Internet Sectoral Overview

Number 3
October, 2024
Year 16

Meaningful connectivity and digital skills

Meaningful connectivity in Brazil: Disclosing hidden disparities[1]

By Graziela Castello[2]

In 2024, Cetic.br|NIC.br, released the publication *Meaningful connectivity: Measurement proposals and the portrait of the population in Brazil*.[3] The book offers insights into how we can measure meaningful connectivity. It includes a republication of the International Telecommunication Union (ITU) article proposing indicators for universal and meaningful connectivity, a chapter by Sonia Jorge and Onica N. Makwakwa, from the Global Digital Inclusion Partnership (GDIP), outlining guidelines for measurement and policy development on the subject; and a final chapter by Fernando Rojas, from the United Nations (UN) Economic Commission for Latin America and Caribbean (ECLAC), sharing regional experiences in meaningful connectivity from Latin America.

Besides those very interesting contents, the publication presents a study, conducted by Cetic.br|NIC.br, on the scenario of the Brazilian population regarding their meaningful connectiveness (Chapter 3, "Meaningful connectivity in Brazil: The portrait of the population"). In this document, some key elements of this study will be present to emphasize the benefits of a multidimensional individual perspective for measurement.

The aim of this study was to present an initial portrait of the Brazilian population in terms of meaningful connectivity, based on the reprocessing of quantitative indicators from the survey on the use of information and communication technologies (ICT) in Brazilian households: The ICT Households.[4] This survey is renowned as Brazil's most comprehensive household sample survey specializing in digital technologies. It adheres to international methodological standards, produces comparable data, and has been conducted annually, without interruption, for the past 19 years.

[1] This article was originally published in English by Global Digital Inclusion Partnership (GDIP). Available at: https://globaldigitalinclusion.org/2024/07/15/the-state-of-meaningful-connectivity-in-brazil-measuring-quality-and-revealing-hidden-gaps

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[3] Available at: https://cetic.br/en/publicacao/meaningful-connectivity-measurement-proposals-and-the-portrait-of-the-population-in-brazil/

[4] Available at: https://cetic.br/en/pesquisa/domicilios/

Photo: Personal archive

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The survey provides indicators for both individuals and households, enabling various controlled analytical approaches through its microdata sets. Furthermore, as this is a survey based on international methodological frameworks and with a long historical series, it is possible to analyze the indicators retrospectively, in order to gauge the country's potential progress to date while simultaneously ensuring the ongoing monitoring of these issues into the future. Moreover, the ICT Households survey microdata ensures a more precise understanding of the individuals' situation across their social, economic, and territorial diversity, allowing a deeper understanding of the phenomenon based on analyses that combine population access types with their Internet uses and activities.

According to the ICT Households 2023 survey (NIC.br, 2023a), 84% of Brazilians aged 10 and above are Internet users, with nearly all of them (95%) using the Internet daily. While this suggests that Brazil is well-connected, the question remains: Do all people have the right conditions for connectivity? This question guided the investigation into the current state of meaningful connectivity in Brazil.

To develop this study, based on existing literature and the propositions for measuring meaningful connectivity from the Alliance for Affordable Internet (A4AI)[5] and the ITU,[6] data from the Brazilian ICT Households[7] survey were analyzed. From this analysis, an analytical and conceptual framework was developed.

Nine indicators across four dimensions were identified to assess the levels of meaningful connectivity among Brazilians. These dimensions, termed critical enabling factors for meaningful connectivity, are as follows:

1. **Affordability**: Examines the cost of staying connected.
2. **Access to equipment**: Assesses whether individuals have the appropriate devices for their needs.
3. **Quality of connections**: Evaluates the reliability and speed of Internet connections.
4. **Connectivity environment**: Looks at the frequency and locations of Internet usage.

The nine indicators, derived from these four dimensions, generated a scale from zero to nine. Each individual in the Brazilian ICT Households survey received a score on this scale, ranging from having none of the indicators (score 0) to having all nine indicators (score 9). The scale was then divided into four categories: (a) score 0 to 2, those who had the worst connectivity conditions; (b) score 3 and 4, those with median-low connectivity conditions; (c) score 5 and 6, those with median-high connectivity conditions; and (d) score 7 to 9, those understood as meaningfully connected, who had at least 7 from the 9 conditions measured. This categorization provides a structured framework to evaluate and address the various levels of meaningful connectivity among the Brazilian population.

