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Development Sector

Challenges and opportunities for sustainable and effective connectivity policies in Brazilian schools

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In Partnership with:

Acknowledgements

This report is one of a series of reports that are part of a wider project focused on promoting effective regulation, greater investment and innovative models for school connectivity in underserved communities and for broader digital inclusion. It has been carried out in the framework of ITU work on school connectivity, and in partnership with the United Kingdom Foreign, Commonwealth and Development Office (FCDO).

The report was prepared by the ITU Regional Office for the Americas and was written by Diogo Moyses Rodrigues in his capacity as an ITU expert. Camila Leite acted as research assistant and the technical revisions were carried out by Ana Luiza Prado and Flávio Prol (MegaEdu); Thalles Gomes (CIEB); Daniela Costa, Fábio Senne, Gabriela Marin and Paulo Kuester (NIC.br). Jeferson Nacif acted as ITU-FCDO institutional coordinator for Brazil.

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The ITU-FCDO partnership, and the support of all stakeholders involved in this report, have also contributed to advancing the ITU-UNICEF Giga initiative to connect every school to the Internet and every child to information, opportunity, and choice.

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Please consider the environment before printing this report.

Foreword

I am delighted to present this report on the challenges and opportunities for sustainable and effective connectivity policies in Brazilian schools.

Since 1989, the International Telecommunication Union (ITU) has been working, through the Telecommunication Development Bureau (BDT), to strengthen technical assistance to lower- and middle-income countries to close the digital divide and drive digital transformation.

Despite the increasing importance of technology in our daily lives, there are still 2.7 billion people offline. Those left unconnected are disproportionally located in least developed countries, in rural or remote areas, or belonging to marginalized groups of society. The power of information and communication technologies, particularly in relation to the opportunities that can be opened up through digital learning, can drive economic prosperity, generate jobs, and advance national digital skills as well as promoting gender equality and encouraging diversity.

With our partners, we are trying to understand how universal connectivity can be achieved, in particular school connectivity, and how we can improve digital skills in low- and middle-income countries to close the digital divide and drive digital transformation. We are focusing on regulatory analysis, capacity development, tools and frameworks to explore innovative sustainable financing and technology development models.

As part of this work, this report analyses current policies relating to the provision of Internet connectivity in public schools in Brazil and explores costs of a sustainable national connectivity plan, presenting recommendations for medium- and long-term policies to achieve their goals. Universal broadband connectivity will ultimately enhance the quality of the education our children receive. It will open the door to an almost unlimited store of online learning content and educational resources, regardless of a child's location and it can significantly contribute to developing that child's full potential.

I recommend this report to national regulators and decision-makers as they work to implement the policies, regulations, technologies, and financing required to ensure that school broadband connectivity is truly universal, safe, sustainable, and equitable to all.

Dr Cosmas Luckyson Zavazava
Director, ITU Telecommunication Development Bureau

Table of contents

List of Tables

Acronyms and abbreviations

A4AI	Alliance for Affordable Internet
Anatel	National Telecommunication Agency of Brazil
C.O.	Central-West Region
capex	capital expenditures
Ceptro.br	Centre for Studies and Research in Network and Operations Technology
CGI.br	Brazilian Internet Steering Committee
EACE	School Connectivity Management Entity
FCDO	Foreign, Commonwealth and Development Office (United Kingdom)
FISTEL	Supervisory Telecommunications Fund
FNDE	National Education Development Fund
FUST	Fund for the Universalization of Telecommunication Services
GAPE	School Connectivity Project Cost Monitoring Group
GESAC	Electronic Government – Citizen Support Service
GICE	Interinstitutional Group on Connectivity in Education
IBGE	Brazilian Institute of Geography and Statistics
INEP	Anísio Teixeira National Institute for Educational Studies and Research
ISPs	Internet service providers
ITU	International Telecommunication Union
LAI	Information Access Law (Lei de Acesso à Informação)
Mbit/s	megabits per second
MCom	Ministry of Communications
MEC	Ministry of Education
MME	Ministry of Mines and Energy
N	North Region
NE	Northeast Region
NIC.br	Brazilian Network Information Centre, responsible for information and coordination in the dot BR domain
opex	operating expenditures
PBLE	Broadband in Schools Programme

(continued)

PDDE	Money Directly to the Schools Programme
PGMU	General Universalization Goals Plan
PIEC	Connected Education Innovation Policy
RNP	National Research Network
S	South Region
SE	Southeast Region
SGDC	Geostationary Defense and Strategic Communications Satellite
SIMET	Internet Traffic Measurement System
MCS	mobile communication service
PSTN	public switched telephone network
TAC	conduct adjustment agreement
TCU	Federal Court of Accounts
ICT	information and communication technology
UNICEF	United Nations Children's Fund

1 Introduction

1.1 Presentation and objectives

This report was prepared under the partnership between the International Telecommunication Union (ITU) and the Foreign, Commonwealth and Development Office (FCDO) of the United Kingdom. The objective is to support the discussion and decision-making processes around public policies for Internet connectivity in Brazilian public schools at the primary and secondary levels, with structural recommendations for its effectiveness and long-term sustainability, and also to support the Giga Initiative launched in 2019 by the United Nations Children's Fund (UNICEF) and ITU.

To achieve this objective, the study looks at the policy situation, reviewing the available data on school connectivity, providing a historical overview of public policy including different programmes, institutional agents, and scopes of implementation, and seeking a qualitative evaluation of these policies and lessons learned that emerge from these processes. It then outlines the projects currently under way, or in the planning stage, and estimates the cost of implementing a national connectivity plan. Finally, it presents structural recommendations for policies to achieve their goals and be sustainable in the medium and long term.

School connectivity in Brazil is at an important juncture, with an unprecedented volume of financial resources available for the achievement of public policies, thanks in particular to revenue from the 5G auctions and the Fund for the Universalization of Telecommunication Services (FUST). Other positive factors, including mature diagnostic and monitoring initiatives and the presence of highly engaged stakeholders including multilateral agencies, civil society and the private sector, contribute to the expectation that public policies to ensure high-quality access to the Internet in all public schools will meet with success in the coming years.

1.2 Scope of the report

This report focuses on telecommunication policies for connecting Brazilian public schools to the Internet, including the communication infrastructure necessary for the effective use of the Internet in the school environment and potential access by the local community. It does not look at the other inputs required to capitalize on information and communication technologies (ICTs) in the school environment, including the organization and distribution of the network within schools, the availability of suitable user devices, high-quality digital educational content, training, and policies of use such as those relating to privacy and child protection. Due to the focus on telecommunication policies, complementary policies for mobile Internet connections for teachers and students are not included in the scope of the study, although initiatives with this focus are described and commented on within the report.

1.3 Research methodology

This study was produced between June and August 2022 based on exploratory research of available data on school connectivity, recently improved by a set of public and private, national and multilateral institutions. There is some divergence in the data due to differences in the sources, methods and timing of data collection/dissemination. In addition, documentary

research was carried out on the main school connectivity policies, the regulatory instruments, and the most relevant qualitative results. The data on connectivity and coverage in schools were produced by a number of organizations, including the National Telecommunications Agency of Brazil (Anatel), the Giga Initiative, the Brazilian Network Information Centre (NIC.br), Anísio Teixeira National Institute of Educational Studies and Research (INEP) and the MegaEdu organization.

In addition, technical meetings were held with representatives of sectors involved in the creation, implementation and monitoring of Brazilian public policies, including members of the federal administration, regulatory bodies, research institutions, companies and civil society.[1] After producing a preliminary report, a meeting was held to validate and collect comments with the technical coordination of the Interinstitutional Group on Connectivity in Education (GICE),[2] formed by over 20 government agencies, operators, regional providers, technology companies, associations and tertiary-sector organizations. At the invitation of the coordinators, the authors participated in five meetings of GICE, an environment of multisectoral dialogue of great relevance to the conclusions and suggestions presented. These dialogues and consultations sought to improve the assessment of public policies already implemented and organize the regulatory options available for the implementation of effective and sustainable policies that are able to provide high-quality, equitable connectivity to all Brazilian public schools.

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1 Technical meetings were held with the following experts: Nilo Pasquali, Eduardo Marques da Costa Jacomassi, Fernando Di Pietro Cordenonssi, Gesilea Fonseca Teles, Livia Caruline dos Santos Lima de Sá and Maria Lucia Bardi, from the Planning and Regulation Superintendence of Anatel/GAPE; Jardiel Nogueira, connectivity consultant at UNICEF and the Giga Project in Brazil; Paulo Kuester Neto, project analyst at the Centre for Studies and Research in Network and Operations Technology (Ceptro.br/NIC.br); Andrei Amaral, Christian Miziara and Takashi Tome, from the National Research Network (RNP); Thalles Gomes, legal and partnership coordinator at the Innovation Centre for Brazilian Education (CIEB); Flávio Prol and Ana Luiza Prado, from MegaEdu, who also kindly provided the technical revision of the report.

2 The GICE was established in 2020 and is responsible, among other initiatives, for the *Guide to Connectivity in Education – step by step for the connectivity of Brazilian public schools*. It is coordinated by CIEB, MegaEdu, NIC.br and Grupo Mulheres do Brasil.

2 Connectivity in schools today

Brazil has a population of 211 million inhabitants in a territory of 8.5 million square kilometres, distributed across 5 568 municipalities. Public schools number 138 803 (61.8 per cent in urban areas and 38.2 per cent in rural areas), serving over 38.5 million students. The sections below provide a snapshot of the Internet situation in the schools of Brazil as regards (1) connectivity, (2) quality and speed of connection, (3) pedagogical use, and (4) coverage/availability of infrastructure.

