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ABSTRACT

This article analyzes the process of digital inclusion/exclusion while taking into account the infrastructure of public schools in the nine states that make up the Legal Amazon region, a geographical area measuring more than 5 million square kilometers, corresponding to 61% of Brazil's territory and 772 municipalities (IBGE, 2021). The main argument presented in this paper refers to the fragile and fragmented internet access policies throughout the Legal Amazon in areas with a Low and Very Low Municipal Human Development Index. Our methodological resource for organizing data and supporting our analysis of connectivity in the Legal Amazon involves studying demographics and identifying variables that influence the distribution of Internet access points in public schools. We also organize digital connection policies and identify digital inequalities that exist in public basic education and how they affect education in the interior of Brazil. We observed that the municipal public schools where internet access and/or quality are generally poor have a dire need for better connectivity and optimized speed. This situation requires coordinated actions to guarantee the real possibility of adequate infrastructure, viable policies that establish rules for public and private investment, and a harmonious and up-to-date legal framework that regulates access and funding, taking into account regional peculiarities.

Keywords: telecommunications infrastructure; geo-economic macro-regions; significant connectivity; public schools; Legal Amazon.

RESUMO

Este artigo analisa o processo de inclusão/exclusão digital levando em conta a infraestrutura das escolas públicas dos nove estados que compõem a Amazônia Legal, uma área geográfica com mais de 5 milhões de quilômetros quadrados, correspondente a 61% do território brasileiro e 772 municípios (IBGE, 2021). O principal argumento apresentado neste artigo refere-se às frágeis e fragmentadas políticas de acesso à Internet em toda a Amazônia Legal em áreas com Índice de Desenvolvimento Humano Municipal Baixo e Muito Baixo. Nosso recurso metodológico para organizar os dados e fundamentar nossa análise da conectividade na Amazônia Legal envolve o estudo da demografia e a identificação de variáveis que influenciam a distribuição dos pontos de acesso à Internet nas escolas públicas. Também organizamos as políticas de conexão digital e identificamos as desigualdades digitais existentes na educação básica pública e como elas afetam a educação no interior do Brasil. Observamos que as escolas públicas municipais, onde o acesso e/ou a qualidade da Internet são geralmente ruins, precisam urgentemente de melhor conectividade e velocidade otimizada. Essa situação exige ações coordenadas para garantir a possibilidade real de infraestrutura adequada, políticas viáveis que estabeleçam regras para investimentos públicos e privados e um marco legal harmônico e atualizado que regule o acesso e o financiamento, levando em conta as peculiaridades regionais.

Palavras-chave: infraestrutura de telecomunicações; macrorregiões geoeconômicas; conectividade significativa; escolas públicas; Amazônia Legal

INTRODUCTION

The conditions generated by economic inequality and the contrast between prosperity and deprivation as a result of territorial planning and the preponderance of technology and its appropriation in modern societies have been highlighted in Brazilian literature over the last decades by authors from the fields of economics (Bacha, 2015), geography (Santos, 1997; 2011; Santos and Silveira, 2003; Becker, 2015; Haesbaert, 2009); social sciences (Ortiz, 2001), education (Ehlert; Bassani, 2013), and communication (Moreira and Del Bianco, 2019; Moreira; Del Bianco; Deolindo, 2020).

The Covid-19 pandemic in 2020-2021 exposed the invisible citizens of Brazilian society when the federal government determined that families would receive emergency aid equivalent to US$120,00. Due to the digital scarcity in different parts of the country, some groups of people had no access, or problematic access, to communication resources, especially the internet. In the year prior to the pandemic, around 4.3 million students in Brazil were enrolled in schools which had no internet connection due to economic reasons or service being unavailable in the areas where they lived (IBGE, 2019). The suspension (or limitation) of in-person classes meant that elementary school students

between the 1st and 4th grades were the ones who were most excluded from digital learning.

Data from the 2022 ICT Households survey, however, show variations three years after the pandemic: 74% of homes in rural areas had internet access and 86% of homes in urban areas had internet access (CGI.br, 2023). With regards to schools, another survey was conducted during the same period by the Brazilian Internet Steering Committee (CGI) and ICT Education 2022 showed improvements in terms of internet access in schools with 79% of municipal schools having access and 74% of state schools. Nonetheless, "only 60% of municipal schools and 61% of state schools had internet access that students could actually use". According to public school administrators, "the school's internet always or almost always failed to handle multiple accesses (...) and the internet signal didn't always reach the rooms that were furthest from the router" (CGI.br, 2023a). School teachers and administrators also reported that, "although 91% of educational establishments had at least one type of computer (laptop, desktop or *tablet*)", only 63% could be used by students in educational activities (CGI.br, 2023a).

