI).

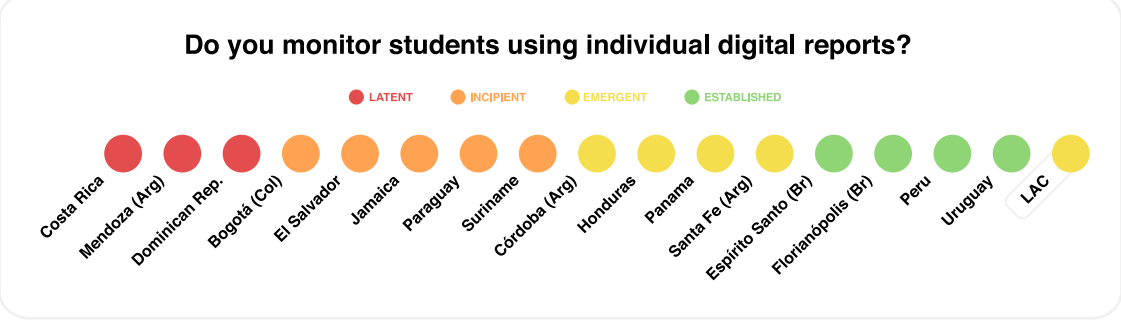


2.2. STUDENT FILE

Individual student report in digital format: emergent.

To monitor students, schools usually keep individual reports with basic data such as attendance, grades, conduct and approval or repetition of courses. The education systems of the state of Espírito Santo, the Florianópolis municipality, Peru and Uruguay have the highest level of development in this field. In Uruguay, this data is recorded on the student's card in the GURÍ system. Parents can use the GURÍ Familia application and website to access daily information about attendance and grades. In Espírito Santo, the State School Management System (SEGES) has a field for justifying absences. Teachers have an application for recording attendance and students' grades in each shift. Information about students' conduct is recorded in a physical book, known as cape preta (black cover), kept by school inspectors and is not entered into the SEGES. Similarly, the Florianópolis municipality uses a module of the SIG Educação education management system to record all pedagogical information about students except for conduct.

In El Salvador, schools use the SIRAI system to generate report cards that parents receive in printed format. This information is uploaded at the end of each school year and the data recorded by the teacher is not validated. In Panama, students' digital bulletin can be accessed through the School Administration System (SIACE) and its update, SIACE 2.0, where, each term, teachers and directors record data such as attendance, grades, conduct and approval or repetition of courses. The bulletin is printed and given to each student. SIACE 2.0 will allow families to access this data online. So far, only the school has access to its students' bulletins, which implies certain limitations in access to the information. For example, the director of a school cannot access the grade history of a student who has not been previously registered with that school. As a result, when students register at a new school, they must present a printed record of their grades at their previous school.



2.3. DATA FOR INFORMATION REQUESTS

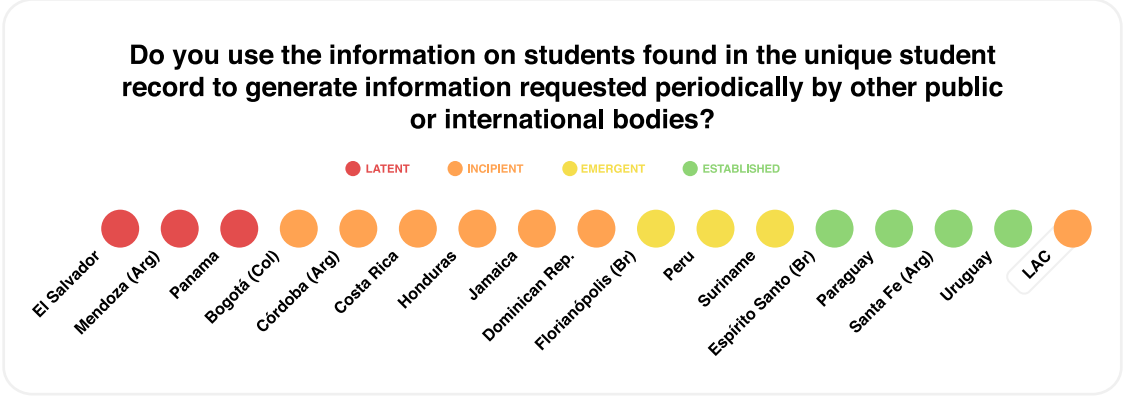
Data for information requests: incipient.

An established SIGED can serve as the principal source of information about education. In LAC, SIGED data, referred to colloquially as administrative data,[31] is often not of good quality because it is incomplete and/or outdated. This means that the different public institutions and international organizations have to seek alternatives for sourcing information of interest. Sometimes, in order to comply with data reporting requirements, ministries send specific forms to each school requesting information they already report to other systems.

The education systems of the state of Espírito Santo, the province of Santa Fe, Paraguay and Uruguay are the most advanced in this field. In Uruguay, all official education statistics come from the GURÍ system. The Florianópolis municipality does not have interoperable systems but the SIG Educação education management system is used for information about the conditions of beneficiaries of the Bolsa Familia conditional transfer program. In Panama, statistical information about education is not obtained from the School Administration System (SIACE), where the nominal register of students is held, but from the Statistics System (SIDE). School directors use the SIDE to complete the initial and final enrollment forms where they report a

31 It is important to differentiate between data generated through specific mechanisms for statistical purposes (such as education censuses, specialized surveys and standardized evaluations) and data from the recording of events or transactions that was originally generated for administrative purposes.

series of aggregated data at the school level. Information from the SIDE is also used for the Educational Statistics Bulletin and the information requirements of the Social Cabinet (Ministry of Health, Office of the First Lady, Ministry of Social Development) and institutions such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Inter-American Development Bank (IDB), the United Nations Food and Agriculture Organization (FAO), the Andean Development Corporation (CAF) and the World Bank. The information in the SIACE overlaps with that reported in the SIDE, implying a double workload for schools.



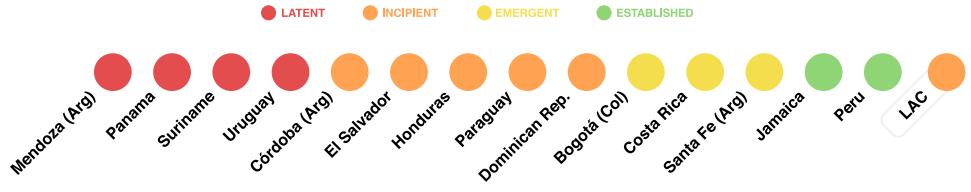
2.4. EXTERNAL EVALUATIONS

External evaluations of learning achievements: incipient. [32]

In addition to the information that external learning evaluations (censuses and sampling) may provide about each individual student, they are also a source of information that can serve as feedback on education policies at different levels. Hence the importance of managing the results of these national and sub-national evaluations at different levels of disaggregation. One of the education systems with the highest degree of development in this field is Jamaica, where the Education Ministry's Planning and Development Division uses the results of the CXC tests as an input for education policies at the national level. Schools can access the CXC portal to view their results and compare them with national trends. For its national tests, Jamaica has a reporting mechanism that allows schools to assess their performance compared to the parish and national averages. El Salvador has an annual Learning and Aptitudes Test for Secondary School Graduates (PAES), implemented by a university, which corrects it. The results are recorded in the Academic and Institutional Register System (SIRAI).

32 Data not available for the state of Espírito Santo or the Florianópolis municipality.

Do you manage the results of external student assessments, whether regional, state or national, and use this information as feedback for educational practices and policies?



3. DIGITIZATION OF PROCEDURES FOR MANAGEMENT OF STUDENTS AND LEARNING

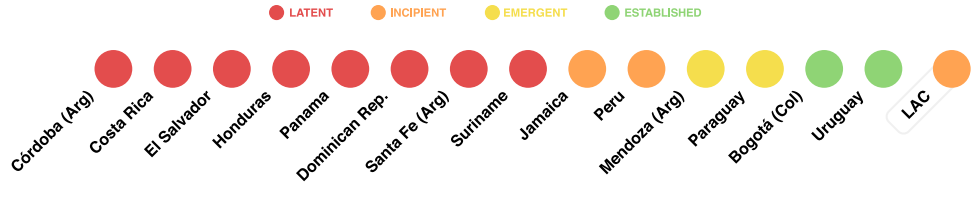
3.1. STUDENT ENROLLMENT AND ALLOCATION

Student enrollment and allocation: latent.[33]

Student enrollment should be managed online in each school cycle, with automatic allocation of students to schools according to the regulation and parameters in force. In this sense, the functionalities of enrollment and student allocation are closely related. The rules for allocating students can have important implications for the equity and efficiency of spending on education (Elacqua and Martínez, 2018; Bertoni et al., 2018).

The education systems of the city of Bogotá and Uruguay are the most advanced in this field.[34] In Uruguay, the GURÍ system uses information from the Public Health Ministry about all live births in order to guarantee universal enrollment. In addition, insofar as students do not change school, enrollment moves with them between levels and years. GURÍ also offers 6th grade students the possibility of early pre-registration for Lower Secondary Education.

Do you have an online process to record and manage enrolment?

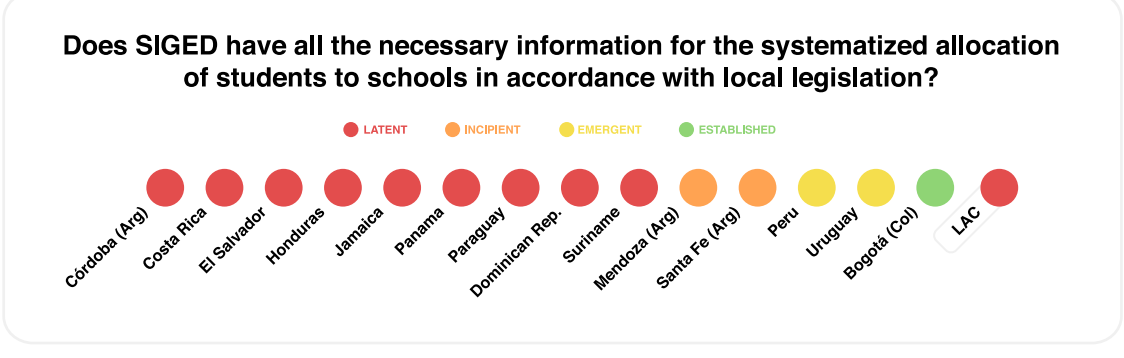


33 Data not available for the state of Espírito Santo or the Florianópolis municipality.

34 Information about these aspects not available for the state of Espírito Santo or the Florianópolis municipality.

Through GURÍ Familia, families can choose up to three options among liceos (traditional secondary schools), establishments that provide technical-professional education (UTU) or rural schools with 7th grade. This initiative forms part of the country's policy of seeking to ensure continuous and complete educational trajectories, implemented by the National Public Education Administration (ANEP), which places particular emphasis on accompanying the transition between educational cycles. The process is not completely automated since, in some cases, it requires the intervention of the director and/or inspector, although this is carried out in the system itself (allocation of places, referrals, communication with family).[35] The criteria for students' allocation to schools are parameterized in GURÍ as regards both the places available and the prioritization criteria.

The city of Bogotá has its own application for an online registration and demand management procedure. Students are allocated to schools in a systematized way as a function of the regulation in force and vacancies. In the state of Espírito Santo, an online enrollment platform is used to apply for a place in the state's public network, with families allowed to select up to three institutions of their choice. The allocation criterion is geo-referenced.



3.2. ISSUE OF GRADES, CERTIFICATES AND DIPLOMAS

Process for the issue of grades, certificates and diplomas: emergent.[36]

At the end of each school year, schools must electronically manage requests for the issue, registration and certification of grades and diplomas for the different educational levels. These documents must be issued and registered by the central administration and sent to schools to be signed by the director and handed out to the students. The education systems with the highest level of development in this field are those of the province of Córdoba, Paraguay, the province of Santa Fe and Uruguay.