2.1 Connectivity

According to the 2021 School Census carried out by the Anísio Teixeira National Institute for Educational Studies and Research (INEP), 30 024 schools lack Internet access entirely. The School Connectivity Data Dashboard of Anatel, using data from the School Census and other public sources but following a different methodology, gives a much smaller number, 13 493, indicating that 22.8 per cent of rural and 1.7 per cent of urban schools remain deprived. Connectivity varies enormously between the federal Regions: in the Northeast, 8.6 per cent of schools (4 358) remain unconnected, and in the North that percentage reaches 38.2 per cent (7 763). These numbers contrast starkly with the 2.9 per cent (1 168 schools) without Internet access in the Southeast, and the 0.8 per cent and 0.7 per cent in the South and Central-West Regions, respectively.

Table 1: Schools without Internet (by region and location)

Region	Not connected		
	Rural (38.2%)	Urban (61.8%)	Overall (for the Region)
Central-West	**2%** (31)	**0.3%** (20)	**0.7%** (51)
Northeast	**14%** (3 867)	**2.2%** (491)	**8.6%** (4 358)
North	**55.7%** (7 482)	**4.1%** (281)	**38.2%** (7 763)
Southeast	**9.5%** (594)	**1.7%** (574)	**2.9%** (1 168)
South	**1.9%** (79)	**0.5%** (74)	**0.8%** (153)
AVERAGE	**22.8%** (12 053)	**1.7%** (1 440)	**9.7%** (13 493)

Source: Anatel School Connectivity Data Dashboard (July 2022, with data from 2021)

2.2 Quality | Speed

The available data on the speed of the connected schools vary according to the source, the collection method and the sampling plan. Based on a cross section of data from the ICT Education 2020 survey, self-reported with sample collection from managers of public schools that had primary and secondary classes, 18 per cent of urban connected schools reported connection speeds of 2 Mbit/s or less, 19 per cent had speeds of between 2 and 10 Mbit/s, and 34 per cent more than 10 Mbit/s. In rural areas, 26 per cent had 2 Mbit/s or less, 29 per cent between 3 and 10 Mbit/s, and 15 per cent more than 11 Mbit/s (see Table 2 below). In 2017,

for comparison, 40 per cent of urban public schools and 61 per cent of rural public schools had a speed of less than 2 Mbit/s.

Table 2: Connection speed of public schools by location (urban/rural)

Speed	Urban area	Rural area
Up to 999 kbit/s	7%	9%
Between 1 and 2 Mbit/s	11%	17%
Between 3 and 10 Mbit/s	19%	29%
Between 11 Mbit/s and 20 Mbit/s	6%	7%
Between 21 Mbit/s and 50 Mbit/s	9%	4%
51 Mbit/s or more	19%	4%
Does not know	28%	27%
Did not answer	1%	2%

Source: ICT Education 2020 (indicator A3) [3]

Working with data from the School Census and the Connected Education Gauge, MegaEdu & Nic.br (2021, p. 7) shows the technology-dependence of the average speeds of public-school connections. Schools with a fibre-optic connection have an average speed of 58 Mbit/s, for example, compared to 24 Mbit/s for those without. The speed is even lower in schools located outside the coverage zone, as shown in Table 3 below.

Table 3: Average speed in public schools*

Reference	Connection	Average number of students per school	% of schools with Internet access	Average speed (Mbit/s)
Schools in coverage zones (111 381)	*Optical fibre (FTTH) (71 849)*	268	92%	58
	Wired only (39 532)	175	83%	24
Schools outside the coverage zone (21 626)	*Connection with technically viable fibre (7 063)*	42	44%	21
	Recourse to alternative technologies (5 092)	42	35%	18
No power or only via generator (5 092)	*N/a*	28	6%	12

* The table depicts the relationship between speed and technology used. Quality of services is also affected by factors such as the school location and the quality of the local infrastructure.

Source: MegaEdu & Nic.br, 2021, p. 7

[3] Data from a cross section taken from the A3 indicator of the ICT Education 2020 survey of public primary and secondary schools.

2.3 Use for pedagogical purposes

The School Connectivity Data Dashboard of Anatel, based on data from the School Census, shows that 75 per cent of public schools use the Internet for administrative purposes, while 49 per cent use it for pedagogical purposes and 31.5 per cent allow other types of use by students (see Table 4 below).

Table 4: Purposes of using the Internet in schools

Project	2021 School Census
Administrative purposes	75.66%
Pedagogical/teaching use	49%
Student use	31.5%

Source: School Connectivity Data Dashboard/ Anatel (July 2022, with data from 2021 from the School Census/INEP)

Further information on the profile of Internet use in schools is available in ICT Education, the most recent edition of which, in 2020, measured the presence of the Internet in the various spaces of the school by means of interviews with teachers, pedagogical coordinators and students.

2.4 Coverage | Infrastructure availability

The Connectivity Dashboard of Anatel shows that 97 per cent of urban schools in the country are located in areas that have Internet coverage (see Table 5 below).

Table 5: Internet coverage (by location)*

Coverage*	Technology	Zones		Overall
		Rural	Urban	
Coverage zone	*Wired*	25.75%	25.43%	25.55%
	Optical fibre in the vicinity	22.47%	71.58%	52.84%
Outside coverage zone	*Alternative connection*	11.63%	0.05%	4.47%
	Viable fibre	22.12%	0.71%	8.88%
	Possible fibre expansion using RNP	7.48%	1.63%	3.86%
	No power or generator only	9.61%	0.01%	3.67%

* The table does not total 100% because it does not include data in the "being updated" category, according to the categorization of the School Connectivity Data Dashboard.

Source: School Connectivity Data Dashboard (July 2022, with data from 2021)

Coverage in rural areas is much lower, at only 53.78 per cent in the Northeast and 21.32 per cent in the North. These figures do not include schools where data is in the process of being updated, or with fibre expansion using RNP, or schools that depend on their own generator or are without electrical power entirely (see Table 6 below).

Table 6: Internet coverage (by region and location)*

	Technology	Location	Central-West	Northeast	North	Southeast	South	Overall	
Coverage zone	Wired	rural	42.54%	28.82%	11.11%	37.58%	28.64%	25.75%	25.55%
		urban	24.41%	36.25%	27.74%	0.27%	19.86%	25.43%	
	Optical fibre in the vicinity	rural	18.83%	24.96%	10.21%	25.15%	43.17%	22.47%	52.84%
		urban	73.21%	58.64%	65.19%	77.93%	78.73%	71.58%	
Outside coverage zone	Alternative connection	rural	12.77%	12.40%	15.78%	4.84%	2.85%	11.63%	4.47%
		urban	0.27%	0.03%	0.20%	0.01%	0%	0.05%	
	Viable fibre	rural	19.93%	22.14%	20.41%	25.74%	22.85%	22.12%	8.88%
		urban	0.93%	1.21%	0.82%	0.41%	0.52%	0.71%	
	Possible fibre expansion using RNP	rural	1.5%	9.68%	5.87%	6.23%	2.05%	7.48%	3.86%
		urban	0.16%	3.22%	5.46%	0.66%	0.32%	1.63%	
	No power or generator-only	rural	3.39%	1.39%	34.48%	0.19%	0.17%	9.61%	3.67%
		urban	0%	0.02%	0.06%	0%	0.01%	0.01%	

* The figures in the table do not total 100 per cent because it does not include data in the "being updated" category, according to the categorization of the Anatel School Connectivity Data Dashboard.

Source: School Connectivity Data Dashboard / Anatel (July 2022, with data from 2021)

In all Regions, rural areas are more affected by coverage gaps than are urban areas, but the effect is particularly pronounced in the North and the Northeast, which still have the largest number of schools located in rural regions and where 66 per cent and 43 per cent of schools, respectively, do not have fixed Internet coverage.

Of schools covered by fixed telecommunication networks, 52.84 per cent have fibre-optic infrastructure in the region and can immediately offer high-speed access services to schools, while 25.55 per cent continue to rely on wired connections, providing service of moderate quality to schools, depending on the number of students served.

2.5 Qualitative overview

As seen in the previous section, connectivity in Brazilian public schools has indeed increased in recent years, but large gaps remain: many schools lack any type of Internet access whatsoever (including some that do not have electric power) and others, while connected, do not have a sufficiently high quality of service to make full use of the potential of ICTs for pedagogical purposes. From a structural perspective, these gaps are more pronounced in the North and Northeast Regions, in rural rather than urban areas, and in municipal schools. Still, the data also indicates that the national telecommunication infrastructure has improved considerably, in terms of coverage and quality, and there is every reason to be optimistic about the prospect that schools will benefit as a priority from the ongoing expansion of service. Consequently, public schools should soon be covered with the best technology available today (optical fibre), with recourse to alternative technologies such as radio and satellite limited to specific, localized cases.

3 History of connectivity policy[4]

3.1 Electronic government – citizen support service | GESAC

The first nationwide digital inclusion programme for schools was launched in 2002 by the then Ministry of Communications. The programme, known as GESAC (*Governo Eletrônico - Serviço de Atendimento ao Cidadão*, or "Electronic Government – Citizen Support Service"), was created to connect telecentres, schools, health clinics, indigenous communities, military border posts and other institutions – many them in remote areas – to the Internet, especially with the use of satellite technology. By 2015, 3 520 schools were connected through the programme, 27 per cent of them in urban and 73 per cent in rural regions. The available speeds – 1 Mbit/s for download and 256 kbit/s for upload – were already considered by students and managers to be far below what was necessary for pedagogical purposes, and numerous installed points remained under-utilized. In recent years, GESAC has been expanded with the entry into service of the Geostationary Defense and Strategic Communications Satellite (SGDC), which made possible superior-quality connections at 10-20 Mbit/s. The programme has been incorporated into the Wi-Fi Brazil programme and, according to updated information, currently connects 9 512 schools (see § 5.5); for comparison, the 2021 Census found that the number of schools served was 11 178.