It has become vitally important to improve the connectivity of public schools and expand the educational use of the internet in the post-pandemic world. Information collected by the CGI over the years points to the need to overcome technological and territorial diversities in order to advance teaching and learning structures so that they address the technological and structural deficiencies faced by students and teachers. The inequality in digital access was one of the reasons various parts of Brazil were excluded during the pandemic. Schools in many areas need educational policies that address their regional geographic realities in order to overcome the adverse circumstances that lead to unreliable and/or problematic telecommunication services. Public digital access policies will allow schools to function as teaching and learning spaces with real infrastructures that enhance connectivity and promote learning.

The objective of our research was to verify the infrastructure in public schools in the nine states that form the Legal Amazon[1], an area measuring more than 5 million square kilometers, corresponding to

1 The Legal Amazon was defined on January 6, 1953, during the civil government of Getúlio Vargas, by Law No. 1,806. Its objective was to promote the economic and social development of the region which was home to around 20 million people. A plan was developed to achieve this goal, called the Amazon Economic Valorization Plan. This Plan contained a collection of measures, services, projects and works designed to increase and better develop extraction and agricultural production, livestock, mineral and industrial production, and trading relationships, the goal being to improve the social standards of living and economic well-being of the region's populations and increase the country's wealth. Today, the Legal Amazon corresponds to the area of activity of the Superintendent of the Amazon Development (SUDAM), as defined in Article 2 of Complementary Law No. 124, 03/01/2007.

61% of the national territory. Seven of these states are located in the North (Acre, Amazonas, Amapá, Pará, Tocantins, Rondônia and Roraima), one in the Midwest (Mato Grosso), and one in the Northeast (part of Maranhão). The Legal Amazon covers 772 municipalities (IBGE, 2021)[2], 349 of which have a low Municipal Human Development Index (MHDI) and 22 have a very low MHDI, indicating vulnerable socioeconomic contexts that may affect basic education.

This article considers the fragility and fragmentation of internet access policies for telecommunications services in locations in the Legal Amazon with Low and Very Low MHDI which, over time, have reduced their capacity to reach public users (students and teachers) in primary and secondary schools in the region. Once in-person classes resumed after the pandemic, schools needed to rely on technological tools to enhance and resume learning. In municipal public schools, where signal quality and internet speed are limited, full connectivity is still a goal that has yet to be achieved.

Our research is based on the assumption that internet access services are essential to guarantee citizens' rights and are determining factors in addressing regional socioeconomic inequalities and promoting human development. Our research is also based on the fact that information technology can facilitate access to pedagogical resources, connect students and teachers outside the physical boundaries of the school, and provide students in different regions with the same digital skills that ultimately result in sustainable regional development.

THEORETICAL-METHODOLOGICAL APPROACH FROM THE PERSPECTIVE OF COMMUNICATION GEOGRAPHY

The theme of internet-school-teaching is included in Communication Geography studies and treat the territory as a methodological category. To define territory, this article uses the conceptual framework of Santos and Silveira (2003), who define it as a lived and appropriated space that encompasses social, economic, cultural and political relations. It is, therefore, both a product of the relationship between social subjects and a space that emerges as a field of tensions and disputes, revealing different dimensions. Milton Santos (1997) also contributes to the approach to social inequalities in the territory by highlighting the social construction of power relations and economic dynamics, taking a critical look at the asymmetries

2 Maranhão is the only state that does not have all of its municipalities (217) included in the Legal Amazon: 181 of these municipalities are part of the designated area.

that challenge the processes of constructing public policies.

The connections between internet-school-teaching and public policies of digital inclusion for regional development start with the characterization of the Legal Amazon as an "imagined" territory (Santos, 2001); its delimitation does not necessarily represent the natural divisions of the Amazon region or its environmental homogeneity. The Legal Amazon was outlined by the State with specific objectives that include the control and exploitation of natural resources, economic development, and organized human occupation – shaped by economic interests, symbolism, public policies and the diversity of local communities. Our methodological option of observing the demographics for this territory allowed us to identify variables that influence the distribution of internet access points in public schools.

To understand the complex web of official programs and projects, we included a timeline based on the documentary analysis of available official data (ordinances, evaluation reports and official websites). The survey on the history of policies and programs helped toward understanding how State programs work and toward our critical analysis of digital inclusion and exclusion in terms of internet access in public schools.