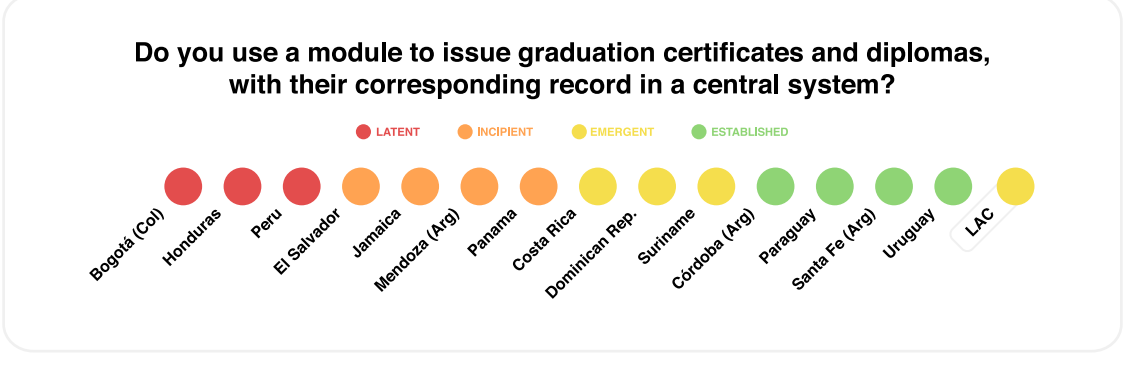
The province of Córdoba has a format for issuing grades at the central level that is validated at the national level. In Paraguay, management of grades is partially digital. Students' data

35 If there are no vacancies at the family's first option, the student is assigned to a school by the inspector.

36 Data not available for the state of Espírito Santo or the Florianópolis municipality.

is taken from the Unique Student Register (RUE) and certificates and diplomas are printed centrally. They are then sent to schools and are registered in a central system. In Uruguay, the GURÍ system does not use electronic signatures and does not issue certificates; instead, it produces reports that are printed for signing by the school director. When moving on to secondary education, students receive a certificate of promotion. In the city of Bogotá, schools manage grades, certificates and diplomas autonomously. The Education Secretariat does not validate, certify or register grades.

Costa Rica, El Salvador and the Dominican Republic have specific parallel systems for issuing secondary school grades These systems are not interoperable with other ministry systems. In Suriname, 8th grade (lower secondary) certificates are generated centrally and depend on the results of tests carried out by the Suriname Examination Office. In upper secondary education, schools generate and issue diplomas in accordance with the requirements of the Education Ministry.



3.3. COMPLEMENTARY SERVICES FOR STUDENTS

When the public sector provides students with complementary services such as school meals, transport or scholarships, these must be managed through the SIGED in a systematized manner.[37] Information about the benefits received by each student must be recorded in the unique student register. The different levels of management of education, including the central level, must be able to monitor the benefits received daily by each student. If transactions for the provision of complementary services are managed through the SIGED, they should be registered as data associated with each student.

Management of school meals: incipient.[38]

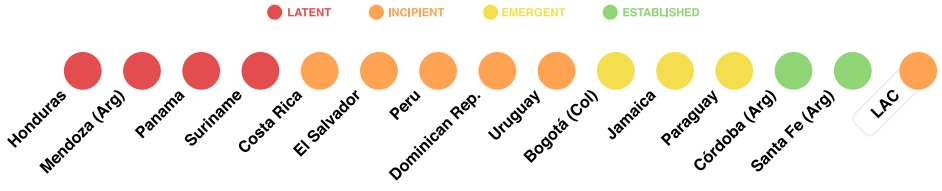
The city of Bogotá, the province of Córdoba, Costa Rica, El Salvador, Honduras, Jamaica, the province of Mendoza, Panama, Paraguay, Peru, the Dominican Republic and Uruguay all have

37 If there are no vacancies at the family's first option, the student is assigned to a school by the inspector.

38 Data not available for the state of Espírito Santo or the Florianópolis municipality.

some type of school meal program.[39] The most advanced in their management are the province of Córdoba and Santa Fe. The former has a regulated management procedure, albeit with opportunities for improvement in its systematization. The province of Córdoba uses the PAICor for all management of school meals.

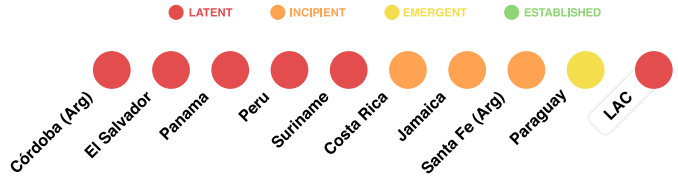
Do you have a systematized process to manage school meals by student?



Management of scholarships: latent.[40]

Very few education systems have scholarship programs in the public sector for early, primary or secondary education. Out of the cases analyzed, only Costa Rica, El Salvador, Jamaica, Panama, Paraguay and Peru offer some scholarships.[41] The most advanced in this regard is Paraguay where the program is managed mainly through the RUE system in a nominal manner, although challenges arise when educational establishments have not yet confirmed student enrollment in the RUE system, particularly at the beginning of the school year. In Panama, the Institute for the Training and Use of Human Resources (IFARHU) has several scholarship programs. In 2019, it awarded scholarships to 711,582 general primary and secondary students, representing a total outlay of US$230 million (IFARHU, 2019). IFARHU is an independent institution and the Education Ministry does not have information about its scholarship holders.

Do you have a process to manage scholarships by student?



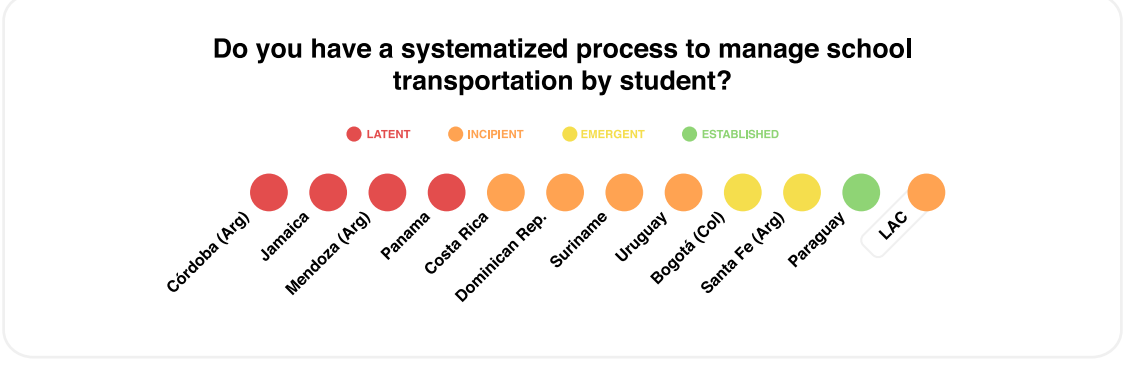
39 Data about school meals not available for the state of Espírito Santo or the Florianópolis municipality.

40 Data not available for the city of Bogotá, the state of Espírito Santo, the Florianópolis municipality, Honduras, the province of Mendoza, the Dominican Republic or Uruguay.

41 Data about scholarships not available for the state of Espírito Santo or the Florianópolis municipality.

Management of school transport: incipient.[42]

The modes of school transport most commonly observed in the case studies are buses for students and subsidies for the use of traditional public transport. The city of Bogotá, Costa Rica, the province of Mendoza, Paraguay, the Dominican Republic, Suriname and Uruguay have school transport services[43] Paraguay is the most advanced in terms of their management. It implements a systematized procedure through the RUE system under which a digital list of confirmed students is prepared for each school cycle and sent to the Vice-Ministry of Transport, which is responsible for generating the reduced-fare tickets provided by the national state. The city of Bogotá has a regulated procedure for school transport, but it is not systematized or integrated with the unique student register. Costa Rica has a system in which, at the beginning of each school year, the school director inputs information about students requiring transport, entering the route and the type of transport required (type of road, bus). A certain amount is given to each student and the family chooses the means of transport to be used. There are no integrated registers of this information.



3.4. COMMUNICATION WITH PARENTS

Portal for communication with parents: incipient.

Technology can facilitate communication between the school and the family. In traditional models of education, teachers sent notes to parents through the students and, for more serious issues, contacted the family by phone. Parents and teachers only saw each other in person at parents' meetings and meetings for the distribution of report cards. Web portals for parents facilitate interaction between the school and the family and enable parents to monitor the information available about the student in real time. The most advanced education system in this field is that of Uruguay. Through the GURÍ Familia portal, parents can access the information that the school provides about their children such as personal data, attendance, grades, teachers in charge and communications. Like directors and teachers, the Council for Early and Primary

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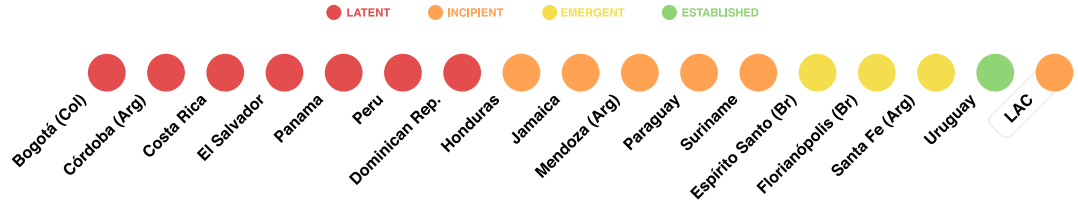
42 Data not available for El Salvador, the state of Espírito Santo, the Florianópolis municipality, Honduras or Peru.

43 In Peru, the Education Ministry's Rutas Solidarias (Solidarity Routes) program has provided 123,040 bicycles for secondary students in rural areas. Jamaica has a pilot transport services program for 7,500 students at 266 secondary schools in rural areas. Panama has a universal public transport subsidy for students.

Education (CEIP) can send messages to students' families and enable an option for them to reply. In the state of Espírito Santo, parents have online access to the information provided by their children's school about grades and attendance. The Florianópolis municipality has a student portal with information for parents and students, but not all schools upload complete information.

Do you provide parents and legal tutors with online information from the updated student records?



Transversal aspects of the management of students and learning

• Low level of provision of information in real time about students for the system's different actors:

In general, little use is made of data from the unique student register to provide accurate information in real time. This data should be available with viewing rights and privileges for the different actors in the education system (director, supervisor, level director, administrative areas, central and decentralized political authorities). In Uruguay, the GURÍ system is used to generate different reports, with differentiated levels of access, for the Education Council and school directors, inspectors and teachers. In the state of Espírito Santo, each user has an access profile. The profile of the director, for example, shows the percentage of attendance and classes taught.

• Low level of articulation with key systems such as those for managing positions and teachers:

With some exceptions, the platforms used for the student management process function as information-collection systems and are not integrated with other complementary tools. In addition, a low level of articulation with the systems used in the other SIGED processes hampers immediate response to elementary requirements such as identification of the teacher responsible for each student. This is important when analyzing educational/professional trajectories and the performance of students and teachers, at both the school and central levels.