3.2 Broadband in Schools Programme | PBLE

In 2008 connectivity of urban public schools became the object of a specific policy. Presidential Decree 6.424/2008 amended the universalization goals of the licensed PSTN operators to include high-speed Internet connection infrastructure in all Brazilian municipalities (backhaul) and the obligation to connect all urban public schools in their respective areas of operation, with maintenance of services free of charge until 2025. This regulatory initiative in turn gave rise to the Broadband in Schools Programme (PBLE). The obligation imposed on operators was to connect all urban public schools by early 2011, at speeds of at least 2 Mbit/s – verified every six months to ensure it corresponded to the best commercial offer available to the public in the service area where the school is located. According to the 2021 Census data on the School Connectivity Data Panel, 57 585 schools are served by the programme.

PBLE was innovative in proposing a universal approach to urban schools. However, 15 years after the beginning of its implementation, it is widely considered as ineffective: its speed goals do not meet the basic requirements for pedagogical use, and the fact that the "federative pact" was not respected has led to states and municipalities launching their own initiatives to obtain access, leading to duplication of effort and overlapping initiatives (see § 3.5 below). Although the expectation is that the programme will be discontinued by 2025 when the licensing regime ends, the transition demands care, since some schools may continue to rely on these connections.

[4] Although data produced on school connectivity policies has advanced in the last period, managers of GAPE, NIC.br and civil society experts still point to conflicting data on the number of schools impacted and/or benefiting by connectivity policies, especially PBLE (§ 3.2) and 4G Rural (§ 3.3).

3.3 Rural Connectivity Programme | 4G-Rural

The most comprehensive regulatory initiative for the connection of rural schools to date is the Rural Connectivity Programme, which imposed coverage obligations on MCS operators in 2012. The bid notice for the 2.5 GHz band for 4G mobile data transmission and the 450 MHz bandwidth auction obliged winning operators to serve at least 80 per cent of the areas within 30 km from the limit of the host locations of all Brazilian municipalities.

Thus all public schools located within those service areas with minimum rates of 1 Mbit/s for download and 256 kbit/s for upload are supposed to have a data connection, free of charge, with no provision for updating the speeds offered.[5] According to information from the School Connectivity Data Dashboard, 33 201 schools are covered.

As in the case of PBLE, the connection of rural schools by the authorized MCS is not funded out of a specific budget but rather entirely through a regulatory contribution from operators. It should also be noted that the speeds offered are very low and do not allow the pedagogical use of ICTs, especially if the current objectives of PIEC (see § 3.4) are taken as a reference. There are few records on the status of the schools served and the effectiveness of the programme. This tool therefore cannot be expected to make a meaningful contribution to a national school connectivity plan.

3.4 Connected Education Innovation Policy | PIEC

The Connected Education Innovation Policy (PIEC), linked to the Ministry of Education (MEC), aims to support the universalization of high-speed Internet access and promote the pedagogical use of digital technologies in basic education. Created by Decree No. 9.204/2017 as a programme and transformed into a policy by Law No. 14.180/2021, PIEC has guidelines and combines efforts between the federal entities with a view to facilitating technology as a pedagogical tool in public schools providing basic education. Through the Money Directly to the Schools Programme (PDDE), PIEC provides financial support for contracting connection services and other inputs, such as procurement of devices, digital pedagogical content and human resources training, with a systemic and innovative look at the inputs necessary to make good usage of ICTs in the school environment. Regarding the quality of connectivity services, the policy specifies bandwidth of at least 100 kbit/s per student.

The official objectives of the policy are spread across three phases, to be accomplished between 2017 and 2024: (i) *induction* (2017-2019), serving 22 400 urban schools and 6 500 rural schools; (ii) *expansion* (2019-2021), serving 68 500 urban schools and 7 500 rural schools; (iii) *sustainability* (2022-2024), serving 100 per cent of urban and rural schools.

Currently, 27 states and 5 425 municipalities have joined PIEC. According to available data, BRL 359 million was allocated from 2018 to 2020 and BRL 320 million in 2021. The projection for allocations in 2022 is BRL 355 million and for 2023 it is BRL 455 million.[6] The size of the annual transfer to schools ranges between BRL 2 451 (for a school with less than 200 students)

[5] According to data from Anatel, 45% are served by speeds of up to 2 Mbit/s, 43% from 2 to 5 Mbit/s, 9% from 6 to 10 Mbit/s and 3% above 10 Mbit/s.

[6] The amounts refer to the total resources allocated through PIEC, including the maintenance of connectivity services, but also other inputs, such as devices.

and BRL 3 892 (for a school with 500 or more students) according to Table 7 below.[7] According to the Anatel Dashboard , 91 424 schools are served by the policy.

Table 7: PIEC: Minimum speed and amount of the annual transfer as a function of school size

Number of enrolments in basic education	Average reference speed (based on ≥100 kbit/s per student)	Annual transfer amount
15-199	20 Mbit/s	BRL 2 451.00
200-499	50 Mbit/s	BRL 3 328.00
500 or more	100 Mbit/s	BRL 3 892.00

Source: MEC – PIEC Manuals

Possible limitations notwithstanding, PIEC has the potential to become the main reference to maintain Internet access services, especially due to the wide dissemination and knowledge of PDDE by local managers. Challenges have been identified in relation to annual allocations to schools, which are considered insufficient for the set of inputs that the policy intends to support (such as connectivity, devices, internal networks). In addition, multisector stakeholders have indicated the need for the policy to cover other instruments to transfer resources. Since PDDE, awards are generally made to schools individually, it does not act as an incentive for universal service plans by states and municipalities. In this sense, in addition to the expansion of the limits of annual resources by schools, there is also the possibility of incorporating other instruments for transferring the resources of the FNDE/PIEC, such as the Articulated Action Plan (PAR), to support universal service plans and the broader transfer of resources.

These and other improvements in relation to PIEC, such as the recommendations issued by the Federal Court of Auditors (TCU) in a report on initial implementation of the policy, including the need for greater coordination, the commitment of more resources and updated speed objectives, can be addressed in a timely manner in the regulation of the law governing PIEC, currently being elaborated by the Ministry of Education.

3.5 Initiatives by states and municipalities

Policies to improve school connectivity include numerous initiatives implemented by various levels of government. In the last decade, these entities, which have direct responsibility for almost all public schools providing basic education in Brazil, have implemented policies for the development of the telecommunication infrastructure and the expansion of Internet access, supporting the expansion of high-speed networks and providing access to their public schools.

One of the most striking characteristics of Brazilian public policies for school connectivity in the last 15 years is the fact that states and municipalities have begun to directly contract the connection services to schools, often duplicating investments, networks and efforts, especially if the scope of the Broadband in Schools Programme is considered, which has turned out to be inadequate in terms of quality, as experience shows on a daily basis. This is borne out in

[7] The amounts are set out in Resolution FNDE/CD No. 09/2018. The budget foreseen by the FNDE for 2022 is BRL 65 billion.

practically all the states and large cities, whose managerial and financial resources allow them to contract these services directly, albeit without uniform quality objectives. To date, there are no consolidated data on the number of schools connected with services contracted by these levels of government without federal funds, as in the case of PIEC.

3.6 Summary table: schools served by public policies

The table below shows the updated figures for July 2022 provided by the public entities responsible for the programmes. The sum of the schools served is greater than the number of existing schools, due to the overlaps between the different actions and, to some extent, potential gaps in public policy monitoring, as is the case, in particular, of PBLE and 4G Rural.

Table 8: Schools served by public policies

Public policy	Schools served
PBLE	57 588
PIEC	91 424
4G-Rural	33 296
GESAC (Wi-Fi Brazil)	11 178

Source: Anatel School Connectivity Dashboard and data obtained via the Information Access Law (LAI).

4 Lessons learned from previous public policies

4.1 Sectoral policies

Stakeholders recognize that well-designed, well-executed policies are necessary to expand the telecommunication infrastructure and to meet the demand for Internet access in Brazil. A history of non-application of the funds raised by FUST, the high tax burden in the sector,[8] bureaucratic obstacles to the use of land and pylons, and the barriers faced by small and medium providers are among the biggest challenges for the expansion and upgrading of the national telecommunication infrastructure. These are structural barriers for the development of the sector as a whole, with a direct impact on the quality of Internet access services available to public schools and to Brazilian society as a whole.

Fragmented sectoral policies may limit the development of telecommunication infrastructure, with an impact on school connectivity.

4.2 Institutional coordination and public policy implementation

Analysis of the initiatives and programmes implemented to date shows the challenges of institutional coordination of a school connectivity plan at the national level, organizing the different investments and activities of the entities in accordance with these policies and preventing fragmentation, dispersion, waste of resources and overlapping among the various initiatives implemented by the Federal Government, states and municipalities.

Fragmented institutional coordination tends to generate losses in the implementation of public policies.

4.3 Universal approach and digital exclusion

Since the first public school connectivity policies, what has been missing is a universal approach, with objectives and actions aimed at connecting all Brazilian schools, including those in rural and remote areas, in all regions, but especially in the North and Northeast. The resulting fragmentation of policies without an effectively universal plan – which should take into account the need for regional and specific approaches – perpetuates existing structural inequalities, leaving schools and students behind.

Lack of a universal approach tends to leave schools and students behind.