[5] Available at: https://docs.google.com/document/d/1qydsmTY4hln3pP4dWJbCSRFna8SfDYAtGfacKYwhVk8/edit
[6] Available at: https://www.itu.int/itu-d/meetings/statistics/wp-content/uploads/sites/8/2022/04/UniversalMeaningfulDigitalConnectivityTargets2030_BackgroundPaper.pdf
[7] Find out more: https://www.cetic.br/en/pesquisa/domicilios/

From this categorization, the study showed that, in 2023, just 22% of Brazilians were considered meaningfully connected, scoring between 7 and 9 points. Unfortunately, the largest group observed performed poorly, with scores up to 2 points, representing a third (33%) of the Brazilian population (NIC.br, 2024). This presented a more challenging scenario than when solely considering the 84% of Internet users (NIC.br, 2023a).

In addition to these enabling factors, the analysis also explored connectivity gaps by examining data across territorial, sociodemographic, and socioeconomic dimensions. This comprehensive approach provides a nuanced understanding of the quality of connectivity for the Brazilian population. And particularly revealed hidden gaps for connectivity. Some results for sociodemographic, economic, and territorial dimensions highlight inequalities in Brazil that were hidden or underestimated when considering connectivity solely by Internet access (Charts 1 and 2). Some key results include:

- **Hidden gender disparities**: According to the ICT Households 2023 survey (NIC.br, 2023a), 83% of males and 86% of females in Brazil were Internet users. At first glance, it might seem that females are better positioned than males. However, a closer look at meaningful connectivity reveals a significant gender disparity: 28% of males have meaningful connectivity compared to only 17% of females (NIC.br, 2024). The poorer connectivity conditions among females worsen existing barriers to their productive inclusion, income equality, public presence, and participation in social, political, and economic life.
- **Age is a barrier to connectivity, not just for older people**: Age has historically been a barrier to digital inclusion, even in economically developed countries (Helsper, 2009; Mubarak & Suomi, 2022). This is also true in Brazil. In 2023, only 51% of Brazilian residents aged 60 and over were Internet users, compared to 84% of the overall population (NIC.br, 2023a). However, when examining meaningful connectivity across different age groups, a different trend emerges. Unlike general Internet usage, where younger people are the majority, only 16% of those aged 10 to 15 and 24% of those aged 16 to 24 have meaningful connectivity (NIC.br, 2024). This highlights a significant issue: While older individuals face greater exclusion, a large proportion of young Brazilians also experience poor connectivity. This puts them at numerous disadvantages in both their personal and professional development.
- **Infrastructure disparities remain in the territories**: Differences in simple Internet access based on the population size of municipalities are minimal. In municipalities with up to 50,000 residents, 81% of the population are Internet users, compared to 86% in municipalities with over 500,000 residents. However, when it comes to meaningful connectivity, there is a direct correlation: The larger the municipality, the higher the proportion of individuals meaningfully connected.
- **Economic disparity is much more challenging**: There are significant differences in Internet usage between economically advantaged and disadvantaged groups in Brazil. While 97% of the wealthiest Brazilians use the Internet, only 69% of the poorest do (NIC.br, 2023a). The disparity is even more pronounced when considering meaningful connectivity: 83% of the wealthiest have meaningful

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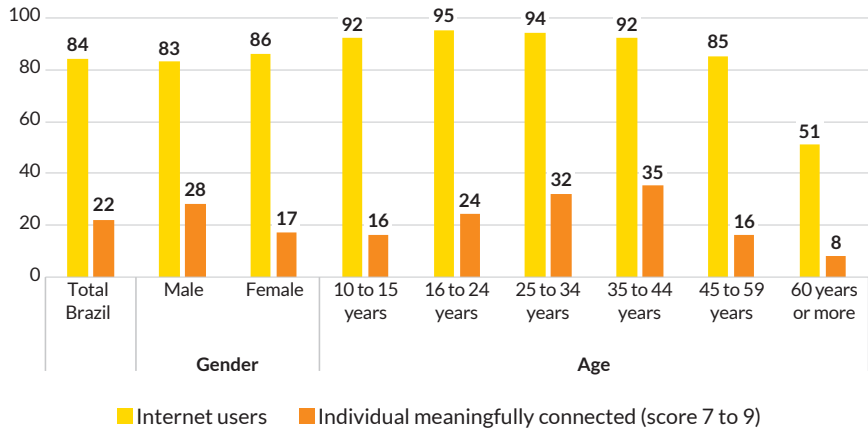
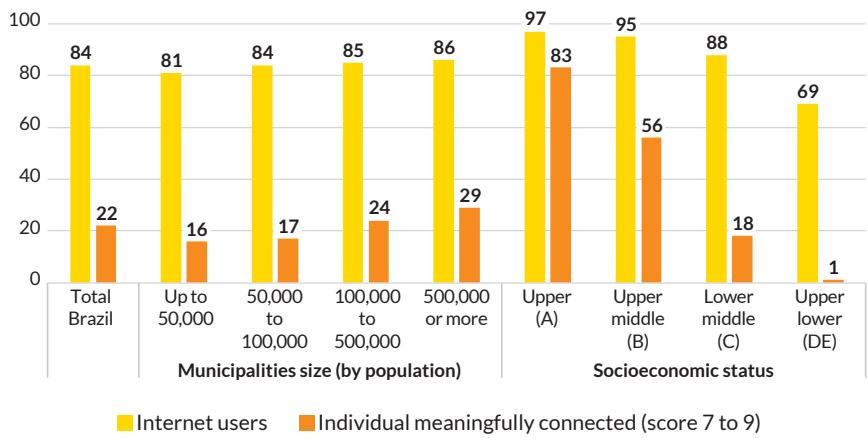
connectivity, compared to just 1% of the poorest (NIC.br, 2024). This extreme inequality directly impacts the opportunities available to different segments of society in the virtual environment, further disadvantaging those who are already vulnerable.