The scope and effectiveness of public policies were measured based on data collected from the following official sources using the documentary analysis method: (i) metrics from the Municipal Human Development Index (2013) in locations with low MHDI; (ii) reports from the Internet Steering Committee – ICT Households 2021-2022, ICT Education 2022-2023, and the School Census 2020 and 2022 (INEP); (iii) databases from the Ministry of Communications (Wi-Fi Brazil Program, 2019-2022) and Ministry of Education (Connected Education, 2022); (iv) data from the National Telecommunications Agency (Anatel, 2022-2023) and the Brazilian Institute of Geography and Statistics (IBGE Cities, 2022-2023); (v) documents and reports from international bodies (UN, 1966; International Telecommunication Union, 2023; Inter-American Development Bank, 2022). All this provided us with information about schools with internet access, the capacity of public policies to meet the demands of the territory, the quality of connectivity available, and any obstacles preventing programs and/or public policies from being implemented.

We organized, assembled and refined the data we obtained from official sources on digital inclusion policies. Even though a large amount of this information is available on the internet, there is not much information on objectives achieved and results obtained, and not much on the different regions, states and municipalities.

THE LEGAL AMAZON: GEOHISTORY AND GEOREGIONS

When we think about the Amazon, we automatically think of the following three Brazilian researchers who encouraged and supported studies on the region, particularly the Legal Amazon: Bertha Becker (1930-2013), Pedro Geiger (101 years old in 2024) and Eidorfe Moreira (1912-1989). Between 1966 and 1967, Pedro Geiger worked with other geographers on a preliminary document reviewing the Regional Division of Brazil "prepared in accordance with Resolution No. 595 of June 17, 1966 of the XXIII General Assembly of the National Council of Geography to support the regionalization provided for in the Ten-Year Plan". He stated that "the principle of connection governs the unity of the land and the definition of regions as parts of a whole" (Geiger, 1967 [2006], p. 59). His thinking on local ties was the precursor to organizing the Brazilian territory into three geoeconomic regions presented in 1969 (Amazon, Northeast and Mid-South). The geoeconomic regions defined by Geiger (1969) included the design of the Legal Amazon in 1953, created by Getúlio Vargas as part of the geographic organization policy for development in the region. Geiger's idea "considered not only physical aspects, but also human, historical and economic ones. This form of organization, in geoeconomic regions, facilitated the understanding of Brazil's social and political relations" (IBGE Agency, 2023).

Oliveira Junior's (2015) writings on the Amazon at the turn of the 20th century claims that "the search for a modern Brazil" began with Eidorfe Moreira (1960), who perceived the northeast and the Amazon in the following manner: "the former is the 'problem region' and the latter is the 'isolated region'; challenges for any public policy" (Moreira, 1960, apud Oliveira Junior, 2015, p. 572). Inspired by Eidorfe Moreira, Oliveira Junior sees the Amazon not as one, "but several Amazons in one, from the hydrographic basin to the economic space – plurality in unity", when describing the concept of the Amazon as a 'landscape' and a 'region' (Moreira, 1960, p. 14, apud Funbosque, 2023).

The Amazon was also an object of research for geographer Bertha Becker. Her first-hand experience and knowledge came from her immersive journeys, learning about and following local realities. She conducted a large number of analyses, wrote articles, held conferences, taught

classes, and authored at least 14 books between 1982 and 2013[3] about the region, her first being *Geopolitics of the Amazon: the new resource frontier*, from 1982. In her book *The Amazon–Geopolitics at the turn of the third millennium* (2007), she states that "the changes that occurred in the Amazon occurred to all dimensions of regional life" (p. 29) and that, especially in the Legal Amazon, the cities and urban subsystems in the cities were characterized "by the presence of few centers with expressive centrality and a large number of cities with weak and very weak centrality" (Becker, 2007, p. 95). Speaking to the changes at the end of the 20th century, she points to telecommunications playing a key role, stating that connectivity allowed "the region to communicate internally with the rest of the country and with the outside world, breaking away from its state as a large 'island' on the outside" (Becker, 2007, p. 29).

A TIMELINE OF DIGITAL INCLUSION PROGRAMS AND EDUCATION POLICIES

In the Legal Amazon, as with other regions, the strategy for overcoming disparity in internet access lies in the definition of sectoral public policies. Saravia (2006, p. 28) defines public policy as "a flow of public decisions, aimed at maintaining social balance or introducing imbalances designed to change this reality". Based on this objective and operational perspective, policies are developed as preventive or corrective actions to maintain or modify the reality of one or several sectors of social life, defining objectives and strategies for action and allocation of resources to achieve said objectives (Saravia, 2006, p. 29).