4.4 Objectives of quality and equity

The projects and programmes implemented so far reveal that the lack of clear and equitable goals for the quality of services offered to schools tends to create an environment that perpetuates inequalities in the ability to use the Internet for pedagogical purposes. In general, it

[8] Brazil is one of the countries with the highest tax burdens in the telecommunication sector. More information at: https://www.teleco.com.br/tributos.asp.

is clear that each individual programme (e.g. PBLE, PIEC and 4G Rural) has its own quality goals, but which in some cases are completely inadequate for the pedagogical needs of students and teachers. Thus, due to the impossibility of a single communication at the national level, additional obstacles are created for the engagement of communities and public managers, especially at the local level.

Heterogeneous goals tend to maintain inequalities and hinder engagement.

4.5 Resources and direct approach to school connectivity gaps

The major initiatives for public school connectivity to date have had only limited resources dedicated specifically to bringing universal access to schools; this concerns in particular investments for the expansion and upgrading of telecommunication infrastructure, including both budgetary resources and public funds such as FUST. Regarding the resources for maintaining connectivity, the situation is similar, although PIEC represented a significant advance, with the current possibility of reviewing the rules and raising the ceiling of resources for schools and education departments. The funds raised under the 5G frequency auction and the effective commitment of FUST money, in addition to the PIEC resources, represents a great opportunity to change this framework.

Limitation of specific and permanent resources may weaken the direct approach on school connectivity gaps.

4.6 Respect of the federative pact and coordination with states and municipalities

An important observation from past school connectivity policies in Brazil is that the national "federative pact", under which public schools are managed by states and municipalities, which are ultimately responsible for ensuring the necessary pedagogical infrastructure, has not been respected. A classic example of this lack of coordination is the Broadband in Schools Programme (PBLE), a federal programme that, due to its low effectiveness, was progressively supplanted by services contracted by states and municipalities. To a greater or lesser extent, the general observation of the implemented programmes indicates the need to position them firmly within the federative pact.

Inadequate respect of the federative pact leads to duplication of effort and wasting of resources.

4.7 Information, monitoring and creating public policies

Since the implementation of the first school connectivity projects and programmes, a lack of information on quality, the technologies used and the connectivity policies in which schools are involved has proven to be a major obstacle to the sectoral diagnosis and the monitoring of policies in a structured manner. Without this monitoring, managers and policy-makers are hampered in assessing policies and the prospects of improvement. The launch of the Connected Education Gauge and the Connectivity Map in Education, increasingly recognized as core monitoring tools, has successfully filled this gap. With improvements, it can be expanded to cover 100 per cent of public schools (see § 5.7). Another point requiring attention in the implementation of public school connectivity policies is the mapping of existing fixed networks

in the country. Various stakeholders have attempted to map high-speed networks in the country, but there is plentiful room for improving these tools, for example by defining highly reliable base mapping to define projects and lines of action. In the current context ITU, UNICEF, NIC. Br, Anatel and MegaEdu have pooled their efforts to overcome this challenge.

Information gaps can create additional difficulties for assessing, monitoring and creating public policies.

5 Current projects and resources for school connectivity policies

5.1 Structural network development

Although not directly linked to connectivity in schools, actions and programmes for the development of structural telecommunication infrastructure have the potential to contribute directly to the objectives of connecting schools with a good quality of service, expanding high-speed networks to underserved locations and upgrading networks to optical fibre.

In this context, investments can be augmented by means of regulatory obligations, such as those derived from the General Universalization Goals Plan (PGMU) and the auction of frequencies for the exploitation of 5G technologies, whose central point is the expansion of high-speed backhauls, as well as obligations resulting from remediation agreements between Anatel and telecommunication operators, known as Conduct Adjustment Agreements (TACs).

Other possibilities include the balances owed by the licensed PSTN operators and the calculation of reversible assets from the conversion of existing concessions into authorizations. Infrastructure expansion projects with budgetary resources, such as the Connected North and Connected Northeast programmes, are also essential for infrastructure development in locations of low economic attractiveness. Finally, while FUST has a specific reserve of 18 per cent for education investments, it can also decisively contribute to sectoral development and, consequently, public school access to high-speed networks, with recourse to alternative technologies (e.g. radio and satellite) in specific, isolated cases where expansion of the land network has been judged to be impossible.

5.2 GAPE | Anatel

The 5G spectrum auction held in 2021 raised about BRL 3.1 billion specifically for investment in public school connectivity, under the coordination of the School Connectivity Project Cost Monitoring Group (GAPE), itself linked to Anatel. The responsibilities of GAPE, which includes representatives from Anatel, MCom, MEC and the successful bidders of the 26 GHz band auction,[9] include defining technical criteria, goals and deadlines of the projects to be implemented, as well as monitoring and overseeing the activities of the School Connectivity Management Entity (EACE), created to handle expenditure under the coordination of GAPE. In May 2022, Anatel published an Ordinance with guidelines to develop connectivity projects, with funding.

By July 2022, GAPE had already held seven meetings and completed its own mapping exercise for public school connectivity status, drawing on the National School Connectivity Programme already available to the general public, with collections of updated data on implemented connectivity and public policies. GAPE has also defined quality objectives[10] and criteria for a

[9] Algar Telecom; Claro S/A; Telefônica Brasil S/A and TIM S/A. Neko Serviços de Comunicações, Entretenimento e Educação Ltda., also winner of the auction, subsequently withdrew from the event.

[10] Regarding the quality parameters, GAPE defined (1) 50 Mbit/s for schools from 15 to 199 pupils enrolled; (2) 100 Mbit/s for schools with 200 to 499 students; and (3) 200 Mbit/s for schools with 500 or more students. Periodic reviews of the contracted capacity are possible to ensure it remains adequate.

pilot project to be used as a reference for larger-scale projects, with the initial priority of serving schools not yet connected to the Internet. The pilot will be carried out in 10 municipalities across the five Brazilian Regions, covering 181 schools.

One of the points that came out of the observation of GAPE´s initial work is its coordination with the other school connectivity actions implemented by the Federal Government, especially the Ministries of Communications and Education and, additionally, the possibility that the projects implemented with the resources raised in the frequency auction for 5G exploration also cover pedagogical inputs, such as the provision of user devices and other equipment and training in human resources, which, if carried out, requires coordination with educational institutions.

5.3 Fund for the Universalization of Telecommunication Services | FUST

Created by Law No. 9.998/2000, the Fund for the Universalization of Telecommunication Services (FUST) is intended to stimulate the expansion and use of telecommunication networks and services and the improvement of their quality; reduce regional inequalities; and stimulate the use and development of new connectivity technologies to promote economic and social development. The main sources of revenue include a contribution of 1 per cent on gross operating revenue from the provision of telecommunication services in the public and private administrative regimes and funds transferred from Fistel (fines and grants) under Law No. 5.070/1996. Since its creation, more than BRL 24 billion has been collected, but little has been used for digital inclusion policies.

The legislation governing the use of the Fund was reformed by Law No. 14.109/2020, aiming to facilitate the use of financial resources for public telecommunication policies in a broad manner, including for Internet access. It also established that a minimum of 18 per cent of those resources are to go to public educational institutions and imposed the goal of achieving universal access in schools by 2024. Fund usage is regulated in Decree No. 11.004/2022, and its Management Council is governed by Ordinance No. 82/2022.

More recently, Anatel published a proposal for five-year strategic objectives to allocate the Fund resources to school connectivity as a priority. The proposals were sent to the Ministry of Communications, which, in July 2022, published an Ordinance confirming these priorities. The Management Board of FUST has also passed a resolution with rules for using the Fund´s monies in programmes and projects compatible with its objectives and purposes. These include selection and tiebreaker criteria (for example prioritizing investments in areas with a lower level of social development), in addition to sanction mechanisms for noncompliance, if resources are allocated but the initiative is not carried out.

There are great expectations among the different multisector agents regarding the effective use of resources, the total amount of which, based on historical trends,[11] should exceed BRL 1 billion per year, as well as on the disbursement modalities and the profile of projects to be executed. For 2022, the budget approved for use by FUST was approximately BRL 750 million, of which BRL 700 million was for reimbursable projects and 50 million for non-reimbursable projects. For 2023, approximately BRL 651 million was approved, with BRL 603 million for reimbursable projects and BRL 38 million for non-reimbursable projects (BRL 10 million has been earmarked

[11] Time series from 2001 to 2021: Fund for the Universalization of Telecommunication Services.

for projects to expand public school access to the broadband Internet).[12] For 2023, there is still the possibility of a waiver in revenue[13] in the region of BRL 143 million.[14]

The recent legislative advances and the inclusion of FUST in the 2022 and 2023 federal budget cement its place as a central element for telecommunication policies in a broad way, and also, specifically, for school connectivity policies. It may be possible to use the Fund both for investments in infrastructure expansion to provide quality services to schools (capex) and, as a complement, for the maintenance of connectivity services (opex), although other sources can also be used for this purpose, especially those coming from the Connected Education Innovation Policy (PIEC).

5.4 Connected Northeast (*Nordeste Conectado*) | Connected Education Project

The Connected Education pilot project is part of the Connected Northeast programme, an initiative of the Ministry of Communications (MCom) to expand high-speed networks in the Northeast Region. Funded by the Ministry of Education (MEC), the project is operationalized through a partnership with the National Research Network (RNP), covering six municipalities in four states of the Northeast Region where RNP already has established metropolitan fibre-optic networks: Campina Grande (PB), Mossoró (RN), Petrolina (PE), Juazeiro (BA), Caruaru (PE) and Caicó (RN). In its first phase, it connected 473 public schools in the urban areas of these municipalities, covering state and municipal basic education schools, with speeds of 100 Mbit/s. RNP expects to launch the second phase of the project in 2022, reaching approximately 1 000 schools.