Chart 1 - INTERNET USERS AND MEANINGFULLY CONNECTED INDIVIDUALS IN BRAZIL, BY GENDER AND AGE (2023)
Total population (%)



Source: NIC.br (2023b).

Chart 2 - INTERNET USERS AND MEANINGFULLY CONNECTED INDIVIDUALS IN BRAZIL, BY MUNICIPALITIES SIZE AND SOCIOECONOMIC STATUS (2023)
Total population (%)



Source: NIC.br (2024).

The study included an additional layer of analysis exploring the association between levels of meaningful connectivity and the quality and type of Internet usage, including digital skills and online activities. The results showed a direct correlation between an individual's level of meaningful connectivity and their digital skills. Higher levels of meaningful connectivity were linked to better technical skills (such as attaching a file to a message) and skills for using the Internet safely and reliably. These skills included browsing safety, privacy protection, and verifying information online.

As meaningful connectivity levels increase, more people possess the assessed digital skills (Chart 3). The findings reveal that those with the most fragile access conditions are also the ones with the fewest skills needed to mitigate Internet usage risks and take advantage of online opportunities.

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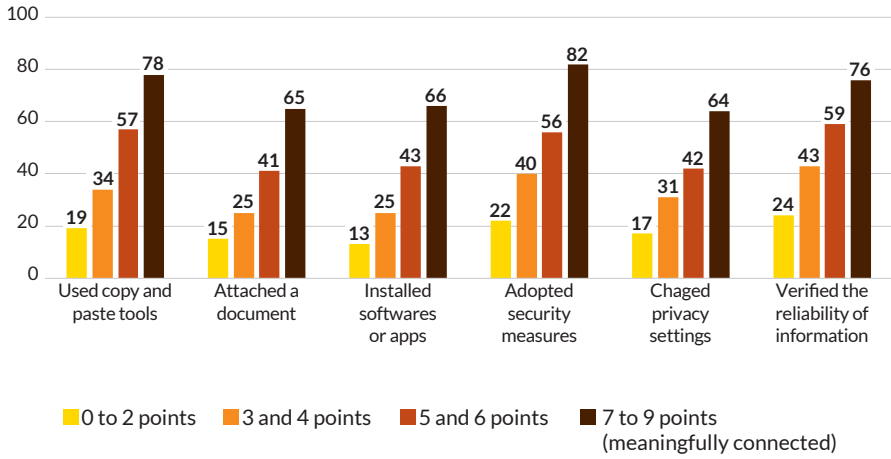
Chart 3 - MEANINGFUL CONNECTIVITY LEVELS IN BRAZIL, BY DIGITAL SKILLS (2023)
Total Internet users (%)



Source: NIC.br (2024).

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Article II

The outcomes of gaining digital skills for young people's lives and wellbeing: A systematic evidence review[8]

By Sonia Livingstone,[9] Giovanna Mascheroni,[10] and Mariya Stoilova[11]

Introduction

The United Nations (UN) agency responsible for global measurement of the adoption of information and communication technologies (ICT), the International Telecommunication Union (ITU), defines digital skills for the global population in terms of their putative outcomes: "The ability to use ICT in ways that help individuals to achieve beneficial, high-quality outcomes in everyday life for themselves and others" and that "reduce potential harm associated with more negative aspects of digital engagement" (ITU, 2018, p. 23). In this, it serves the multiple and diverse interests of its members (most countries and many public and private sector stakeholders) who seek to thrive and compete in the digital age, including delivering the UN's Sustainable Development Goals (SDG).[12]

Theory development is more advanced when it comes to the general population, with a notable focus of attention on the specific and tangible outcomes of gaining digital skills (Helsper et al., 2015; van Deursen & Helsper, 2018). Conceptualized as the "third-level digital divide," researchers propose that digital inequalities