Since 1997, Brazil has developed public policies that address inclusion of information and communication technologies in education, aiming to improve forms of learning and reduce rates of social exclusion. Eight national programs with different characteristics but with similar objectives were implemented between 1997 and 2022 (Table 1).

3 More on the books of Bertha Becker can be found at the website of the State University of Rio de Janeiro's GeoBrasil Group, accessible at: http://www.grupogeobrasil.uerj.br/geografo.php?id=36&lab=1

Table 1 | Timeline of national digital inclusion programs and policies

Year	Program	Objective	Target Public	Technology	Management
1997	National Educational Technology Program (ProInfo)[4][5]	Using information and communication technologies (ICTs) for pedagogical purposes.	Public elementary and secondary education	Computers, digital resources and educational content. Tablets for teachers.	Ministry of Education
2002	Electronic Government Program (GESAC)[6]	Broadband internet with access points - routers installed in public squares with free and open access.	Schools, libraries, telecenters, indigenous villages and communities in vulnerable situations.	Free terrestrial and satellite broadband. Wi-Fi router in public squares.	Ministry of Communication
2004	Complementary inclusion programs to ProInfo Computers, computer refurbishment centers.	Training in computer use and refurbishing, proper disposal of electronic waste.	Low-income high school youths.	Computer refurbishment	Ministry of Communication
2005	Connected Citizen - Computer for All - Digital Inclusion Program[7]	Digital inclusion by providing more affordable computers and financing.	General public	Computers for R$1,400.00 (one thousand and four hundred reais)	Ministry of Science and Technology
2005	Casa Brasil Project	Connectivity with local cultural events to encourage community participation and involvement	Cities with a low Municipal Human Development Index.	Distribution of computers, telecenters and public libraries. Multimedia studio, computer assembly and laboratory, provision of radio workshops.	Ministry of Education, Ministry of Science and Technology, Communication Secretariat for the Presidency of the Republic, Technological and CNPq.
2008	Broadband in Schools Program (PBLE)[8]	Urban public schools with high-speed internet, services with no membership required.	Urban public schools	Broadband network	Ministry of Education, Anatel, and Ministry of Communications in partnership with state and municipal education departments.

4 Created by Ordinance No. 522/MEC, of 04/09/1997.

5 Before computerization in schools, ProInfo provided political-pedagogical support for several Ministry of Education administrations providing textbooks, national curriculum parameters, TV-School, distance education, valorization of teaching, decentralization of resources for schools, and evaluation of educational quality.

6 MC Ordinance No. 256, from 03/13/2002, updated by MCTIC Ordinance No. 7,154, from 12/06/2017.

7 Decree No. 5,542, from 20/09/2005.

8 Created by the Federal Government by Decree No. 6,424/2008, which amended the General Goals Plan for the Universalization of the Publicly Switched Fixed Telephone Service – PGMU (Decree No. 4,769).

2017	Connected Education Innovation Program[9] (PIEC)	Universal access to high-speed internet, promotion of digital technologies for educational use. Incorporated ProInfo and PBLE	Basic education public schools	Broadband, equipment, teacher training, digital and educational solutions bank, planning for innovation.	Ministry of Education
2021	Wi-Fi Brazil Program	Access to wireless connection services for digital and social inclusion and access to e-government actions. A part of GESAC and was incorporated by PIEC	Access points installed in rural areas that are isolated from urban centers.	Satellite internet hotspots offer high-speed broadband.	Ministry of Communication

Source: Prepared by the authors based on the official program websites.

Over the course of 25 years, the programs have indicated two basic concerns. Until the mid-2000s, the focus was on providing public schools with computers. Then, actions were needed to improve connectivity using broadband access infrastructure. In order to serve rural communities and cities with low MHDI, these actions had to be realized as a joint effort between ministries, states and municipalities. In the timeline above, there is no information about program end dates because the old ones tend to be incorporated into the emerging ones. One example is the Connected Education Innovation Program (PIEC) which incorporated ProInfo, Wi-Fi Brazil, Gesac and PBLE without dismantling them.

An examination of the effectiveness of these programs shows that their biggest challenge is serving municipalities in the Legal Amazon. For example, Melo Neto and Oliveira (2022) observed low local participation: in 2019, only 4% of public schools in Amazonas and 8% in the North region signed up for the Connected Education Innovation Program (PIEC). For these authors, the mechanism that provided schools with technical and financial support from the MEC was exclusionary, thus preventing universal internet access in basic education public schools. The main reason for this was the eligibility criteria: in order to receive high-speed internet, urban schools had to be in an area with land fiber optic connection coverage and have at least three computers for student use and one computer for administrative use.