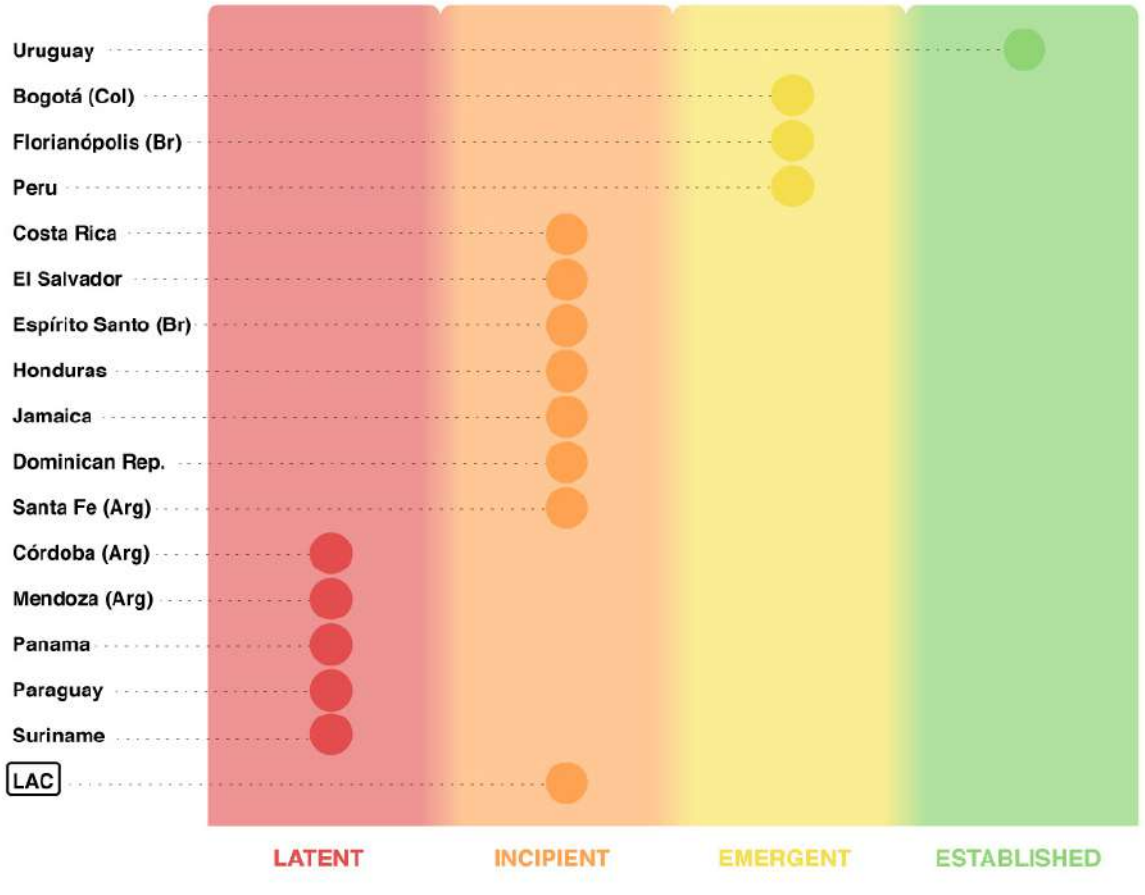
PROCESS 5:

Management of digital content for student learning and teacher training: Incipient

This study shows that, on average, management of digital content has an incipient level of development (level 2 out of 4) and that most of the cases analyzed correspond to the latent or incipient level (Figure 3.7).

FIGURE 3.7

Level of development of SIGEDs: digital content for student learning and teacher training



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

Broadly speaking, the different countries have made important efforts to provide digital content and platforms to support student learning and teacher training. Uruguay is the most advanced and has reached an established level of development in this field. Its digital transformation in education has been driven mainly by Plan Ceibal, an autonomous body responsible for providing digital content for primary and lower secondary education, managing learning platforms and resource repositories, implementing certain programs (such as Ceibal in English

and digital laboratories) and training teachers, based on the deep learning methodology. Students and teachers have access to a number of learning platforms (such as PAM and Matific), learning management platforms (such as CREA), digital content (applications and games) and repositories such as the digital library and open educational resources.

The city of Bogotá, the Florianópolis municipality and Peru have reached an emergent level of development in this field. It is worth highlighting the case of Peru, which has achieved significant development in the use of digital content for teacher training. Its Education Ministry has a teacher training plan, based on the needs of the curriculum, and a digital tool for online support and monitoring of teacher training throughout the sector. Teachers have continuous access to digital content designed for their professional development. They also have at their disposal a central repository of digital content classified by educational level, modality, type of resource and area. However, there has been little development of the use of digital content for students.

Digital content comprises all the pedagogical resources that can be accessed online or asynchronously. Efficient management of digital content is based on curricular demands and guarantees access, regardless of the beneficiary's location. As more technology is incorporated into pedagogical practices, in an established SIGED, digital content must be managed in such a way as to support students' syllabuses. Indeed, there is evidence that the guided use of technology in the classroom can improve learning (Arias Ortiz and Cristia, 2014). With the closure of schools due to COVID-19, countries have had to move rapidly to emergency remote education models (IDB, 2020a). Many have relied on digital media to give continuity to educational work, supplementing them with analog means of reaching populations without access to digital media. This situation, which called for prioritization within the curriculum, revealed a need for greater alignment between digital content and the curriculum. The transition to hybrid teaching schemes only underscores the importance of digital content (IDB, 2020b).

Teachers should have access to a repository of digital resources organized by, at least, grade and subject to which they can turn at any time to obtain timely and relevant content for incorporation into their teaching. Given the increasing availability of digital resources, it is key to have a central area that defines guidelines on the digital content to be used and ensures quality standards and interoperability criteria between different systems and providers. With the necessary business intelligence (BI) arrangements, the different support tools for the use of digital resources can serve to monitor student performance. Some of these tools, such as adaptive platforms, permit the personalization of students' learning processes. They include not only content platforms but also learning management system (LMS) platforms through which groups or classes can be kept in contact with the teacher. With all the groups registered in the LMS, the users can upload work, post materials for students, exchange opinions through forums and videoconference with each other while parents can see what their children are doing, including their tests, exams and other activities. It is important that these platforms can be accessed from different devices (computer, cell phone or tablet) and that users can work offline in order to avoid restrictions in cases of limited connectivity.

An established SIGED must support and monitor the plan for teachers' professional development. Basic teacher training is usually the responsibility of higher education institutions, which align it

with the national curriculum, while in-service training is managed by the Education Ministry. In general, teacher training and development plans are drawn up and defined at the central level, while the training itself is implemented, in varying degrees of collaboration, by regional offices or specific suppliers. At the same time, the central level determines the relationship between in-service training and the career structure. In some cases, hours of in-service training count as credits for moving up the career structure. Tools for supporting and monitoring teacher training can facilitate the validation of promotions while providing information about each teacher's individual training history. All this information should also be stored in the unique repository of data on human resources (see Process 3 for a description).

BOX 3.10

Management of digital content: the cases of France and Estonia

France's Mon Lycée system permits the creation and storage of resources using templates and integration with digital resources and third-party services. This system's approach is based on the existence of a control panel or a main desktop as the only point of access to the information, applications and resources that different people or different actors in the provision of educational services may need. This control panel can be customized in line with the user's role and the needs of that role at each moment. The system's modular architecture means that new functions, applications and resources can be added or incorporated as needed. In particular, in the case of digital content, the system includes third-party editorial resources (English Attack!, etc.), pages, a search engine and wiki. For in-service and personalized teacher training, the Ministry of National Education has the M@gistère online platform.

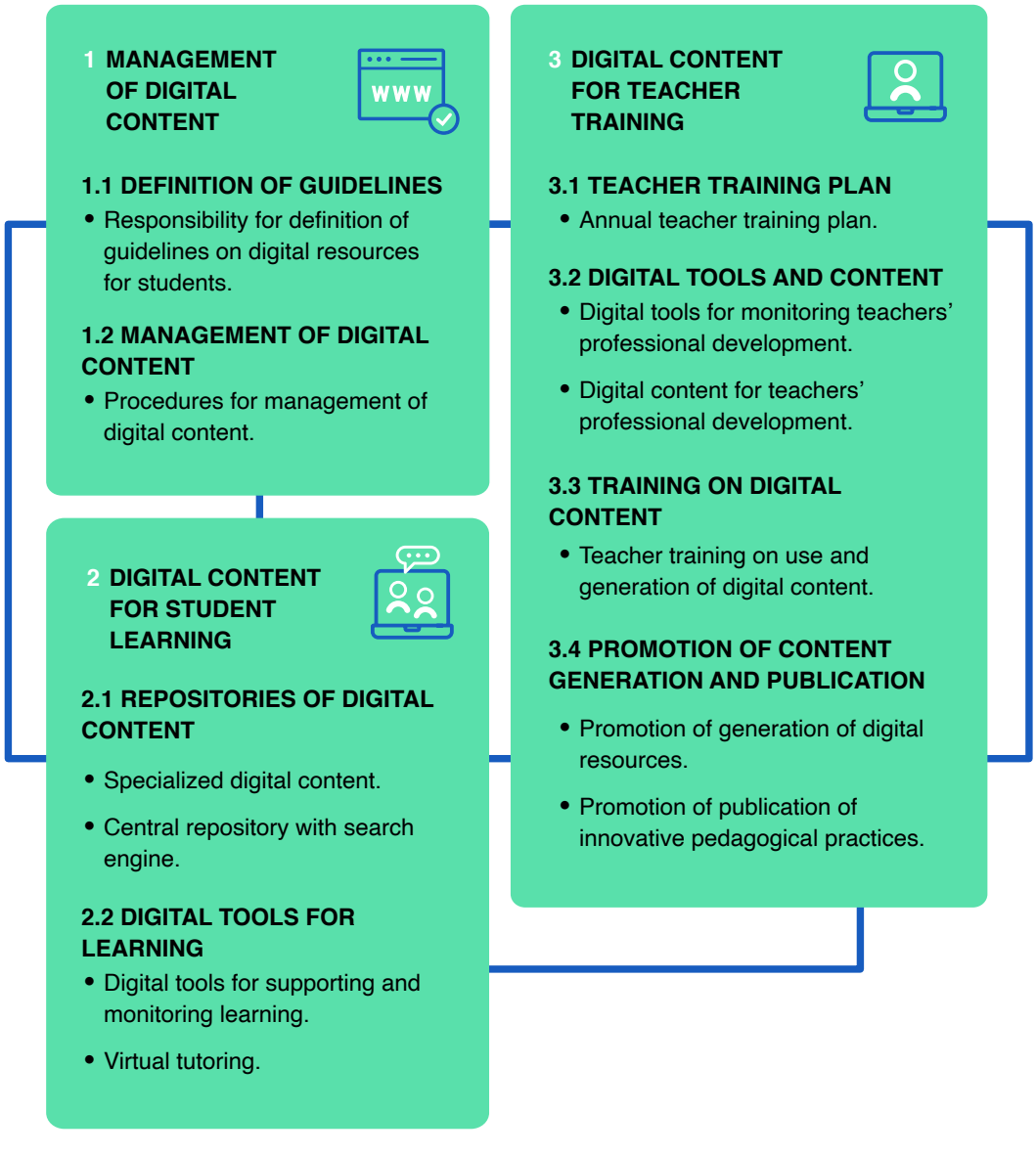
Estonia's e-koollikott is a digital learning resources portal that provides up-to-date didactic materials for teachers' professional enrichment, self-learning by students and the support of parents. It contains educational materials for basic, general and vocational education that are prepared in cooperation with other partners. Estonia also has the Opiq learning platform for the management of educational content. The study materials available there are created by professionals, whether scientists, editors or teachers. Content is verified, edited and reviewed within the platform. In turn, the authors of the material can verify that the content is in line with the national curriculum. The different platforms' interoperability with eKool is key because it facilitates use of all the available resources.

Source: Compiled by authors based on Smith (2019c; 2019b).

For the analysis of arrangements related to the management of digital content for student learning and teacher training, the functionalities are divided into three broad categories: i) management of digital content; ii) digital content for student learning; and iii) digital content for teacher training. The study's results for each category are presented below and a brief description of each functionality is provided, along with a graph with a score, corresponding to the median of the 16 education systems studied that reflects the level of development, and a review of good practices and the experiences of the cases with the highest levels of development.

INFOGRAPHIC 3.7

Summary of functionalities of the management of digital content for student learning and teacher training



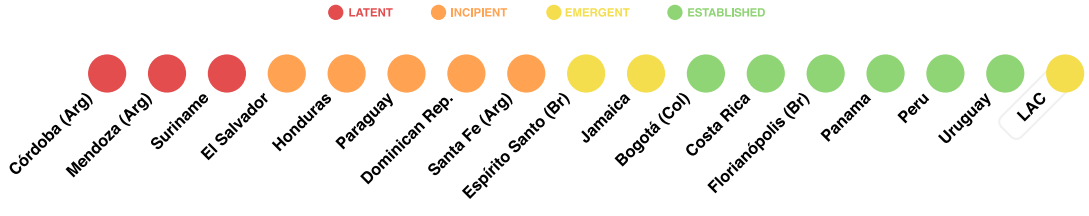
1. MANAGEMENT OF DIGITAL CONTENT

1.1. DEFINITION OF GUIDELINES

Responsibility for definition of guidelines on digital resources for students: emergent.