In this project, agreements are signed with state and municipal boards of education, appointing local managers to handle liaison with the schools to ensure the effectiveness of the policy and the fluidity of project communications. In the current design of the project, RNP contracts Internet Service Providers (ISPs) to build the last mile of optical fibre (where necessary), ensuring access in the schools served for a period of 5 to 20 years. The project also seeks to offer other inputs for the effective pedagogical use of digital resources, through a partnership with CIEB.

5.5 Wi-Fi Brazil

Wi-Fi Brazil, the successor of GESAC, was developed by the Ministry of Communications as a programme of the Federal Government. In relation to schools, it has two specific actions: the connection of schools through the use of the Geostationary Defense and Strategic Communications Satellite (SGDC), implemented by Telebras; and the pilot programme *Connected Schools*, in partnership with the National Research Network (RNP).

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12 Ministry of Communications. 2023 Budget: Fust´s Management Council approves BRL 651 million to expand internet access. Aug. 09, 2022.

13 A reduction in the revenue contribution was provided for in the FUST reform legislation (Art. 6-A), allowing operators to set off part of their investments approved by FUST´s Steering Committee against the assessed contribution, within established limits.

14 Ministry of Communications. Resolution No. 01/2022 of August 09, 2022.

5.5.1 Wi-Fi Brazil | Telebras

The Geostationary Defense and Strategic Communications Satellite (SGDC), managed by Telebras, was launched in 2017. According to information from the Ministry of Communications, as of July 2022 it was providing connections for 15 705 Internet points in 9 853 schools spread across 3 055 municipalities, 93 per cent of them in rural areas, with speeds of 10 to 20 Mbit/s. The objective of the programme is a continuation of that of GESAC: seeking to bring connectivity to locations in the country where there is none or little, especially socially vulnerable communities.

Although modest by comparison with more advanced fixed technologies, the speeds offered by SGDC offer a substantial improvement, particularly considering the average size of rural schools, with less than 50 students. Recently, investments of some BRL 85 million per year were announced for the connection of 12 000 schools.[15] Of these, 10 000 points will be installed in schools in rural areas and 2 000 in urban areas.

Regarding educational institutions served with satellite technology, in the current situation it would be prudent to consider whether the demand can be fully met by SGDC, whether it meets the desired quality standards, and whether other providers might be contracted to provide this service, for example by means of new services using low-Earth orbit satellites.

5.5.2 Wi-Fi Brazil | Connected Schools

The Connected Schools project falls within the scope of the Wi-Fi Brazil programme and aims to connect schools that do not yet have an Internet connection. Implemented by RNP, it is considered a pilot project, but its scope of action is broad, seeking to connect 8 341 schools, of which 2 940 are urban and 5 401 in rural regions, in all the Regions: 5 026 in the Northeast, 2 160 in the North, 900 in the Southeast, 197 in the South and 58 in the Central-West.

Primary and secondary schools of municipal, state and federal public networks will be served with connection speeds of up to 200 Mbit/s, assigning priority to the use of fibre-optic technologies (FTTH). The interlocutor for the benefiting federal entities, especially municipalities, is the Ministry of Education, which is also responsible for providing the other inputs that allow effective use of the Internet for pedagogical purposes.

Once RNP hires local providers to serve schools, the connection should be guaranteed with the contracted quality for 12 months, after which time it should be covered by programmes and actions of the federal administration. The large number of proposals submitted by providers with the potential use of fibre-optic networks and alternative technologies (radio, in particular) indicate that this project model can be very promising. One hundred and eight providers have already been selected for the project, which has resources of about BRL 31.7 million, and the connections are expected to start being implemented in the second half of 2022.

5.6 Law 14.172/2021 | Connectivity Law

Law 14.172 was enacted in June 2021 and gave rise to a Decree in January 2022, with the objective of ensuring the transfer of resources from the Federal Government to states and the Federal District for investment in Internet access for students and teachers of public schools, due to the public calamity resulting from Covid-19. With the legislative changes that occurred

[15] Government promises to install internet in 12 000 public schools by July. Telesintese, 2022.

during its passage, the states now have a deadline of the end of 2023 to use the resources, which total BRL 3.5 billion.

Due to the context in which it was developed –the acute phase of the Covid-19 pandemic – the law was directed, as a priority, to the purchase of equipment and mobile data for students and teachers, but also providing financial support for home and school connections. The funds have already been passed on to the states, which have presented plans for their use. According to data organized by MegaEdu from Plataforma +Brasil, most states plan to focus on portable equipment and devices, totalling:

i. BRL 1.6 billion for mobile devices that, for the most part, will be transferred to students and teachers;
ii. BRL 1.38 billion for mobile data;
iii. Some BRL 400 million to improve the internal infrastructure of schools to distribute connectivity in pedagogical environments and/or to ensure that schools are connected to the best available technology.

The current context, of the reopening of schools for compulsory classroom teaching, together with the extension of the deadline for the use of resources from 2022 to the end of 2023, may lead to a re-evaluation in relation to the priority use of resources, from the allocation of mobile devices and data towards the connectivity of schools, spurring efforts on the national connectivity plan. The Ministry of Education recognizes the changed context in relation to the initial conception of the law, which has implications for the efficient and effective use of resources.

5.7 Internet Brazil Programme (*Programa Internet Brasil*)

In May 2022, Law No. 14.351/2022 came into being, creating the Internet Brazil Programme. The law, whose origin dates back to Provisional Measure No. 1.077/21 and the context of the Covid-19 pandemic and remote teaching, aims to promote free mobile broadband access to the Internet to public basic education students from families enrolled in the Unified Registry for Social Programmes of the Brazilian government (CadÚnico).

As provided for in Inter-Ministerial Ordinance No. 5.193/2022, the Ministry of Communications will be responsible for implementing and coordinating the programme, including the transfer of BRL 3.5 billion to states and the Federal District, which can carry out direct partnerships with municipalities for transferring funds. It has been announced that during the initial phase the Federal Government will make available about 700 000 cards and data packages in cities already served by the Northeast Connected programme. Although the potential is there to employ the resources for connectivity in public schools, this is not a priority objective for the programme.

5.8 Connected Education Gauge (*Medidor Educação Conectada*) | Connectivity in Education Map

The Connected Education Gauge was launched in 2018 as an integral part of PIEC with the objective of monitoring the quality of Internet access of Brazilian public schools, which it does by collecting data through the Internet Traffic Measurement System (Simet). It was developed by the Centre for Studies and Research in Network and Operations Technology (Ceptro.br), a department of the Information and Coordination Centre of Point BR (NIC.br), an entity linked to the Internet Steering Committee of Brazil (CGI.br). Currently, there are approximately 59 000

schools with active Gauges in 5 289 municipalities, participating through the software modality, in which a measurement program is installed on a school computer.

The connectivity quality data collected through SIMET makes it possible to determine whether the quality of the contracted connection is compatible, for example, with the objectives determined by PIEC. Currently, a pilot led by UNICEF and the Lemann Foundation is in progress for the use of the firmware version of SIMET (embedded in the connection input router), seeking to ensure that the measurement is not affected by parallel activity, which may occur on a computer with the software installed, or by a temporary shutdown.

The Gauge is the contribution of the Connectivity in Education Map, an initiative coordinated by NIC.br together with CIEB. The Map integrates several databases (originating from MEC, MCom, Anatel and NIC.br, among others), with information on speed and other quality attributes; public policies, among others with the possibility of viewing data by schools, federal unit and network (state/municipal); and aggregated national data. Its parallels with the Connectivity in Schools Dashboard of Anatel/GAPE (§ 5.9) mean there is potential for create synergies.

5.9 School Connectivity Data Dashboard – GAPE/Anatel

In July 2022, Anatel launched the School Connectivity Data Dashboard. Like the Connectivity in Education Map, the new digital environment gathers information from several sources, such as the School Census, the commitments arising from the 4G Auction Notice and the NIC.br speed gauge. The dashboard, structured by GAPE, presents information on (1) the total number of active basic education schools; (2) the number of urban and rural schools; (3) the number of schools without Internet, urban and rural; (4) the number of schools without a computer lab; and (5) the number of schools without electricity.

The available filters allow data to be segmented by Region, state, municipality, school name, dependency (federal, state, municipal or private), location (urban or rural) and unique location (settlement area, quilombola area or indigenous land). It is possible to verify, in each state, the number of students enrolled per school, the schools that have or do not have Internet and a computer lab, any connectivity programme that serves the school and the speed of data transmission, if the NIC.br gauge is available.