9 Program institutionalized as a Connected Education Innovation Policy by Law No. 14,180/2021.

This is evidence of the fact that policies do not always reach the majority of schools. Such is the case with the Connected Education Innovation Program (PIEC), which in 2023 served 3,345 schools in the Legal Amazon, or 20.9% (21%) of the total number of institutions (Table 2).

Table 2 | Schools participating in the Connected Education Program in the Legal Amazon

State	Number of participating schools	Number of public schools	Program Service
Pará	1,380	5.956	23%
Maranhão	1,281	5.251	24%
Amazonas	374	3.107	12%
Acre	129	752	17%
Tocantins	76	231	32%
Rondônia	66	131	50%
Roraima	18	338	5%
Amapá	11	149	7%
Mato Grosso	10	63	15%
	3,345	15,978	

Source: Prepared by the authors based on data from the Ministry of Communications (2023) and Inep (2023).

Regarding connection quality, data from the longest-running program, ProInfo, show that it is still far from achieving its goal of providing public schools with high-speed internet. Between 2013-2023, the ProInfo Program installed broadband points in 62,418 urban schools across the country at a connection speed that was slower than the average required for pedagogical use. However, most of these schools (64%) had a speed of 5 Mbps (Anatel, 2023), which allowed them to access online videos and radio stations and download and send files, albeit with some degree of slowness (good performance requires 10 to 20 Mbps to download and send larger files). Only 5% of schools had internet speed above 50 Mbps (Anatel, 2023).

In 2021, the partnership between the Ministry of Communications, Telebras and the Banco do Brasil Foundation installed 13,213 broadband and high-speed satellite internet points in remote regions of the country. This was an improvement from 2019 when resources for connections in remote locations or locations without adequate service provision had to come from parliamentary amendments and the federal budget, with decentralized execution by federal administration bodies (Agência Brasil, 2021).

Another public policy is the structural actions for the Legal Amazon region. One such action is called Norte Conectado[10], a partnership between the Ministry of Defense, Ministry of Communications and the Ministry of Science, Technology and Innovation. The goal is to expand the communications infrastructure by installing 3,000 kilometers of underwater optical networks in riverbeds to provide the region with greater internet capacity than domestic broadband. Between 2015-2021, around 2,000 kilometers of fiber optics were installed along the Negro and Solimões rivers, providing around 1.2 million people with internet (Brazilian Army, 2021).

Digital inclusion actions could have a greater reach in the country if the Universalization Fund for Telecommunications Services (Fust), created to guarantee "fixed telephone services in places with low population density, low population income, and lack of adequate infrastructure" (Eletronet, 2021), applied all its resources to expand connectivity. The amendment to Law No. 14,109, established in 1997 and modified in 2000, redefined the purpose, the allocation of resources, the administration and the objectives of Fust. It expanded internet, broadband and mobile services to precarious locations in rural and urban areas, facilitating the change to digital, particularly in basic education schools and non-profit organizations that serve people with disabilities (PwD). If reorganization is approved by the Federal Fund Chamber[11], it will be possible to properly allocate the funds and resources it needs that, since its creation in 2000, have been reallocated to pay the country's budget deficits[12].

The survey identifies the existence of several digital inclusion actions put into practice by different governments over two decades. However, it is not uncommon for pre-established initiatives to overlap with others, and for projects to coexist independently and in a disjointed manner under different ministries. The indicators show that these policies are fragmented and lack connection between programs. Even with limitations for data crossing, this article explores the public school sector to examine the capacity of current projects on digital inclusion in precarious locations with low and very low MHDI.

10 Established by Interministerial Ordinance No. 586/2015 within the scope of the National Broadband Program (PNBL)

11 Originally, Law 9,998 of 2000 created the Telecommunications Services Universalization Fund (Fust) and required all companies in the sector to allocate 1% of gross operating revenue to expanding the service, especially in regions deemed unprofitable (Agência Senado, 2020).

12 In 2019, Fust had R$21.8 billion in cash (Chamber of Deputies, 2019). In 2023, the Minister of Communications, Juscelino Filho, announced the full use of these resources by allocating R$2 billion to connectivity projects, which includes providing 100% of Brazilian public schools with high-speed internet (Prescott, 2023).

IS THERE SIGNIFICANT CONNECTIVITY IN PUBLIC SCHOOLS IN THE LEGAL AMAZON?