The increasing availability of digital resources means that an area at the central level is required to define guidelines for all the digital content used in teaching processes. In order to ensure minimum standards, it is also useful for the central level to select and curate digital resources and incorporate them into a repository or portal. The most advanced education systems in this field are those of the city of Bogotá, Costa Rica, the Florianópolis municipality, Panama, Peru and Uruguay, all of which have an area for this purpose. In Panama, the National Directorate of Curriculum and Educational Technology is responsible for promoting the use of technologies in teaching and learning processes and has a specialized area for the generation of digital resources. In Costa Rica, the Directorate of Technological Resources in Education defines guidelines and develops digital resources.

Do you have an area that defines guidelines and uses technologies to generate and use digital resources to develop students' learning and skills?

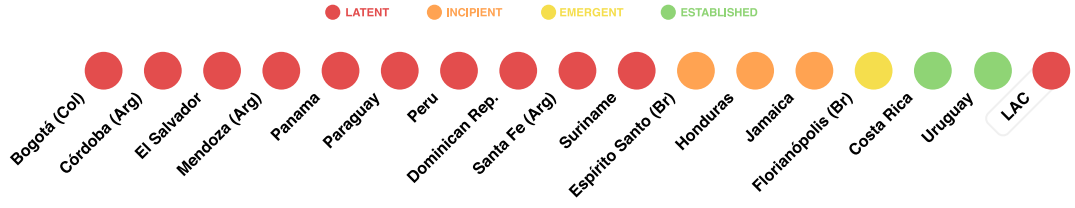


1.2. MANAGEMENT OF DIGITAL CONTENT

Procedures for management of digital content: latent.

Having a procedure for managing digital content means that it is possible to monitor all the stages of its development, including generation of the resource, its analysis, use, evaluation and subsequent publication. Systematization of procedures is vital to facilitate the standardization and monitoring of each element, from the moment the idea arises through to its publication as a duly curated and classified digital resource. The education systems of Costa Rica and Uruguay are the most advanced in this field. In Uruguay, quality control is exercised by the content area of Plan Ceibal in a certified process that is audited annually, from the moment a purchase is mooted through to the resource's validation and use.

Do you have an established process to manage digital content that provides virtual follow-up for generation, analysis, use, evaluation and subsequent publication of the content?



2. DIGITAL CONTENT FOR STUDENT LEARNING

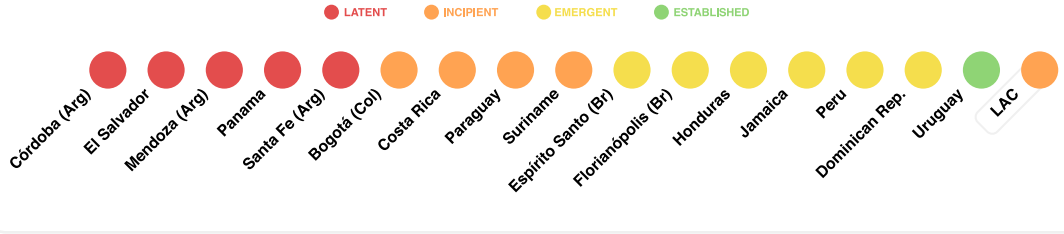
Education ministries can develop content of this type or they can buy packages of specialized digital content. In any case, the content must be aligned with the curriculum and be easy for teachers to access and use.

2.1. REPOSITORIES OF DIGITAL CONTENT

Specialized digital content: incipient.

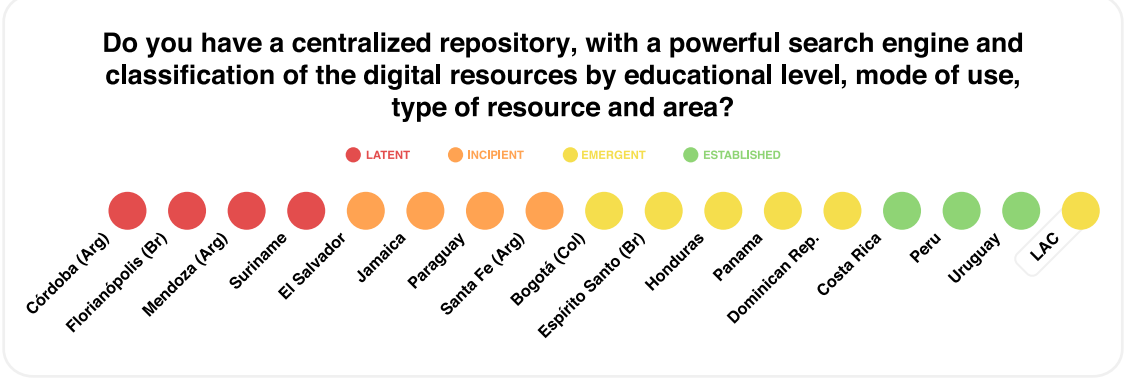
It may be convenient to acquire packages of digital resources for curricular support from specialized publishers when an education ministry does not yet have an area with the experience or capacity to develop content of this type. Out of the cases analyzed in this study, only Uruguay has acquired and developed repositories, doing so through Plan Ceibal. It has also innovated in how this content is acquired by combining traditional procurement models with content development agreements with companies. Through its Digital Republic initiative, the Dominican Republic has acquired a package of simulators (PhET) which, at the time of the study, it was beginning to use in 150 schools. In Honduras, the Education Secretariat commissioned the development of a package of some 1,500 digital resources. The content was selected in light of the results of national tests. In addition, this country's Education Secretariat is a member of the Latin American Network of Education Portals (RELPE) through which it shares resources with countries such as Argentina, Colombia and Chile.

Have you acquired repositories of digital resources to support curricular training from specialized suppliers? Do you use these resources?



Central repository with search engine: emergent.

The use of a central repository facilitates the review and selection of digital content and ensures that all teachers have access to all the existing content from the same access point. The resources in this repository should be organized by, at least, educational level, modality, type of resource and area and the repository should be equipped with a search engine for browsing the content. Advantage can be taken of this classification to determine how the content relates to the official curriculum so that teachers can incorporate it into their teaching more effectively. The education systems of Costa Rica, Peru and Uruguay are the most advanced in this field. Costa Rica has an education portal with resources[44] that uses a standard classification defined by the RELPE where the resources can be found. Each resource in this portal records the number of visits it receives, the number of users who rate/vote the resource and the average number of votes. The case studies carried out identified various portals with digital educational content, but it is important to note that development and use of these resources increased markedly with the closure of schools due to COVID-19 (see Box 3.11).



44 See https://www.mep.go.cr/educatico.

BOX 3.11

Digital content for the continuity of education during the COVID-19 pandemic

The closure of schools in the face of the pandemic led countries to implement emergency remote education models as a temporary measure so as not to interrupt students' learning processes. Given the prevailing digital conditions in education systems and students' homes, the different countries combined digital channels (such as platforms and digital content) with analog channels (such as TV or printed material) in order to reach all students. The rapid deployment of digital content stands out. Some countries already had digital content selected in line with the curriculum while others created it in response to COVID-19. The educational portals through which the countries analyzed have provided digital content are listed below:

- **Argentina:** Seguimos educando.
- **Brazil:** Aprende em casa.
- **Colombia:** Aprender digital, contenidos para todos, which forms part of *Colombia Aprende*
- **Costa Rica:** Aprendo en casa.
- **El Salvador:** Portal educativo del Ministerio de Educación.
- **Honduras:** Educatrachos and Centro educativo virtual.
- **Jamaica:** Book fusion, Learning hub, EduFocal and CHEETAH.
- **Panama:** Educa Panamá.
- **Paraguay:** Tu escuela en casa.
- **Peru:** Aprendo en casa.
- **Dominican Republic:** Eduplan, EDUCANDO, IQ.EDU.DO and enlinea.minerd.edu.do.
- **Uruguay:** Ceibal en casa.

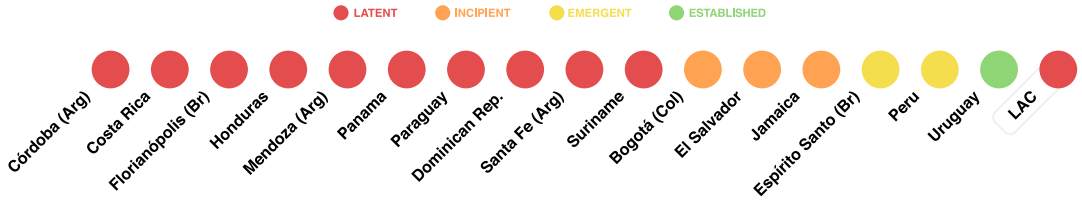
2.2. DIGITAL TOOLS FOR LEARNING

Digital tools for supporting and monitoring learning: latent.

Different digital tools can be used to support teaching, personalize students' experience and monitor learning. This is the case of learning platforms, such as those specialized in mathematics, reading and languages, and virtual laboratories as well as evaluation and distance learning platforms. Learning management system (LMS) platforms not only serve as a channel of communication between teachers and students, but can also be used to manage digital content, assign tasks and monitor and evaluate learning.

Out of the education systems analyzed, the Uruguayan system is the most advanced in terms of the use of digital tools for student learning. Through Plan Ceibal, students and teachers in primary and lower secondary schools have access to a broad menu of tools and platforms. For mathematics classes, they have Matific and the Adaptive Mathematics Platform (PAM, produced by Bettermarks) and, for English classes, the Ceibal program in English under which children in schools are connected by videoconference to a specialized English teacher whilst receiving in-person support from another teacher. This strategy has served to offset Uruguay's shortage of English teachers. Uruguay also has the Online Learning Evaluation System (SEA), a platform that provides teachers with feedback about students' learning. Different assessments are carried out through the SEA: i) training evaluations; ii) autonomous evaluations; iii) English evaluations; iv) reading, writing and speech evaluations; and v) categories of the Global Learning Network. In addition, Uruguay uses Schoology's LMS for Content and Resources for Teaching and Learning, which functions as a learning community and space for virtual collaboration between teachers and students. During the closure of schools due to COVID-19, Uruguay was able to implement an emergency remote education model through different platforms (see Box 3.12).

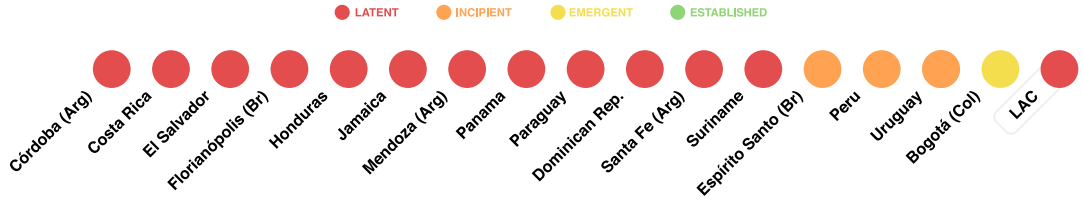
Do you use tools to support and monitor students' learning and skill development?



Virtual tutoring: latent.

Virtual tutorials, given either synchronously and asynchronously, can be used to reinforce specific subjects where learning difficulties have been detected. When held virtually, the group can include students from different schools. The case studies indicate that there has been little development of this option in LAC. The city of Bogotá has a tutoring program, but only in the in-person mode. In Uruguay, the Ceibal English program for secondary students offers options in the conversation class mode on aspects of writing, differentiated by level.

Do you use a transversal virtual tutoring scheme (asynchronous and/or synchronous teaching), used as a measure to support specific subjects within students' curricula in the case that learning difficulties are detected (according to pedagogical indicators)?



BOX 3.12

Platforms and the closure of schools: the case of Uruguay

Uruguay was the only LAC country with the basic digital conditions to respond to the pandemic by moving to a completely digital emergency remote education model. Thanks to Plan Ceibal, this country had devices, content platforms and learning management systems for all students. Extensive training in the use of these tools had been provided for teachers and new pedagogical practices were being promoted. The platforms used in Uruguay include:

- CREA: This virtual learning platform, with an educational social network logic, seeks to make learning more dynamic through collaboration and constant communication between students, teachers and families.

- PAM: This mathematics platform, with more than 100,000 activities, adapts to each student's learning pace and allows teachers to provide individualized attention. The levels of the activities range from the 3rd year of primary school to the 3rd year of secondary education.

- Matific: This mathematics platform was introduced only recently and is designed for children from early education (level 5) through to the 6th year of primary school. Through activities lasting approximately five to 15 minutes, it addresses specific math concepts. It allows the teacher to record the score and performance of each student.