5.10 Summary table

Table 9: Summary of projects and actions for school connectivity

Policy | Programme	Definition	Benefiting schools	Responsible entity	Positive points	Points requiring attention
Structural network development	- PGMU and 5G notice - TACs - Conversion balance and PSTN reversible assets - Connected N and NE - FUST	N/A. Impact on the coverage of schools with high-speed networks	MCom and Anatel	- FUST legal reform in 2021 - Expansion of fibre-optic networks (PGMU, 5G) - Structural development of the N and NE Regions	- Effectiveness in the full use of FUST - Supplementary budgetary resources - Full implementation of obligations already defined - Take schools into account in any new obligations
GAPE | Anatel	Group to guide use of 5G auction resources for investment in school connectivity	In the defining and planning phase of pilot projects	Anatel	- Specific resources for school connectivity - Priority of service to unconnected schools	- Coordination with other actions of the Federal Government - Respect of federalism in projects - Scope of inputs
FUST | Fund for the Universalization of Telecommunication Services	Fund to stimulate the expansion and improvement of networks and services * 18% goes to public schools	In the planning phase	MCom	- Legal reform unlocked use of resources - Steering committee established and guidelines approved	- Uncertainty about full use of resources - Modalities of use of resources not yet validated - Initial investment beyond infrastructure can reduce impact

(continued)

Policy | Programme	Definition	Benefiting schools	Responsible entity	Positive points	Points requiring attention
Connected Education Innovation Policy | PIEC	Linked to the MEC, transfers resources to schools and departments to contract connection services and other inputs	91 424 schools have already received funds	MEC/FNDE	- Transfer instrument (FNDE) recognized and used by schools and municipalities - Robust source for OPEX - Link transfer to the Connected Education Gauge - Potential to guide national quality goal	- Current limit of resources per school to contemplate the different dimensions for effective use of ICTs - Difficulties in contracting (such as the absence of tender specifications) reduce the impact of the policy on small municipalities
PBLE | Broadband in Schools Programme	Urban school connectivity programme started in 2008	57 585 schools	Anatel	- Scope of the programme	- Quality inadequate for current needs - Ineffective goal review mechanisms - Discontinuity demands attention
Rural Connectivity Programme 4G-RURAL	Rural connectivity programme, through obligations of MCS operators	33 201 rural schools	Anatel	- Scope of the programme	- Quality inadequate for current needs - Lack of revision of quality goal
Connected Northeast **Connected Education**	Initiative for expansion and internalization of networks in the NE Region	473 schools in urban areas in six municipalities in the NE	MCom, with MEC resources and execution by RNP	- Quality of the services - Relationship with federal entities - services maintained for a reasonable time	- Respect of "federative pact" - Possible service gaps in the municipalities covered
WI-FI BRAZIL 1 | SGDC (GESAC)	Schools connected through SGDC	11 178 schools	MCom, execution by Telebras	- SGDC expanded coverage - Higher quality than previous satellites	- Coordination with other programmes - Respect of federative pact - Ability to meet demand

(continued)

Policy | Programme	Definition	Benefiting schools	Responsible entity	Positive points	Points requiring attention
WI-FI BRAZIL 2 | Connected Schools	*Connected Schools* pilot programme, in partnership with RNP	8 341 schools (2 940 urban and 5 401 rural)	MCom, RNP execution	- High quantitative and qualitative impact - Execution agent (RNP) with high execution capacity with ISPs	- Maintenance and sustainability after the initial contract expires - RNP with already consolidated attributions may require another institutional design
LAW 14.172/2021	Law to ensure mobile connectivity during pandemic	Schools to be served not accounted for	Federal, execution by states	- Resources transferred to federal entities focused on connectivity	- Context of face-to-face classes can reduce effectiveness
Connected education gauge	Incorporated in 2018 to PIEC, to monitor quality of the services	59 000 schools, in expansion	Ceptro.br / NIC.br, with support from MEC	- Reliable gauge - Scalable to 100% of schools - Firmware version already in pilot	- Universalization of the Connected Education Gauge requires broad institutional coordination - Dependence on suppliers for diffusion of the firmware version
Connectivity in education map	Mapping 100% of public schools with data aggregation	100% of schools, with some level of information	Ceptro.br and CIEB, with support from MEC	- Map at an advanced stage of development - Input for monitoring and policy forming	- Divergent policy data limits the reliability of this information - Non-universalization imposes limits on monitoring

6 Funding coverage and connection of schools

A study published by MegaEdu, BCG and UNICEF (2022) based on the quality objective of 1 Mbit/s per student (considering the shift with the largest number of students in the school) estimated the investments required to connect all Brazilians schools to the Internet. The estimate covers both schools potentially served by fibre-optic networks and those that should be served by alternative networks (radio and, in particular, satellite), due to the current impracticality of expanding fibre-optic networks to those locations.

6.1 Investments in fixed network expansion and upgrading | capex

To achieve this, the study considers that it would be necessary to invest BRL 7.2 to 9 billion in the expansion of fibre-optic networks to reach the remaining 10.5 per cent of schools potentially connectable by these technologies. It would take another BRL 2.4 billion to upgrade the wired networks, converting them into fibre-optic networks. In addition, BRL 8 to 36 million would be required to introduce alternative technologies to areas outside the coverage zones, which affects 5.3 per cent of schools. In short, it would take BRL 9.6 to 11.4 billion to connect or convert the connections of public schools into optical fibre. That figure does not include bringing services to the 5 435 public schools (3.9%) that are off the electricity grid.

6.2 Resources for contracting and maintaining services | opex

According to these estimates, maintaining the 51.8 per cent of schools already served by fibre-optic networks would take BRL 132 million per year.[16-17] As for the contracting and operation of alternative/satellite technologies for the remaining 5.3 per cent of schools, BRL 12 to 54 million per year would be necessary, based on an average cost of USD 1 000 per connected point. In addition, the annual cost of Internet plans would be about BRL 12 to 54 million.

The study does not include the public schools off the electricity grid; projects to extend service to them will require the participation of other institutional agents.

[16] The calculation considers all schools, including those currently served and those potentially served with direct funding from states and municipalities, but does not account for the fact that initially some of the schools will have the services covered by combined investments in network expansion, with capex-type investments reducing initial opex costs.

[17] On a national average, for schools with 100 students/period, the annual cost for service maintenance is BRL 1 200/year (BRL 120/student), while for schools with over 500 students/period the amount is BRL 4 680/year (BRL 93.6/student) (fibre-optic plans in both cases). The calculated cost, based on market research, takes into account variations in size, region and school area.

6.3 Resource estimates for expansion and upgrading of fixed networks and service maintenance

Table 10: Investments to reach public schools with optical fibre

Fixed broadband coverage zone	Connection status	Number and % (in relation to total schools)	CAPEX Infrastructure (connection / antenna)	OPEX (Cost of Internet plans/ year)
Schools in coverage zones (111 381)	*Optical fibre (FTTH) (71 849)*	*72 282 (51.8%)*	N/A	BRL 132 million
	Wired only (39 532)	*39 738 (28.5%)*	BRL 2.4 billion	BRL 65 million
Schools outside the coverage zone (21 626)	*Technically viable fibre (7 063)*	*14 623 (10.5%)*	BRL 7.2-9.0 billion	BRL 20-27 million
	Alternative technologies (5 092)	*7 438 (5.3%)*	BRL 8-36 million	BRL 12-54 million
No power or only via generator (5 092)		*5 435 (3.9%)*	To be addressed jointly with other institutional agents	
TOTAL INVESTMENTS			Approx. BRL 9.5 to 11.4 billion	Approx. BRL 229-278 million per year

Source: MegaEdu, BCG and UNICEF, 2022, p. 27.

7 Structural recommendations for a sustainable and effective public policy

In the following chapter, structural recommendations are presented to ensure the public policy for a connectivity infrastructure for Brazilian public schools is effective and sustainable. These recommendations are only suggestions, based on a qualitative assessment of past policies, in the planning or application phase of pilot projects, and are meant to support the discussions currently under way and the decision-making process of the public managers involved.

7.1 Organic development of the sector

Development of the telecommunication sector is a precondition for the universalization of school connectivity, which can be strengthened by deepening a structural approach that acknowledges Internet access as essential. In the coming years, the **fulfilment of the obligations provided for in the PGMU and the notice for the exploitation of 5G technology** will be crucial for this development. In addition, systematic observation of the sector suggests that efforts will be needed to structurally expand the supply of services, looking at, among other things, **revision of the sectoral tax burden** and **simplification of the processes for land and post use** by telecommunication companies.

The role of small and medium-sized ISPs in Brazil is important: they have grown significantly in recent years, and are moving into areas where coverage by the large operators is deficient, including schools. For this reason, structural actions to **incentivize small ISPs** should be made a priority by defining asymmetric rules and providing viable and executable financial support in the form of accessible financing, including alternative forms such as the issuance of debenture bonds on favourable terms.

7.2 Schools as an infrastructure expansion vector

In Brazil, the finely-meshed network of public schools covering the national territory is a natural choice for bringing open connectivity to local communities that remain deprived of Internet access; the resources available for the expansion and upgrading of telecommunication infrastructure should therefore look at the public schools in the basic education system as the primary vector for the necessary investments.

In the current context of Brazilian telecommunication policies, this vector includes **financial resources already devoted to school connectivity**, such as those derived from the 5G frequency auction and the expected percentage from FUST, as well as others that are created by contractual obligations, such as the **investment balance arising from the conversion of existing concessions** into authorizations and new **Conduct Adjustment Agreements** (TACs).

7.3 Universal approach: no student left behind

The success of the school connectivity policy hinges on its ability to leave no student behind. Observation of the policies already implemented suggests that the challenge of connecting Brazilian schools is best faced with a **plan that covers 100 per cent of schools in urban and rural areas,** drawing on the existing panoply of policies including PIEC, FUST and resources from the 5G auction. Defining **coverage and connectivity goals** for all schools based on **quality and equity objectives**, with **specific actions and resources** for their fulfilment over the coming years, is decisive for the success of the country school connectivity policy. Linking together the countless actions during the stages of planning and execution, and coordinating the action of the different institutional agents, will be one of the main challenges for the next period.

In parallel with the efforts to improve the quality of Internet access services for the locations and schools that have not yet met the quality targets, consideration should be given to **prioritizing schools that currently have no connectivity at all**. Bringing high-quality service to these institutions will require a particular focus on the North and Northeast Regions, targeting the 5 000-plus schools deprived of electricity; in areas of low population density, the option of community access networks, recommended by the Giga Initiative (2021), should be given particular attention.

7.4 Coordination of policies and institutional agents

For the success of school connectivity policies in Brazil, a central factor will be institutional coordination in order to **organize the different programmes and actions**, frequently developed in a dispersed and fragmented way; coordination is needed both at the federal level and in the relationship with the other federal entities. Specifically at the national level, observation of previous policies or those currently in the planning stage reveals that it is crucial to **coordinate policies by entities with the institutional capacity** to influence state agents that act in the sector in a comprehensive way, in order to organize the different initiatives in the form of a plan, generate synergies, universal and equitable approaches, and avoid duplication of efforts and waste.