The answer to this question is: not yet. Our analysis begins by looking at internet access as a human right. According to the United Nations (UN, 2011), failing to provide the population with conditions to connect to the digital space is a violation of the International Covenant on Civil and Political Rights of 1966[13], which guarantees that "Everyone shall have the right to freedom of expression; this right shall include freedom to seek, receive and impart information and ideas of all kinds" (UN, 1966). Even though the internet is now more accessible "in all regions of the world and among all income groups", the poorest continue to lack access: "2.7 billion people, approximately one-third of the global population, remain disconnected from the Internet (Becker, 2023).

The current perspective is the search for *meaningful connectivity* to overcome the inequality. The Alliance for Affordable Internet (A4AI) uses four indicators to measure real connection and communication capacity: (i) daily use, (ii) smartphone ownership, (iii) unlimited broadband connection at home, work or school; and (iv) 4G-like speeds (A4AI, 2020, p. 3). Connectivity is a current public problem, as Cefaï states (2017), which requires a solution due to its social scope. It demands physical infrastructure that ensures digital network interaction between devices and the circulation of content among people.

The type of network access reflects on the quality of connectivity in schools. According to data from Anatel (2022), 3.4 thousand Brazilian schools (2.5%) did not have access to electricity, 9.5 thousand (6.8%) did not have internet access, and 46.1 thousand (33.2%) did not have computer labs. In four states in the Legal Amazon, more than ten percent of schools did not have electricity (35.3% of schools in Acre, 21.5% of schools in Roraima, 19.9% of schools in Amazonas, and 12.2% of schools in Pará). The percentage of schools with no internet access in the following six states with a Very Low MHDI were: 41% in Amazonas, 46% in Acre, 36% in Roraima, 28% in Pará, 27.5% in Amapá, and 12% in Maranhão. At the other end of the connection spectrum, the highest percentage of schools with internet access are located in regions with the highest *per capita* income: Mato Grosso do Sul (100%), Goiás (99.9%), and Distrito Federal (99.9%), according to data from Anatel (2022a).

13 Article 19, paragraph 2.

A document on technical cooperation between the Inter-American Development Bank (IDB)[14] and Anatel[15] entitled *C2DB2 - Crowdsourcing to Identify Digital Gaps and to Estimate the Cost of Bridging those Gaps*, reported that "*crowdsourcing* can complement the regulatory toolkit by providing accuracy, completeness, and timeliness in the geographic location of the demand and supply of digital connectivity in rural areas". The document points out that "as digital connectivity requires significant investments", the trend is to form public-private partnerships. And the public sector, in turn, must accurately define the eligibility criteria for its policies and efficiently adapt them to the dynamic development of the sector (IDB-Anatel, 2021-2022, p. 3).

In order to calculate the profits from private investment with public contribution, the Boston Consulting Group and the Lemann Foundation used different public databases in 2021 such as the 2020 School Census, the Anatel Data Portal, and the annual ICT Household surveys to "geographically identify each of the almost 140 thousand schools in Brazil" (BCG-Lemann Foundation, 2021). Information from the public sector showed that 25% of schools (from a total of 35,000 public schools in Brazil) did not have access to the internet. 50% of the 104,000 connected schools did not use the internet for educational purposes or for students, due to low connection speeds.

There was no defined regulatory framework for regulating private participation in programs that bring internet to public schools in 2023, and even if all schools wanted to contract high-speed internet services it would not be possible because one-quarter of them are located in municipalities without this service. The connectivity problem is more evident in the North and Northeast regions where there is a greater number of rural and municipal schools and a smaller number of enrolled students.

In addition to connection quality, there is a demand for browsing capacity to perform online activities that require more speed and data, such as video sharing, social participation, access to health service applications and social benefits, attending online classes, or searching for work, all essential activities for participating in the digital economy.

14 The IDB has been studying the development of broadband in Brazil since 2019, analyzing the application of *crowdsourcing* to assess broadband service, monitoring the use of the radio frequencies, assessing the digital divide, and estimating the cost of eliminating it.

15 As a sectoral regulatory agency, Anatel studies the population coverage of broadband services and the presence of fiber optic transmission network infrastructure for data transmission at the municipal level (municipal *backhaul*), and updates the level of economic competence in broadband markets, among several other functions and responsibilities.

Anatel's 2023-2027 four-part plan is committed to the demand for increased internet speed. It includes: (i) the introduction and gradual expansion of new 5G technologies, (ii) increasing OTT (*over-the-top*[16]) services, (iii) cybersecurity and privacy of personal data, and (iv) more agile, responsive and articulated regulation. To support the significant connection, Anatel is building sustainable networks by modifying the *backbone*[17], *backhaul*[18] and final accesses of the network, observing long-term infrastructure attributes such as scalability, reliability, quality, simplicity and connectivity systems (Anatel, 2022b).