In Uruguay, the use of platforms is not mandatory in the education system. However, during the closure of schools, the number of teachers and students accessing the learning management system increased fourfold compared to before the pandemic; more than 75% of students and over 84% of teachers connected to the platform.

Source: Compiled by authors based on Ithurralde (2019b) and Pérez Alfaro (2020).

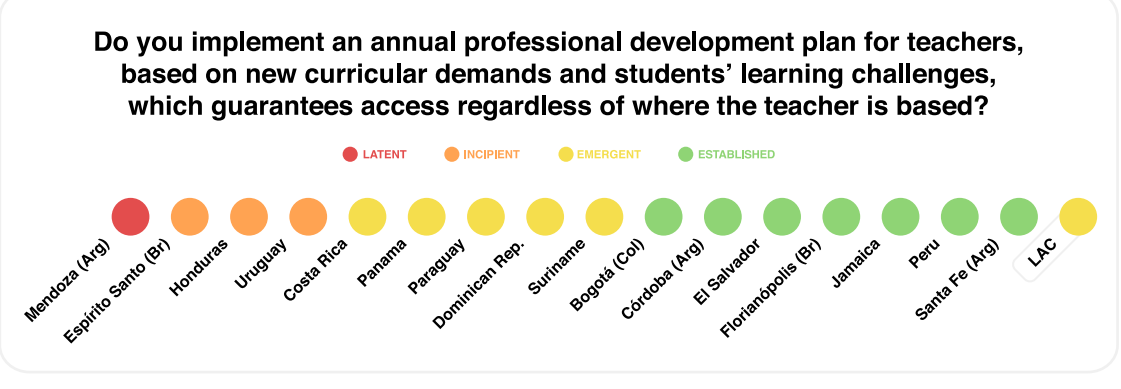
3. DIGITAL CONTENT FOR TEACHER TRAINING

Platforms and digital content can also be used for teacher training. When virtual, they can facilitate the mass implementation of short in-service training courses that would otherwise require important logistical arrangements. Digital resources also have the advantage that teachers can consult them at any time and use them to reinforce specific content depending on their particular needs.

3.1. TEACHER TRAINING PLAN

Annual teacher training plan: emergent.

Annual teacher training plans should be based on new curricular demands and the needs of teachers and should guarantee access for all teachers, regardless of their geographical location. Systematization of teacher training needs, which is a challenge in most of the education systems analyzed for this study, would permit the design of plans compatible with the curriculum that fully address teachers' requirements. A number of the region's education systems have achieved a good level of development, including particularly those of the city of Bogotá, the province of Córdoba, El Salvador, the Florianópolis municipality, Jamaica, Peru and the province of Santa Fe.



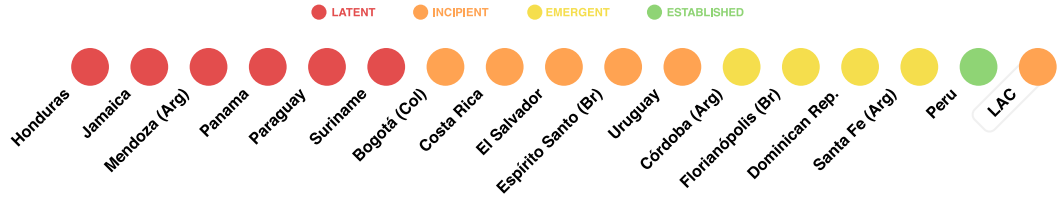
Peru's In-Service Teacher Training Directorate (DIFODS) implements a plan that includes both in-person and virtual training (DIFODS In-Service Training Plan). The platform has between 25,000 and 30,000 registered users. Teacher training also includes a number of Massive Open Online Courses (MOOCs) each year. In the province of Córdoba, the Moodle platform provides courses for all teachers, which are combined with other types of training. In El Salvador, a survey conducted in 2014 revealed shortcomings in teachers' knowledge of subjects on the curriculum and pedagogical methodology and, in 2015, a global plan was drawn up and is implemented each year, with adjustments for new curricular demands. So far, 80,000 primary and secondary teachers (26,000 per year) have participated in virtual and in-person training under the plan, which is supported by an LMS where teachers can access specific material from the training process.

3.2. DIGITAL TOOLS AND CONTENT

Digital tools for monitoring teachers' professional development: incipient.

Digital tools can facilitate monitoring of the professional development plan for teachers. Peru uses the PerúEduca Digital Learning System, a program managed by the Directorate of Technological Innovation in Education (DITE) that combines a content manager with a virtual classroom. In Florianópolis, the Municipal Education Secretariat uses the SISEF system to monitor teacher training. The Dominican Republic uses a system known as SCAT to record the list of scholarship holders, the results (if the course was completed and the grades obtained) and the payments of each scholarship holder. It also has a history of all training processes. This information is not integrated into the human resources system.

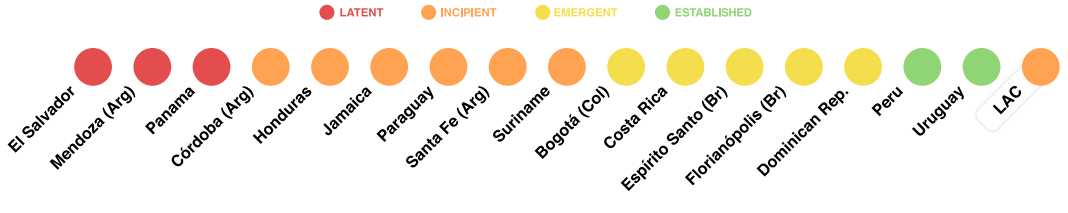
Does your educational system implement digital support and monitoring tools for teacher's professional development?



Digital content for teachers' professional development: incipient.

All virtual teacher training content can be distributed in digital format or used through platforms such as LMS. The education system that stands out in this field is that of Uruguay. Plan Ceibal has an area that focuses on the development of digital content and a certified management process that is audited annually. All this content is available on the CREA platform, Uruguay's main LMS. In addition, it has a digital library with official textbooks and a repository of open educational resources where teachers share the resources they develop. In Peru, the PerúEduca platform provides digital resources.[45] In the case of Jamaica, the Education Ministry has an alliance with the British Council and the OASIS Virtual Campus (similar to Edx) for the provision of online courses and programs for teachers. Although there is a charge for the certificate of course completion, the content is available free-of-charge.

Do teachers have access to digital content for their professional development and is this content incorporated in Learning Management System (LMS) tools?

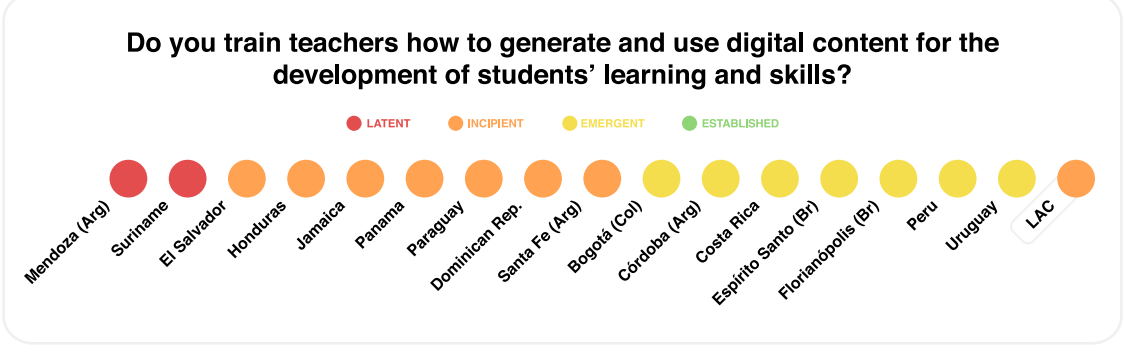


45 The main users are teachers. However, regional officials, students, parents and other actors also use the platform.

3.3. TRAINING ON DIGITAL CONTENT

Teacher training on use and generation of digital content: incipient.

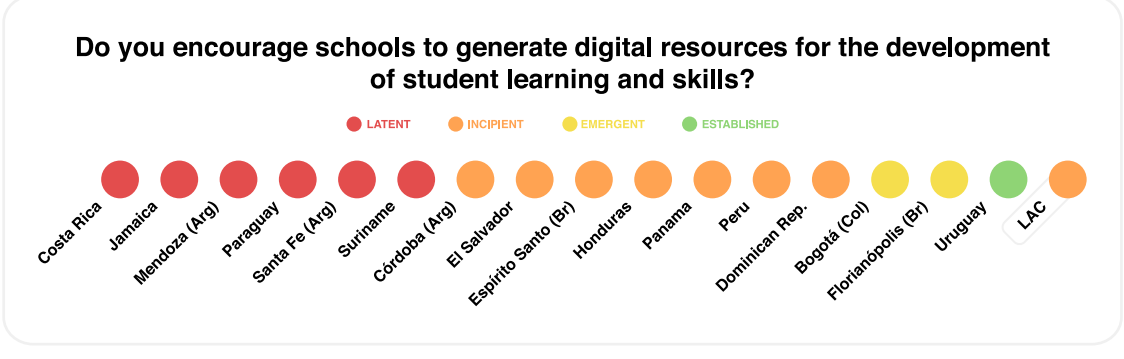
One of the objectives of an education system should be for teachers to know how to use and generate digital content. The results of the PISA 2018 test revealed a low level incorporation of technologies in the classroom (Rieble-Aubourg and Viteri, 2020). The training of teachers in the use and creation of digital content can contribute to better use of digital technologies in the classroom. In a number of the region's education systems, training initiatives or programs of this type were observed, but none of them were of universal scope. Costa Rica offers scholarships for training in tools for the creation of digital resources and, although they are not massive in scope, the country does have a specific plan for this purpose. In Uruguay, Plan Ceibal provides training of different types for teachers and also encourages the creation of digital content through Open Educational Resources (REA). Whenever new content is created, a teacher's guide or support material is prepared for its classroom use.



3.4. PROMOTION OF CONTENT GENERATION AND PUBLICATION

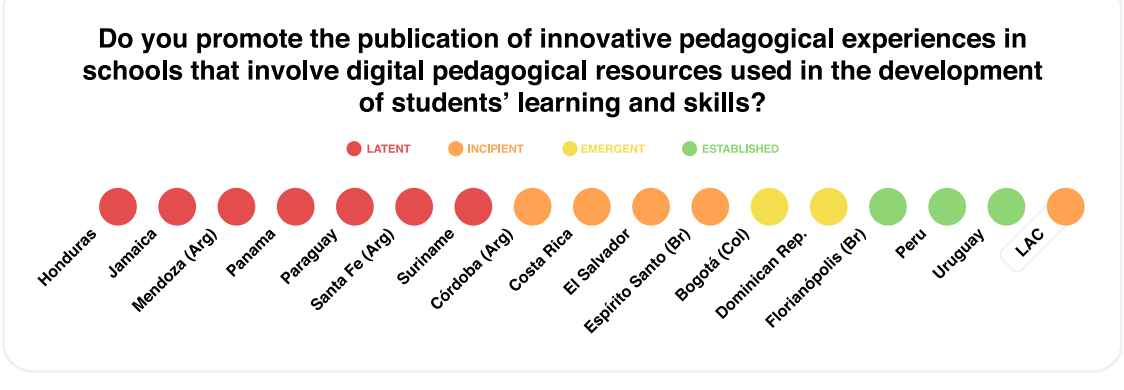
Promotion of generation of digital resources: incipient.

Many of teachers' pedagogical practices and their knowledge can serve as the basis on which they themselves can generate digital content. Once reviewed and curated, this content can be made available to the community of teachers and students. In Uruguay, content creation by teachers is fostered by Open Educational Resources (REA) and Plan Ceibal, which hosts a website called ITC Toolkits (https://valijas.ceibal.edu.uy/) where teachers are invited to create digital content with their students. In the Florianópolis municipality, the Department of Educational Technologies implements a number of initiatives to encourage the creation of digital resources.



Promotion of publication of innovative pedagogical practices: incipient.