In the Brazilian institutional context, the role of coordination of telecommunications falls to a central executive authority, the Ministry of Communications (MCom). During the initial implementation period of the policy in particular, GAPE must play a central role, depending on the resources under its management, while Anatel retains operational and information production leadership to implement the national school connectivity plan. Institutions such as the National Research Network (RNP) and Telebras are also crucial for the implementation of infrastructure expansion, activation and maintenance projects.

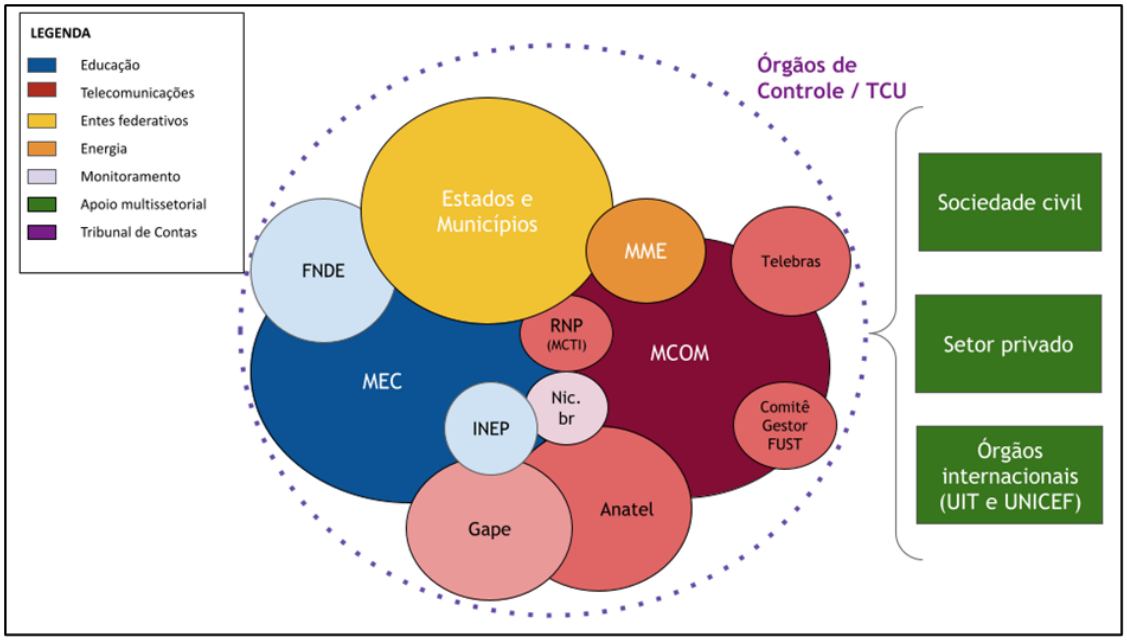
NIC.br plays a central role by producing data on the quality of services offered to schools. For schools currently without electricity, other leading agencies and parts of the Federal Government are also of importance, in particular the Ministry of Mines and Energy (MME). Civil society organizations with technical expertise, such as CIEB, MegaEdu and the Network Rights Coalition (CDR), as well as large and small access providers, are also of importance in the multisectoral approach to school connectivity.

Intersectoral coordination between the Ministry of Communications and the Ministry of Education will be decisive for the connectivity plan, to ensure that the institutional agents and technical areas contribute to the public policy on the basis of their specific institutional

jurisdiction and expertise. To this end, agencies linked to the telecommunication sector should prudently evaluate the prospects of leadership in the supply of inputs of a pedagogical nature, such as digital educational resources or training. Alternatively, coordination of public policy can be performed by an umbrella agency; in Brazil, this could be the Civil House of the Presidency of the Republic which would ensure overall policy coherence. Regardless of the design chosen, international experience suggests that the chances for success of an integrated plan for school connectivity tend to be maximized with the specific allocation of human and operational resources for the management of the connectivity plan.

Finally, multisectoral dialogue has shown the importance of coordinating the connectivity plan with oversight entities, such as the Federal Audit Court (TCU) and state audit courts, to create confidence at the federal level that connectivity projects and initiatives can achieve success and to minimize legal hazards that could delay implementation. Below is a template for discussion and further exploration:

Coordination of the institutional agents: discussion template



7.5 Respect of federative pact | Relationship with states and municipalities

In addition to the coordination of policies at the federal level, their **compatibility with the Brazilian federative pact** is also crucial, since states and municipalities play a central role in the administration of schools. Federalism is one of the main lessons to emerge from the evaluation of the most comprehensive programme ever implemented at the federal level, the Broadband in Schools Programme (PBLE). Failure to respect this aspect of the institutional-administrative order of Brazil undermines the sustainability of the policies in the medium and long term.

Given the stage of development at which the federal entities find themselves today, the **federal states and large and medium-sized municipalities have the capacity to implement connectivity policies** themselves, guided by national objectives and in some cases drawing on federal resources. **Small municipalities, on the other hand, and their inter-municipal consortia, require**

close support to guide their contracting policies. In cases such as those of schools currently unconnected or with a significantly substandard infrastructure, the Federal Government must act directly, including for the coverage and initial activation of the services. Still, even in these cases, the dialogue with the local administration will be central for the sustainability of the policy and a subsequent transition to other forms of financing the services, whether it be with local or federal resources.

7.6 Equitable quality objectives

Equitable and clear objectives are another requirement for the success of school connectivity policies. While many inputs need to come together for ICTs to be effectively incorporated in a pedagogical setting, an effective telecommunication policy should focus on connectivity to ensure equal opportunities for schools, educators and students at the material level. For this purpose, download speed, even more than connection latency, is the most appropriate indicator of quality of access and can be used to define quality goals.

School connectivity programmes and policies have historically used their own parameters as objectives, without any overall coordination with other policies or actions. This makes for persistent inequity, despite initiatives such as PBLE, the 4G Rural programme and PIEC, three of the most comprehensive programmes currently under way, and the ongoing pilot programmes implemented by RNP. The Ministry of Education and GAPE also suggest different targets based on school size. The Giga initiative and, more recently, GICE, also propose quality objectives based on the number of students per school.

Table 11: Quality goals and/or references (by programme/institution)

Programme or institution	Goal or reference	Observations
PBLE	2 Mbit/s per school	Forecast of biannual review – highest supply in the region (not performed)
4G Rural	1 Mbit/s per school	No provision for periodic review
Connected NE | Connected Education	100 Mbit/s per school	Goal established in public bid/RNP terms of reference
Wi-Fi Brazil | Telebras (SGDC)	10-20 Mbit/s per school	In general, satellite service is intended for rural schools, which have a small number of students
Wi-Fi Brazil | Connected Schools (RNP)	Up to 200 Mbit/s per school	Goal established in public bid/RNP terms of reference
PIEC	100 kbit/s per student	Legal reference for transferring resources
Giga initiative	100 kbit/s per student	Basic proposal, to be adapted to national realities

Table 11: Quality goals and/or references (by programme/institution) (continued)

Programme or institution	Goal or reference	Observations
MEC	60 Mbit/s – schools with 1-199 students 140 Mbit/s – 200-499 students 280 Mbit/s – over 500 students (standard: 280 kbit/s/student)	Objectives for 2023/2024, presented to GAPE Source: MEC, 2021b, p. 4-5
GAPE	50 Mbit/s – schools with 15-199 students 100 Mbit/s – schools with 200-499 students 200 Mbit/s – schools with 500 students (minimum 256 kbit/s per student)	Reference for pilot projects, in the planning phase
GICE	(1 Mbit/s per student / biggest period) 100 Mbit/s – up to 100 students/ period 200 Mbit/s – 100-200 students/ period 500 Mbit/s – 200-500 students/ period	Proposed goal for reference of public connectivity policies

Source: Programme data

In Brazil, the current situation with regard to high-speed networks, based on fibre-optic technology within the reach of larger schools, as pointed out by GICE´s Technical Note (2022), suggests that bolder objectives can be set, such as making 1 Mbit/s per student, already achieved in some of the largest schools, the national standard and extending its benefits to the typically smaller schools in rural and remote regions. For half of the schools, this can be achieved by contracting a 100 Mbit/s plan. Only 10 per cent of schools would need to contract a plan higher than 400 Mbit/s, and these are generally in urban locations that are served by high-capacity networks. The objective would also be in line with the concept of Significant Connectivity, promoted by the Accessible Internet Alliance (A4AI).

To update the parameters that define the objectives of the different initiatives, it is recommended to revise the regulation of PIEC, the priority instrument for service maintenance, with goals to be incorporated by the set of school connectivity initiatives. The same objective, updated periodically, should be used by monitoring tools such as the Connected Education Gauge, to monitor and assess achievement of national quality goals.

The establishment of equitable goals for the whole country, besides harmonizing the guidance of the different connectivity policies, has the potential to increase engagement among school administrators and within the school community, particularly with easily calculable targets, such as extending the 1 Mbit/s reference to schools of all sizes, bringing a degree of coherence to the objectives of GAPE, MEC and MCom projects.

7.7 Specific, sufficient and stable resources

The high priority given to school connectivity policy and the availability of specific resources (5G/GAPE, FUST, PIEC) has created an ideal opportunity for the implementation of universal school connectivity initiatives. The guarantee of sufficient resources for investments in the expansion and upgrading of high-speed networks to optical fibre (capex), as well as stable financing for contracting and service maintenance (opex) for all technologies to be used (optical fibre, wire, radio and satellite), are essential requirements to meet the connectivity goals. **Agreement on the commitment of investments and additional budget contributions is central to the success of the plan**.