CONNECTIVITY INDICATORS IN PUBLIC SCHOOLS IN THE LEGAL AMAZON

The 2022 Basic Education Census confirms information on the overall connectivity levels in the Legal Amazon by recording the impacts that digital inclusion policies have on schools. The Census sample base shows greater participation from the municipal public network (69% of enrollments) in the first years of elementary education, followed by private (19%) and state (12%) networks. The census shows that 87% of students are in urban schools. In 2022, the public network had the largest age/grade disparity (average of 13.8%), with higher rates in elementary school (INEP, 2023, p. 22-25).

Of a total of 1.4 million elementary school teachers, 87% have completed higher education (85% have a licentiate degree, 2% have a bachelor's degree) and 8.5% have completed secondary education (regular schooling/teaching). The percentage of basic education teachers with postgraduate degrees increased from 37.2% in 2018 to 47% in 2022. Indicators of adequate teacher training are still worrying: less than half of foreign language teachers in elementary schools in the north, northeast, and part of the midwest regions have not received adequate training (INEP, 2023 p. 41-45).

In Brazilian basic education, the public municipal network provides elementary education in two thirds (60%) of schools, followed by the private network (23%) (INEP, 2023). The lack of digital whiteboards (11%), desktop computers (39.4%) or laptops (30%), internet (33%), and multimedia projectors (56%) in the municipal network is an indicator of the connection gaps. Seventy-eight percent of schools have the internet, 64% of these have broadband. Compared to the 2020 Census, there were minimal changes in terms of the equipment made available to schools. It is clear that the internet is being used more for administrative purposes than it is for pedagogical purposes, as shown in Table 3.

16 OTT – *over-the-top*: deliver video content through the internet directly to the consumer.
17 Backbone – part of a network that connects and communicates between multiple networks.
18 Backhaul – connects a core network to a local network.

Table 3 | Internet access and technological resources in public municipal schools (Brazil)

Type of Internet	2020	2022	Difference
Any type of Internet	64.7%	78.1%	+13.4%
Broadband	52.2%	64.2%	+12%
Internet for students	23.8%	32.2%	+8.4%
Internet for administrative purposes	61.6%	73.8%	+12.2%
Internet for teaching and learning	33.7%	48.5%	+14.8%
Digital whiteboard	9.9%	11.3%	+1.4%
Multimedia project	54.4%	55.9%	+1.5%
Desktop computers for students	38.3%	39.4%	-1.1%
Laptops for students	23.8%	30.2%	+6.4%
Tablets for students	6.0%	10.3%	+4.3%

Source: Prepared by the authors based on data from the Basic Education Census 2020 and 2022

Most elementary schools have internet access, although there are exceptions depending on the region. In terms of technological resources by region, the disparity between the north and other regions of the country is evident: in nine of the ten items analyzed in 2020-2021, the north region presented percentages below 50%, with only 40.3% of elementary schools connected to broadband internet. In the Northeast, the percentages of internet (83%) and broadband internet (67.7%) are better, but still lower compared to the South, Southeast and Midwest regions.

A comparison between the 2020 and 2022 Basic Education Censuses shows growth rates below 10% for all items, indicating that public inclusion policies were less effective at reducing inequalities in that region of the country (Table 4).

Table 4 | Access to internet and digital resources in public municipal schools (Northern Region)

Type of Internet	2020	2022	Difference
Internet in schools	43.2%	52.2%	+9%
Broadband	31.4%	40.3%	+8.9%
Internet for students	15.0%	19.0%	+4%
Internet for administrative purposes	41.2%	48.9%	+7.7%
Internet for teaching and learning	18.5%	26.9%	+8.4%
Digital whiteboard	4.7%	5.1%	+0.4%
Multimedia project	38.7%	39.0%	+0.3%
Desktop computers for students	25.5%	24.4%	-1.1%
Laptops for students	14.3%	14.8%	+0.5%
Tablets for students	5.4%	5.5%	0.1%

Source: Prepared by the authors based on data from the Basic Education Census 2020 and 2022.

One of the internet access policies implemented by Jair Bolsonaro's government between 2021-2022, the Wi-Fi Brazil Satellite Connection Program, developed by the Electronic Government Program - Citizen Service (GESAC) installed internet points in public schools in the Legal Amazon. However, the service capacity was still below 40% in most states in the Legal Amazon region (Table 5).