Promotion of the publication of innovative pedagogical practices can serve as an incentive for teachers to innovate constantly and help to scale up the use of effective practices that contribute to improving student performance. The most advanced education systems in this area are those of the Florianópolis municipality, Peru and Uruguay. In Peru, the database of participants in the National Good Teaching Practices Contest and its winners is systematized. In addition, participants answer an annual survey about various aspects of good practices, from their inception to their implementation and monitoring. These innovative pedagogical experiences developed in schools are published on PerúEduca, the content management platform for teachers. The Florianópolis municipality holds seminars and socialization activities to publicize good practices.



Transversal aspects of the management of digital resources

• Low level of provision of information in real time about teachers' profile and online training:

In the education systems analyzed, accurate, real-time information about the management of digital content is rare. This data should be available with viewing rights and privileges for the different actors in the education system (director, supervisor, level director, administrative areas, central and decentralized political authorities). Instead, the data contained in the different learning platforms is not integrated with registers of students or teachers. Uruguay, for example, has separate registers for the teacher and student training programs implemented by the In-Service Training Institute (IFS), Plan Ceibal and the SEA. In the city of Bogotá, the virtual classrooms of Espacio Maestro for digital teacher training have monitoring and information provision tools. However, this information is stored only in the Virtual Space and is not integrated with the unique teacher register.

• Low level of articulation of teacher training sub-processes and the way demand is calculated:

Except in the case of Uruguay, results are provided in isolated form, without systematization and upon request. There is little association of digital resources with the curricular model and the articulation of this process with others is limited since, in general, the results of, for example, training processes are not integrated into the unique register of teachers (see Process 3: Management of human and budgetary resources). These aspects are important for the integral evaluation of teachers' performance.

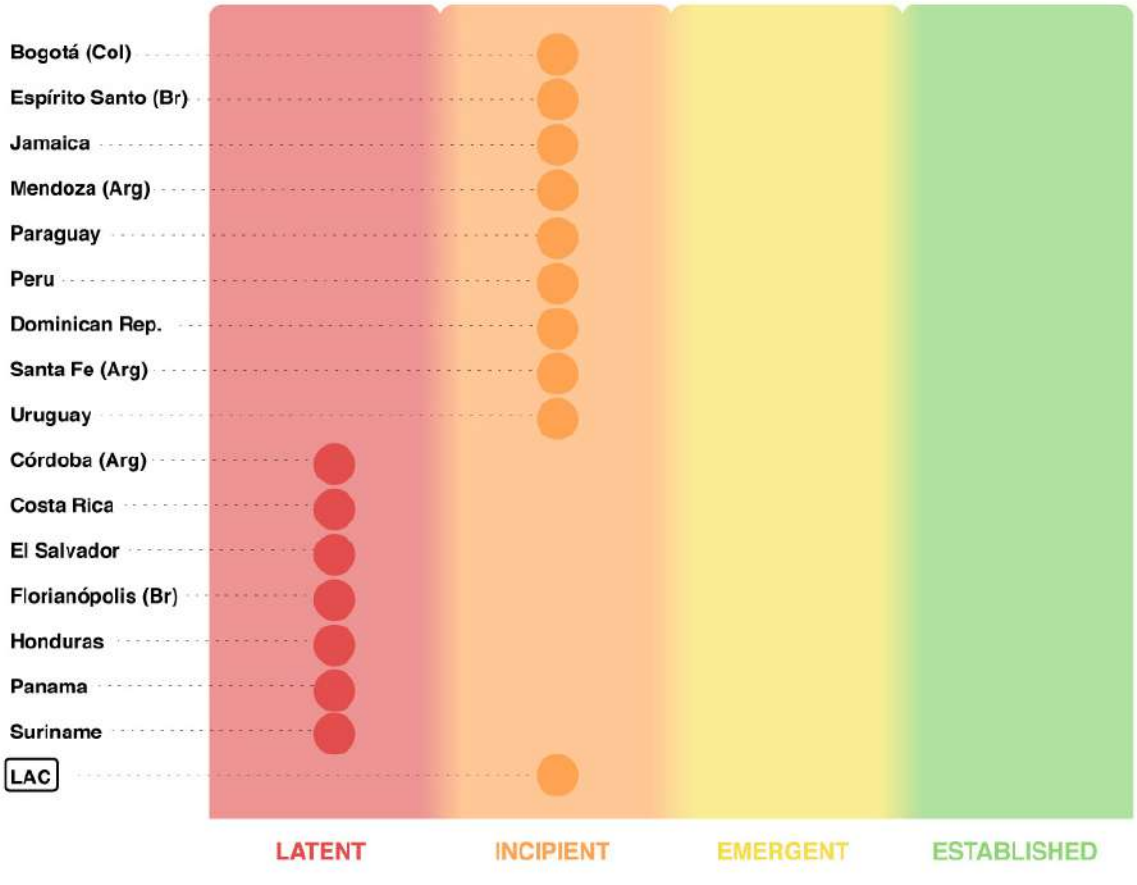
PROCESS 6:

Tools for strategic management: Incipient

The study's results indicate an incipient level of development (level 2 out of 4) of tools for strategic management. Most education systems are at a latent or incipient level of development in this field (Figure 3.8) and none of those analyzed had achieved an emergent or established level.

FIGURE 3.8

Level of development of SIGEDs: tools for strategic management



Source: Compiled by authors.
Note: Within the same category, countries are in alphabetical order.

Among the education systems at an incipient level of development, the Dominican Republic stands out for its development of a business intelligence tool with a series of dashboards, which it has recently begun to use at middle management levels. This tool was developed and is maintained in a participatory manner. Information requirements are determined through workspaces integrated by various sectors. The dashboards or reports are designed, produced

and administered directly by the users responsible for them. More than 200 government officials have been trained in the tool's use. The main challenge is to improve the quality of the data used by it and the frequency with which it is updated. This is important because, as well as deploying tools, it is necessary to make efficient use of the information they produce. If the data fed into these tools is precarious, the impact on management can be counterproductive. In other words, if the data generated by the SIGED processes is not of the required quality, the tool that processes it will produce inconsistent and/or obsolete results, limiting their use and contribution to the education system's management. A further challenge is to provide schools with dashboards they can use in their daily management.

Uruguay has a Primary Education Monitor, which uses data from the GURÍ education management system to generate/visualize some individual or combined student performance indicators for the different levels (enrollment, attendance, grade repetition rate and average group size). It also permits comparisons over time at the section, school, supervisory circuit, regional or administrative headquarters levels. It has a module that provides information about the population at risk of dropout. However, the Council for Early and Primary Education (CEIP) does not have business intelligence tools and, instead, generates certain indicators through SQL queries or by processing specific data. Similarly, it does not have dashboards that incorporate data from the learning platforms managed by Plan Ceibal. The latter has its own business intelligence tool - IBM Cognos - for monitoring its programs and platforms and extracts reports that can be accessed by each of the areas. Although this study found an important level of development in this field, there is a pending challenge as regards the generation of information that integrates multiple SIGED processes (for example, indicators that bring together data on teaching positions, the organic and functional structure, school places, students and building infrastructure).

Tools for strategic management include the information for decision-making that is generated by daily management of the different levels of the education system. These tools can take the form of individual indicators or management dashboards and, in turn, can serve as an input for management. Each procedure and activity carried out in the education system - for example, the registration of a student's absence or grades or the hiring of a new teacher - is recorded in the different applications as data. Using business intelligence tools, this data is processed and presented as indicators with different levels of disaggregation. In this way, a teacher can easily monitor students' performance or absences while a director can compare this same information by school year and section. These indicators can also be visualized by geographical area or groups of schools, enabling the regional and central levels to monitor the education system and providing information for policy design. Independently of the use of business intelligence tools, the capacity of education systems to generate useful indicators for all levels of management depends on the availability and quality of data.

However, in systems with little digital basis, the data generated on a daily basis in education systems is often recorded on paper or scattered across different registers. This could be mentioned as one of the causes of the top-down approach characteristic of the region's SIGEDs. In response to a lack of access to the information they need, the different departments at the

central level develop specific information-gathering mechanisms, and this may also occur in sub-national offices. This means that schools must record the same information more than once on different spreadsheets or in different systems. It is also common for data to be reported at the school year, section, or school level, and not at the nominal level (by student). This culture of information gathering, closer to the logic of a census, is in marked contrast to efficient SIGED practices under which a unique data repository (data warehouse), updated as processes advance and managed in the transactional support systems, serves to generate any indicator or information required for management. It also represents a major limitation on the use of data for integral analysis of educational quality, budget planning, the calculation of optimal staffing levels, the projection of building infrastructure needs, the monitoring of individual student trajectories, research and the cross-referencing of data arising from the numerous SIGED sub-processes.

BOX 3.13

Tools for strategic management: the cases of England and Estonia

At the level of the school or group of schools, England uses the SIMS SchoolView module to gather the data required for an overall view of a school's key performance indicators (KPIs). The information can be organized and presented according to students' demographic data. The dashboards, which use data from all the SIMS modules, offer a complete overview of schools in terms of the indicators established, such as student attendance, number of students, conduct, evaluation, information about personnel and the status of students with special educational needs (SEN). As it is a web module, the information can be accessed and viewed from different devices with Internet access. In addition, the SIMS Assessment module shows historical or real-time information about students or individuals, permitting the detection of risks and difficulties in the learning processes. With this module, it is possible to locate and document all the information related to the evaluation of students and their performance and, at the same time, monitor their progress in relation to the syllabus. The module can be adapted to each school's syllabus, topics and subjects can be added and it supports both continuous and accumulated evaluation. Evaluation data can be viewed graphically using SIMS Discover, which permits rapid analysis of both specific KPIs and the performance of groups or classes. Finally, the SIMS Teacher application allows teachers to view individual data about their students and information about attendance, evaluations and performance.

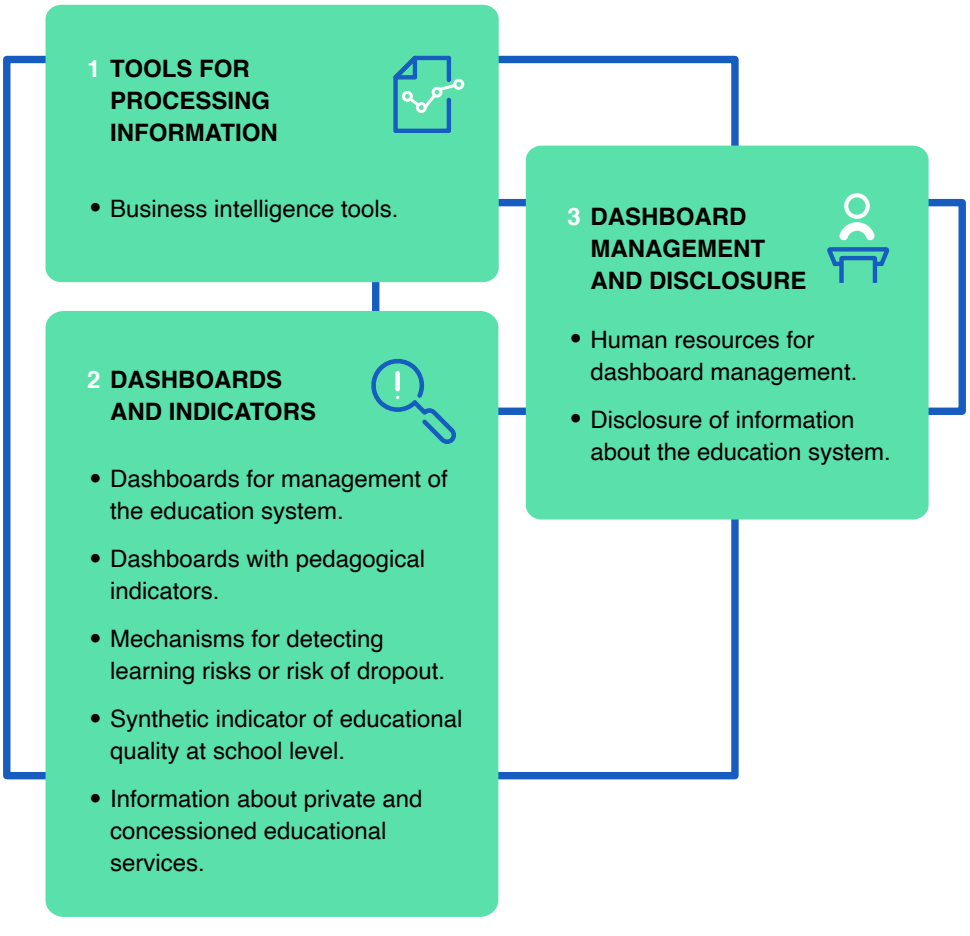
In Estonia, the eKool system has different dashboards and report generators for strategic management and reporting obligations. It integrates different types of data, including a discipline module, attendance data, school-level workload data, a list of resources and reserves, grades and a register of students. One of the dashboards compares schools on attendance and grades. In addition, the system produces automatic reports generated specifically for the protection of educational trajectories, identifying students at risk. The data can be presented at different levels of aggregation, depending on the type of user.