7.7.1 Infrastructure investments and service activation | capex

In terms of actions for developing telecommunication infrastructure and covering schools with the best available technologies, the necessary work, as described by MegaEdu, BCG and UNICEF (2022), can be launched with existing resources such as those from the **5G auction** (BRL 3.1 billion) and **FUST** (minimum of BRL 1 billion/year). In the specific case of FUST, although the current rules specify a minimum of 18 per cent for school connectivity, nothing prevents other projects from incorporating the coverage and connection of public schools as an objective, given its grass-roots relevance and its importance for digital inclusion of communities more broadly. Sustained FUST-funded work on the expansion of fibre-optic networks, in a continuous and uninterrupted way, while not a panacea for the sector shortcomings, is crucial to substantially increase connectivity rates across the country and, consequently, in schools as well.

Expansion and upgrading may also be funded by creating obligations under the **Conduct Adjustment Terms**, the remedial terms that Anatel negotiates with operators, or from the **reversible assets** mechanisms and the **remaining balance related to the obligations of universalization** of PSTN operators. Like the ongoing projects, these represent investment to create coverage for schools and maintain service during a transitional period, with a view to the subsequent transfer of responsibility to states and municipalities.

Given the centrality of the public policy of school connectivity, funding the necessary work will be more effective if agreed in the **federal budget**. Contributions can also be considered from states and other federal entities with greater financial and management capacity to contribute to the connectivity plan.

Table 12: Capex investments

Investments required	Sources for investments	Amounts
BRL 9.6 to 11.4 billion* **Schools without electricity not included*	*5G auction*	BRL 3.6 billion
	FUST (four years)	BRL 4 billion
	Federal budget/contributions/matching funds from states and municipalities	BRL 2 to 3.8 billion
	New contributions (TACs; PSTN conversion)	

Source: estimates by MegaEdu, UNICEF and BCG (2022)

7.7.2 Service maintenance | opex

The institutional design to ensure sustained funding of access to the service must consider the administrative and financing capacities of the different federal entities (states and municipalities). States and large municipalities tend to have sufficient resources to maintain services in line with national quality goals, while medium and small municipalities tend to depend more on federal funding transfers.

In addition, sources must be stable and secure. Among the available options are **resources from PIEC** (forecast of BRL 355 million for 2022 and BRL 455 million for 2023)**, from FNDE**, whose budget is robust (BRL 65 billion planned for 2022), and the resources from FUST, with its statutory minimum of 18 per cent for investment in educational establishments. Due to the long history of resources being transferred from FNDE to municipalities, with tools widely disseminated and used as a matter of public policy, as well as the nature of school maintenance services (linked to the education sector), the possibility should be considered of **prioritizing PIEC for the task of maintaining services in the medium and long term, while FUST focuses on infrastructure projects** ensuring the continuation of service until such time as the responsibility can be progressively transferred to states and municipalities, with the support of PIEC.

An assessment of PIEC as the priority source further suggests that it can be improved, with **an increase of the current limits of resources per school** (see § 3.4),[18] for example through transfers to fund both the maintenance of connectivity services – including satellite services, when necessary – and the purchase or contracting of other inputs for the effective use of ICTs in the school environment, such as user devices and other resources. Moreover, given the fragmentation of PDDE resources school by school, **other forms of transfer of PIEC resources might be considered, such as the Articulated Actions Plan (PAR)**, to stimulate the implementation of broader/universal plans by municipal school boards and administrations. The PIEC regulations, still under development, represent an opportunity for such improvements.

A review of current policies also highlights the importance of streamlining administrative processes, with simplified accountability and tendering specifications provided for use by municipalities and municipal consortia.

[18] Amounts specified in Resolution FNDE/CD No. 09/2018.

Table 13: Opex investments

Investments required	Sources for investments	Amounts	Description
BRL 229-278 million/year* **Schools without electricity not included*	*PIEC / FNDE*	2022 – BRL 355 million 2023 – BRL 455 million *Origin of the source – FNDE* 2022 – BRL 65 billion	Priority source for opex
	FUST	BRL 180 million/year (18% of the BRL 1 billion/year revenue estimate)	Additional funds to cover opex, after initial years of prioritization of the fund for capex until expansion and universalization of network coverage
	States and municipalities	States and large municipalities already absorb part of the costs	

Source: Estimates by MegaEdu, UNICEF and BCG (2022)

7.8 Information for monitoring and creating public policies

7.8.1 Connected Education Gauge | Education Connectivity Map

The Connected Education Gauge is a powerful tool for monitoring the quality of Internet access in Brazilian public schools. The Gauge is a mature tool that can be linked to all the initiatives that make up public connectivity policy, with the objective of **universalizing school connectivity**. It is also a priority tool for monitoring achievement of the nationally established objectives. The measurement system, while already possessing a high degree of technical confidence, can be further improved by providing data from the incoming router. This measurement through **firmware** is more robust, as it reduces dependence on a computer hosting the measurement software, which can be temporarily turned off. A pilot project is under way, as a result of a partnership between NIC.br, UNICEF and the Lemann Foundation.

The associated Education Connectivity Map is an essential input for monitoring school connectivity policies. Notably, it allows for improvements through coordination with the National Dashboard launched by Anatel and the creation of synergies, in order to support managers and decision makers.

7.8.2 National School Connectivity Data Dashboard – GAPE/Anatel

The recently launched National School Connectivity Data Dashboard of Anatel/GAPE is the public window on the parameters that guide funding support for projects to be implemented using the funds raised by the recent spectrum auction. It also stimulates discussion of synergies with the Connectivity in Education Map. Given the institutional role of Anatel, which includes the production of sectoral data to guide public policy-making, one option for organizing the work of institutional agents is to reserve for NIC.br the leadership in the management of the Connected Education Gauge and the production of data linked to the pedagogical uses of ICTs, with the creation of more user-friendly interfaces for managers and the public, and to assign to Anatel the task of organizing information on public connectivity policies in general.

7.8.3 Mapping the telecommunication infrastructure

Efforts have been made in recent years to overcome the information gap in relation to the extent and the quality of the available infrastructure, such as the initiatives developed by the National Telecommunication Agency, the Giga initiative (ITU and UNICEF), NIC.br and MegaEdu. These seek to identify what is required to provide fibre-optic coverage in schools that do not have fixed broadband, to ensure that they can benefit from the funds available for universalization. The convergence between these different efforts, with their different methods and tools, should produce something greater than the sum of its parts: a single, highly reliable and publicly accessible mapping exercise, which can be used to define projects and priorities. This is crucial for the execution of a connectivity plan with the ambition of universalizing high-quality access to the Internet, including Brazilian educational institutions.

7.8.4 School census | MEC and INEP

Experts and managers have pointed out the importance of improving the methodologies of the School Census carried out by the Anísio Teixeira National Institute for Educational Studies and Research (INEP), an essential source of data to create and monitor public policies for the connectivity of educational institutions. This topic has been the subject of specific work and partnership between CIEB, the University of Brasília (UnB) and NIC.br, with the objective of presenting proposals to INEP to improve the census.

7.9 Summary table | Lessons learned and recommendations

Table 14: Summary table – lessons learned and recommendations

Theme	Lessons learned	Recommendations
Sectoral policy	Fragmented sectoral policies can limit sectoral development, with an impact on school connectivity	- Review sectoral tax burden - Simplify processes for land use and posts - Increase incentives for SMEs - Fulfil obligations under PGMU and 5G Notice, TACs and PSTN conversion balances/reversible assets
Schools as a vector for infrastructure expansion	Disregarding schools as a connectivity vector reduces the scope of school connectivity policies	- Make schools a vector of infrastructure expansion, including them in viable projects and initiatives, such as new TACs and PSTN conversion balances
Universal plane	Lack of universal approach tends to leave schools and students behind	- Create a school connectivity plan to serve 100% of schools, with quality goals, designation of responsible federal entities, monitoring tools, schedule, resources, specific actions and compatible institutional organization

Table 14: Summary table – lessons learned and recommendations (continued)

Theme	Lessons learned	Recommendations
Institutional organization	Fragmented institutional coordination can hamper the implementation of public policies	- Coordinate actions and initiatives of the different national and regional institutional agents with a view to taking a universal approach, generating synergies and eliminating duplication - Provide the specific human and material resources needed to ensure coordination of the plan at the national level
Federative pact	Failure to respect the federative pact leads to duplication of efforts and waste	- Ensure that there is no overlap between the activities of the Federal Government and those of other federal entities - Provide states and municipalities with the necessary capacity to implement connectivity policies, guided by national objectives and drawing on federal resources if possible - Directly support small municipalities and municipal consortia and ensure that federal projects dialogue with benefiting entities, the objective being to become sustainable once the services have been launched
Quality of the services	Heterogeneous goals tend to maintain inequalities and hinder engagement	- Establish national quality goals that are equitable and aligned with current needs, as a reference for federal policies and federal entities - Define mechanisms for revising goals - Continue to improve monitoring tools
Resources	Limitation of specific and permanent resources weakens the direct approach of school connectivity gaps	- Agree on investment commitment to expand and upgrade the infrastructure so as to serve schools, with a focus on optical fibre - Prioritize PIEC for service maintenance, with an increase in the limits of resources per school and adoption of other forms of transfer, such as PAR
Information and monitoring	Information gaps impede diagnosis, monitoring and policy-making	- Universalize the firmware version of Education Connected Gauge - Improve the quality of data on public policies for the Dashboard and Connectivity Map; define a priority monitoring environment (Dashboard X Map) - Define single, high-trust infrastructure mapping to guide project definition and priorities - Improve the School Census

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