Table 5 | Wi-Fi Brazil Program distribution points in schools in the Legal Amazon

State	Number of Wi-Fi Brazil points	Internet points in schools	Total Number of Public Schools	Program Reach
Pará	1,912	1,727	5,557	31%
Maranhão	1,398	1,315	4,691	28%
Amazonas	966	624	2,989	20.87%
Acre	226	152	716	21.22%
Roraima	180	86	256	33.59%
Rondônia	61	47	118	39.83%
Tocantins	46	34	209	16.26%
Amapá	41	32	126	25,39%
Mato Grosso	8	6	61	9.83%
	4,838	4,023	14,723	

Source: Prepared by the authors based on data from the Wi-Fi Brazil Panel (May/2023) and Inep (2023).

One item that stands out is the fact that Wi-Fi Brazil's internet points are directed at rural areas (a total of 3,232 points or 66.8%), which is double the number of points installed in urban areas (a total of 1,606 points or 33.2%). Similar figures can be found for educational institutions: there are 4,023 internet points installed in schools, 2,813 are in rural areas (69.92%) and 1,210 in urban areas (30.08%). Also of note is that the Wi-Fi Brazil Program has connected 16,000 public schools in 3,201 municipalities in the country, using an average connection speed of up to 20 Mbps (Ministry of Communications, 2023).

On a much smaller scale, the Wi-Fi Brazil Program also installed internet points in other locations such as health units (175), public security services (113), single registries (79), indigenous areas (61), community groups (49), telecenters (30), public security units (24), rural settlements (23), fishing communities (21), land ports of entry and social assistance reference centers - CRAS (17 points each), open universities-UAB (12), quilombola communities (11), and environmental agencies (10). Additional points, in smaller numbers, were set up in places such as libraries, extraction reserves, and research centers (Ministry of Communications, 2023). Having designated Wi-Fi installation points does not necessarily mean that they are up and running. The project's public consultation panel[19] , which aggregates information on the level of connectivity of schools, states that most of the points intended for municipalities are still "in the installation phase".

CONCLUSION

The universalization of digital access through the internet is a reality, but it is still a challenge in Brazil to guarantee quality services using available digital solutions. This includes appropriate devices with fast and stable connections and data plans with minimally acceptable browsing capacity. This is what is meant by significant connectivity, enabling full access to the different types and formats of digital content.

Over the years and many governments, we have observed official national initiatives of digital inclusion, but they are often limited regarding their scope and quality of services in places/municipalities with lower human development indices (Low and Very Low MHDI), especially those in the Legal Amazon. In order to reduce inequalities of this nature, coordinated actions need to be taken at three levels

19 Wi-Fi Brazil Panel as of November 2024. Available at: https://www.gov.br/mcom/pt-br/acesso-a-informacao/acoes-e-programas/programas-projetos-acoes-obras-e-atividades/wi-fi-brasil

(national, regional, and municipal) to guarantee (i) appropriate infrastructure, (ii) viable policies for the sector and organizing standards for public and private investments, and (iii) a harmonious and modern legal framework that regulates access and forms of financing, and takes into account regional peculiarities.

Infrastructure is vital for the implementation of digital inclusion policies. Analyzing the various programs, projects, and specific actions in Brazilian communications it becomes evident that the country is facing some adversity: no continuity regarding the development of initiatives coupled by the fact that many of these initiatives are managed by different governments. It is as if each new administration restarts the initiatives that were already in force. This mirrors the current situation in Brazil: a vast territory with a varying geography and diverse cultures, where inhabitants of isolated regions or those with a low level of development are oblivious to changes and innovations; there is a lack of digital information and resources in the country. Therefore, there is always urgency regarding the viability of public policies for the sector, including the registration of actors who participate or participated in each project or program. The public society cooperating with the private sector has helped to advance state policies. It is essential that private participation is transparent, that it can be checked by society as the telecommunications sector involves large-scale investments and affects social, political and economic interests.

We understand that outlining public actions of national and social interest is important, as is outlining commercial interests that aim at profit and economic influence. But who defines these policies? Since the advantages can also be political in nature, it is important to have projects and programs that record the reasons behind the investments (for example: why invest in this municipality or state and not in another? Why in this school and not in another?). Commitments that are made to the population need to be reported on regularly and present a detailed look at the application of resources, the goals achieved, and the justification for the investment choices. This might reduce the stop-and-start nature of infrastructure actions and promote evidence-based public policies that put the country on the path toward overcoming regional digital inequalities in this era of abundance provided by networks.

When schools have access to information technology and qualified teaching staff, students naturally have more learning opportunities and are given the ability to compete in a progressively digital world. Reducing regional disparities in education has an impact on local economic development and helps form efficient and effective public policies that can reduce inequalities between regions.

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