Source: Compiled by authors based on Smith (2019d; 2019b).

For the analysis of arrangements related to tools for strategic management, the functionalities are divided into three broad categories: i) tools for processing information; ii) dashboards and indicators; and iii) dashboard management and disclosure. The study's results for each category are presented below and a brief description of each functionality is provided, along with a graph with a score, corresponding to the median of the 16 education systems studied that reflects the level of development, and a review of good practices and the experiences of the cases with the highest levels of development.

INFOGRAPHIC 3.8

Summary of functionalities of process of tools for strategic management

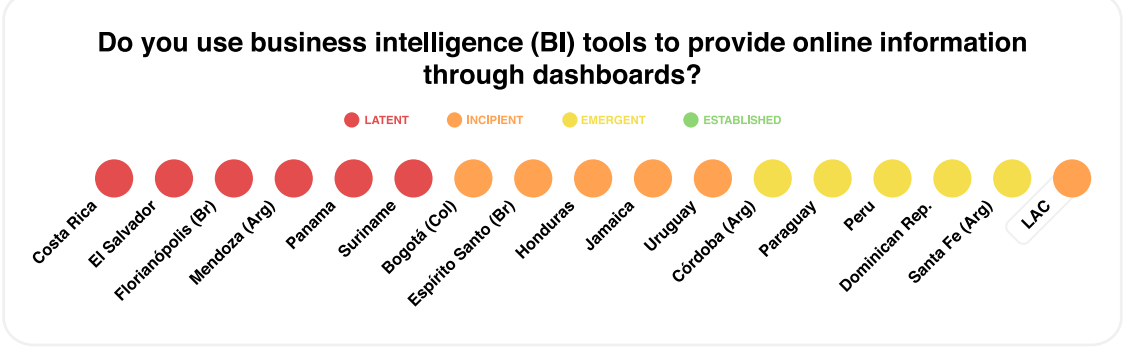


1 TOOLS FOR PROCESSING INFORMATION

Business intelligence tools: incipient.

Business intelligence tools are applications designed to support the visualization of key indicators by generating dashboards pragmatically.[46] With tools of this type, the different managers of the education system can generate dashboards dynamically. Despite their usefulness, none of the education systems analyzed has business intelligence tools that generate online information in the form of dashboards for all the education system. However, significant development in this field is seen, particularly in the province of Córdoba, Paraguay, Peru, the Dominican Republic and the province of Santa Fe.

The Dominican Republic uses Microsoft Power BI and has a unique data repository that integrates information from numerous different systems and spreadsheets. The quality of the data and the frequency with which it is updated limit the tool's use. However, the data source for the dashboards could be modified without significantly impacting the design of the information presented. Peru uses the Integrated Information System (SIDI), an application developed in Power BI that consolidates information from 13 different data sources. It provides updated dashboards in four categories: learning, teaching, modernization of management, and infrastructure. In Uruguay, although the Council for Early and Primary Education (CEIP) does not have business intelligence tools, Plan Ceibal uses IBM Cognos to process information from learning platforms.



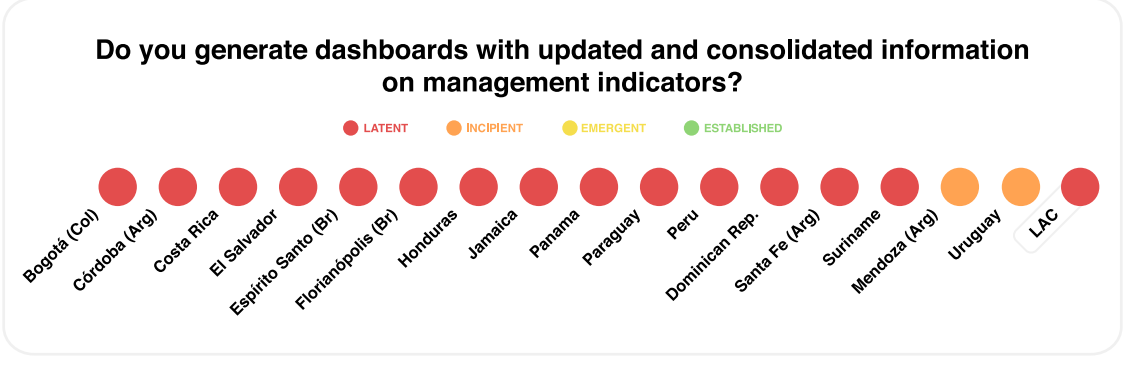
2 DASHBOARDS AND INDICATORS

Dashboards for management of the education system: latent.

In the education systems analyzed, there has been little development of dashboards with management indicators, such as positions (occupied or vacant), medical and administrative absenteeism, salary payments or occupation of school buildings. Uruguay uses SQL queries to generate some management indicators, including indicators of positions, medical and administrative absenteeism and outlay on student benefits such as transport and school meals. The Dominican Republic has dashboards for salary payments by position and level. Peru's

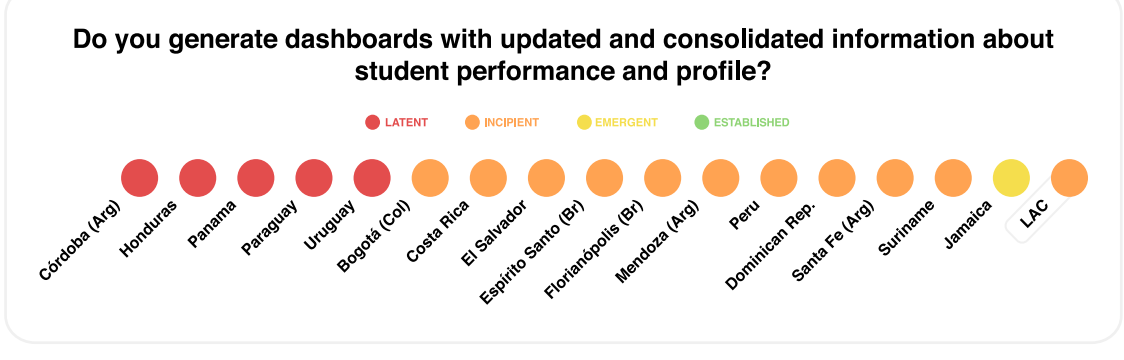
46 Examples of business intelligence tools include Power BI, IBM Cognos, Oracle BI, Sisense and QlikView.

Integrated Information System (SIDI) generates indicators of occupied and vacant positions using information from the Nexus system for the administration and control of teaching positions. The SIDI also uses data from the Information System for Support of the Management of Educational Institutions (SIAGIE) and the Education Census to produce indicators on the relationship between teaching positions and students and the occupation of school buildings.



Dashboards with pedagogical indicators: latent.

Similarly, there has been little development of dashboards with information about students' performance and profile. Although education ministries commonly produce regular reports with descriptive statistics about the education system, these are generally not supported by dashboards with updated indicators. The Dominican Republic has dashboards for some indicators of educational progress (dropout, completion or repetition of year) and the results of national diagnostic tests. In the state of Espírito Santo, dashboards for school directors have been developed with basic indicators such as attendance. Dashboards facilitate the comparison of indicators across schools, providing strategic information for decision-making and the implementation of improvements. Some examples of pedagogical and management indicators are presented in Box 3.14.



BOX 3.14

Examples of dashboard indicators expected in an established SIGED

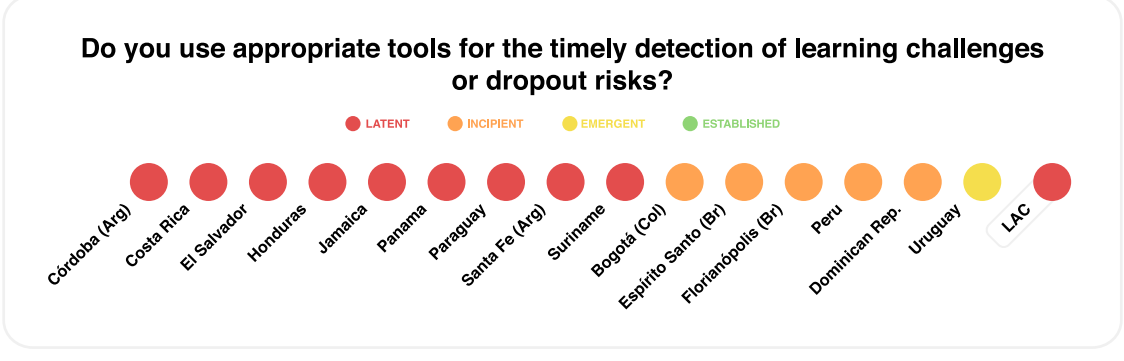
The indicators that are useful for managing an education system and monitoring students include:

- Indicators of individual and collective student performance;
- Historical evolution of teaching positions (occupied, vacant, etc.);
- Trends in absenteeism on medical and administrative grounds;
- Trends in monthly salary payments;
- Positions assigned (in classroom and total) in relation to number of students;
- Occupation of school buildings;
- Real square meters used per student per school classroom;
- Total investment by school compared to academic results;
- Investment in student benefits (transport, school meals, scholarships) compared to academic results;
- Investment in school buildings, with variations in investment per square meter, locality or area (with comparisons):
- Indicators of educational quality, by school and compared with the supervision circuit;
- Indicators with consolidated pedagogical information about private schools.

Multiple dimensions:
the construction and presentation of the information in the indicators should be such as to permit its viewing in a way that can be parameterized according to multiple dimensions such as educational level, region, sector (public, private), department and supervision circuit. Using selection criteria, it should also be possible to compare different elements in the same dimension (for example, between regions, levels and supervision circuits of a given level).

Mechanisms for detecting learning risks or risk of dropout: latent.[47]

In the education systems analyzed, little use is made of tools for timely detection of challenges in terms of learning or dropout risk. The case that stands out in this field is Uruguay, which has a model for monitoring educational trajectories. GURÍ has a module that provides information about the student population at risk of dropping out and a system that issues an alert when any of the following events occur: three consecutive absences, a high number of non-consecutive absences, the loss of family benefit or a high number of absences over the course of a student's school life.



Synthetic indicator of educational quality at school level: latent.[48]

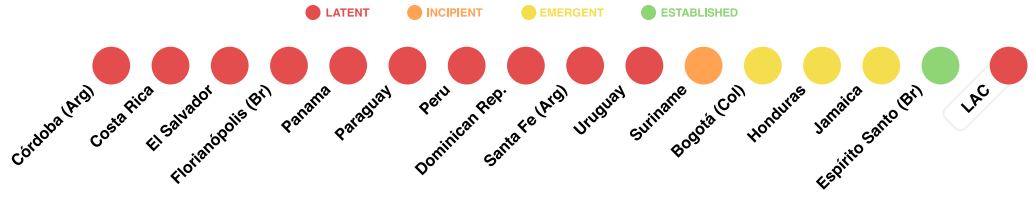
The educational quality index is a proxy that synthetically and accurately measures the quality of the educational services a school provides (Elacqua, Martínez and Westh Olsen, 2019). These indicators serve to monitor school practices and provide information for decision-making. Out of the cases analyzed, the education systems of the state of Espírito Santo is the most advanced in this field. Brazil has developed a methodology for calculating the Primary Education Development Index (IDEB), a synthetic indicator of educational quality at the school level.[49] The IDEB is used throughout the country, albeit with varying levels of adoption and integration (see Box 3.15). Colombia uses the Synthetic Index of Educational Quality (ISCE), a numerical indicator on a scale of 1 to 10. Calculated since 2015 for all the country's educational establishments by the Colombian Institute for the Evaluation of Education (ICFES), it uses data on school performance, progress, efficiency and the school climate from the Saber tests and the Integrated Enrollment System (SIMAT). The ISCE is published on the 360 platform but lacks a functionality for comparisons between schools, broken down by, for example, area, type or level.

47 Data not available for the province of Mendoza.

48 Data not available for the province of Mendoza.

49 For further information about the IDEB, see http://portal.inep.gov.br/ideb.

Does the system calculate some synthetic indicator of the quality of education at the school level?



BOX 3.15

Brazil's national indicator of the quality of education

he Primary Education Development Index (IDEB), created in 2007, is an index of educational quality with values between 0 and 100. It is calculated using data on course approval obtained from the School Census and information on average results in the Primary Education Assessment System. It is used as a tool for monitoring the quality goals of the Educational Development Plan (EDP) for primary education, the objective of which is to reach an average of six in 2022, a value on a par with developed countries.

Source: Compiled by authors based on Elacqua, Martínez and Westh Olsen (2019).

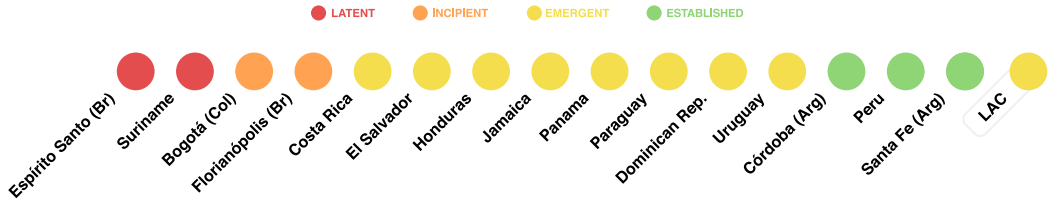
Information about private and concessioned educational services: emergent.[50]

Some countries only consolidate information about public schools. However, important progress has been made on the integration of information about private and concessioned educational services. Progress has been greatest in the province of Córdoba, Peru and the province of Santa Fe, which have complete information for the education system at the early, primary and secondary levels. The other education systems analyzed face challenges as regards capturing

50 Data not available for the province of Mendoza.

information from private schools. Uruguay, apart from the information about public schools, has data available for only around the half of private schools that adhere to the GURÍ school management system.

Do you consolidate information only for state schools or do you also include information about the private sector?

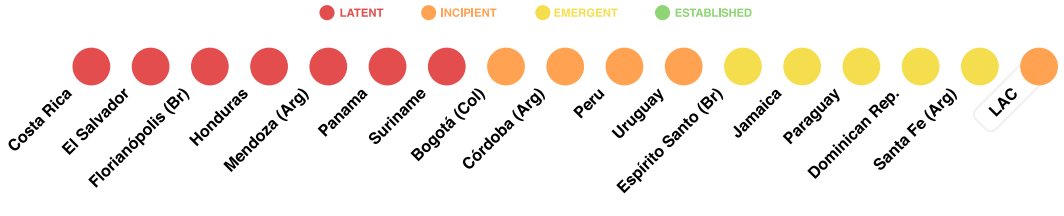


3 DASHBOARD MANAGEMENT AND DISCLOSURE

Human resources for dashboard management: incipient.

In the education systems analyzed, education ministries and secretariats have limited capacity in terms of the human resources for designing, producing and analyzing dashboards and fostering their use. Due to the low adoption and scant use of dashboards, the education systems have not formed specialized teams. In the Dominican Republic, just one person in the planning area manages dashboards, with the participation of other human resources involved. The situation is similar in Peru where only one person is responsible for the SIDI project.

Do you have the human resources to design, produce and analyze dashboards and communicate their results?

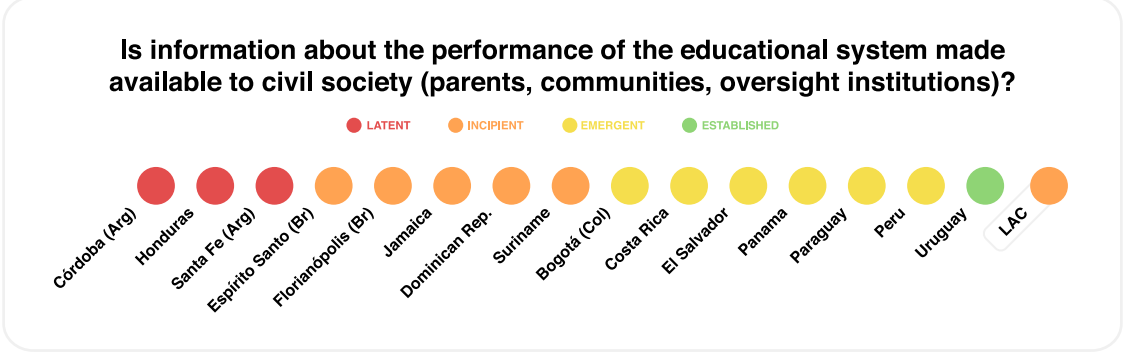


Disclosure of information about the education system: incipient.[51]

One of the responsibilities of education ministries and secretariats is to share information about the performance of the education system so that the different actors in civil society, such as parents, communities and oversight institutions, can monitor results. Uruguay is the most

51 Data not available for the province of Mendoza.

advanced in this field. The Council for Early and Primary Education (CEIP) has an educational monitor through which information is provided to the general public. In addition, parents can monitor students' performance through GURÍ Familia. In the city of Bogotá, information is published annually on the website of the Education Secretariat, with disaggregated indicators of academic performance. The Education Ministries of Costa Rica and El Salvador publish school census data on their websites. The Dominican Republic uses a dashboard known as "How my school doing". However, as of completing this study, this tool had only been implemented in 300 schools in paper format. In addition, educational statistics are published annually on the website of the Education Ministry.



Transversal aspects of the management of strategic tools

• **Scant development of dashboards bringing together data from different applications:**

This hampers integral analysis of the performance of processes. The absence of dashboards with integrated indicators of the costs and performance of the system hinders, for example, online monitoring of the quality of education offered by each country or region in relation to the corresponding resources. A key aspect in this field is the development of different user levels (school, district, sub-national and national), which would permit analysis of information at the level of aggregation necessary for efficient decision-making.

CHAPTER 4

Conclusions and policy considerations

This document contributes to closing the gap in knowledge about Education Management and Information Systems (SIGEDs) in Latin America and the Caribbean (LAC). The results and analysis underline the importance of the SIGEDs for improving education. Processes, systems and information are essential in order to advance in the transformations required to optimize efficiency and equity in the allocation of resources, including both human resources (students and teachers) and budgetary resources. Moreover, the SIGEDs are key for progress in the design of evidence-based policies to improve the quality of learning (for example, through modernization of the teaching career), reduce learning gaps and protect students' educational trajectories by reducing dropout and exclusion. As a fundamental strategy for promoting the necessary reforms in education, the region's countries need to consolidate their SIGEDs.

It is also important to bear in mind that the confinement measures imposed in response to COVID-19 have demonstrated the great potential that the SIGEDs have for decision-making. During both the closure of schools and their reopening, administrative information has served to design strategies and monitor students, and continues to do so. For example, early warning systems are being put in place so that students at risk of dropping out can be identified opportunely and measures taken to mitigate this risk. Mechanisms of this type are particularly relevant in the context of COVID-19 since it is estimated that 1 million students between the ages of 6 and 17 - mostly from poor families (38%) and the vulnerable middle class (44%) - could abandon the education system (Acevedo et al., 2020). As of November 2020, students in LAC had missed, on average, four times more days of school (174) since the beginning of the pandemic than those in the rest of the world (UNICEF, 2020). This will have serious consequences for coverage and the learning of the region's children and young people, given that, according to pessimistic forecasts for 2020, the prolonged closure of schools (seven months) will reduce average world schooling by 0.9 years (figure adjusted for quality) from 7.9 to 7.0 years (Azevedo et al., 2020).

The pandemic has accelerated the digital transformation in all its aspects. In the education sector, governments are already making important investments in equipment, connectivity and platforms. Countries face the challenge of responding to the interruption of in-person classes in the short term and guaranteeing enduring appropriation of these technologies in the medium and long term. In hybrid education models, which combine different digital tools and channels of content, the SIGEDs provide a basis for combining tools that complement each other and consolidating information for decision-making. Strengthening the SIGEDs, with a focus on the use of technology where its effectiveness is proven, is one of the priority areas of action in response to the pandemic (Save our Future, 2020).

The cases analyzed in this study illustrate good practices and the lessons learned in the digital transformation of SIGEDs in LAC. The countries that participated in the study represent the three sub-regions (Central America, South America and the Caribbean) as well as different operating frameworks, with a greater or lesser degree of decentralization. In the analysis, rather than

resorting to comparisons between countries, the emphasis was on describing how education systems have been adopting technology to improve management.

The data shows that, in most of the cases analyzed (ten out of 16), the SIGED is at an incipient level of development or, in other words, only partially covers the processes that define the education system and its strategic orientation should be strengthened. In four cases - the city of Bogotá, Peru, the province of Santa Fe and Uruguay - the SIGED has reached an emergent level of development, indicating that these cases are better prepared for the digital transformation of education management.

The educational processes in which a higher level of development is observed are those related to students and their learning: two systems (the state of Espírito Santo and Uruguay) have reached an established level of development in this field while five (the city of Bogotá, the Florianópolis municipality, Paraguay, Peru and the province of Santa Fe) are at the emergent level. One of the processes with the lowest level of development is that involving tools for strategic management on which all the systems analyzed are at a latent or incipient level. In this sense, the findings reveal great challenges associated with the quality and availability of data. In turn, this limits the implementation of dashboards and the use of business intelligence (BI) tools for management, of which there is a low level of adoption in the region.

The education systems analyzed also face critical transversal challenges as regards consolidating a vision of the SIGED as an integral management platform for the education system. Indeed, the results show a low level of interoperability between systems and applications and a scarcity of human and financial resources for SIGED development. In general, the level of systematization and automation of procedures is also low.

An established SIGED takes an integral approach to the education system under which the different tools and applications interoperate through digital technologies in order to achieve the system's efficient management. In line with this, each case study is accompanied by a series of recommendations for the authorities' consideration. The adoption of unique identifiers for the different elements of the education system (for example, students, positions, schools and buildings) is fundamental if systems are to be interoperable. This is an aspect on which countries have worked, but has not been adopted by all the education system. It is vital to develop the concept of unique identifiers that are maintained over time and used for management of all the education system.

As regards the availability of up-to-date information, the main challenge is to move from the use of isolated data registers to a data warehouse for the entire system. Here, it is also important to change the traditional approach of collecting information for the central level and to adopt a transactional systems approach under which the different users have digital tools through which

they perform their daily activities and, at the same time, provide input for the data warehouse. In this way, all the system's users can generate information and, at the same time, have access to the information they require for their functions.

Technology in itself does not solve management efficiency problems. Independently of the use of digital platforms or tools, procedures for the operation of the education system must be organized in an efficient manner. In some cases, it may, therefore, be advisable to review procedures and, if necessary, re-engineer processes. Once a decision to incorporate or expand the use of digital technologies has been taken, a change management strategy should be considered to facilitate adaptation and appropriation on the part of the education system's different actors.

The results of this study indicate the path for the digital transformation of SIGEDs required by the education systems of LAC. For each case, the study not only carried out a diagnosis of the SIGED, but also sketched out a plan for its strengthening based on a medium-term vision. As a result, in some cases, such as those of Espírito Santo and Suriname, lending by the Inter-American Development Bank (IDB) has included activities or components that support this vision of SIGED improvement. A strategic plan for SIGED optimization is essential in order to change the way these systems have evolved in the past: in a fragmented manner and exclusively linked to the demands of specific sectors of the education system.

This document reflects the situation of the SIGEDs at the time of conducting the case studies. The diversity in the region, seen in these studies, represents a wealth of experiences that countries can share and take advantage of to learn new lessons as they seek to address challenges that have become more evident than ever due to the COVID-19 crisis. The authors are convinced that the results of this work constitute a step towards the transformation of education that is so necessary in LAC.

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