[8] Edited version of the homonymous work published in New Media & Society. Available at: https://doi.org/10.1177/14614448211043189

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[12] Find out more: https://sdgs.un.org/goals

involve more than a binary opposition between those who do or those who do not have access to the Internet (the "first-level digital divide"), and also more than the promotion of digital skills (the "second-level digital divide").[13] Indeed, promoting access and skills without attention to outcomes can reproduce social inequality and exacerbate prior exclusion (van Deursen & van Dijk, 2014). Specifically, whether concerning education, work, health, or other areas, what matters is that individuals have the resources to deploy digital skills in ways that bring about tangible outcomes that benefit them (van Deursen & Helsper, 2018).

By contrast with adults, where the starting point is assumed to be digital ignorance, children and young people are often assumed to be "digital natives," a problematic implication being that young people will "pick up" the digital skills they need spontaneously, without the need for resource-intensive interventions. Researchers had to dismantle this myth by showing that not only might young people lack valuable skills, but also that they may struggle to translate these into tangible outcomes, especially in situations of socioeconomic disadvantage (Helsper & Eynon, 2010). Problematically for those promoting the digital skills agenda, research also found that the more children engage in online activities, gaining digital skills and enjoying the opportunities to benefit, the more they are likely to encounter some risk of harm (Helsper & Smahel, 2020; Livingstone et al., 2017). This raises the pressing question of whether digital skills can play a role in optimizing beneficial outcomes while minimizing rather than amplifying harmful ones (Livingstone et al., 2018).

This article builds on the systematic evidence review to identify clearly the range of outcomes from gaining digital skills, and to explore the nature of the relationship between digital skills and outcomes. After screening out studies where the definition of digital skills was unclear or inconsistent, we added a new step by coding the dimensions of digital skills measured in each study to discover whether these dimensions are differently linked to particular outcomes. We used the four-dimension classification of digital skills identified in a recent analysis of the wide array of different measures commonly used within the youth literature (Helsper et al., 2021; van Dijk & van Deursen, 2014). Each dimension (defined in Table 1) encompasses functional subskills and digital knowledge (or critical literacy), and all are important for well-being in a digital society (Helsper et al., 2021; Mascheroni et al., 2020). They can also be combined to generate more complex skills — for instance, the skills required for problem-solving online, or to protect one's privacy or safety online, participating in civic activities, or coping with harmful experiences.

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[13] See Hargittai (2002).

Table 1 - THE FOUR DIMENSIONS OF DIGITAL SKILLS

Dimension	Description
Technical and operational skills ("tech")	The ability to manage and operate ICT and the technical affordances of devices, platforms, and apps, from "button" knowledge to settings management to programming
Information navigation and processing skills ("info")	The ability to find, select, and critically evaluate digital sources of information
Communication and interaction skills ("comm")	The ability to use different digital media and technological features to interact with others and build networks as well as to critically evaluate the impact of interpersonal mediated communication and interactions on others
Content creation and production skills ("create")	The ability to create (quality) digital content and understand how it is produced and published and how it generates impact

Source: Adapted from Helsper et al. (2021).

We formulated the following three research questions of significance for research and policy and practice:

- **Research question 1**: What are the outcomes of young people's digital skills?
- **Research question 2**: Can the different dimensions of digital skills be linked to distinct outcomes?
- **Research question 3**: How does the research literature explain the outcomes of digital skills?

Methods

We conducted a systematic evidence review (Gough et al., 2012; Grant & Booth, 2009; Sutherland, 2004) following the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocol (PRISMA-P) guidelines (Moher et al., 2015). The search protocol was registered on (repository and registration number anonymized) and designed to be comprehensive in its coverage of relevant databases and search terms, consistent in its application of the same search word strings across databases, and efficient in minimizing the number of irrelevant results.

The search involved two international research database aggregators, Web of Science[14] and Scopus,[15] supplemented with six specialized databases: International Bibliography of the Social Sciences,[16] Communication and Mass Media Complete,[17] ERIC,[18] PsychINFO,[19] Embase,[20] and SocINDEX.[21] It was applied based on titles, keywords, and abstracts to English language publications in the decade from January 2010 to January 2020 (when the search process began).

Four groups of search terms were selected, drawing on consultation with relevant experts and test searches of several databases: (a) child terms (to identify research with children and young people); (b) method terms (to identify empirical studies); (c) technology terms (to ensure relevance to the digital environment); and (d) skill terms (to match the focus of the review). Groups c and d were searched jointly using all possible combinations.[22] The final search string took the form: Child terms AND methods terms AND a digital skill phrase (digital term + skill term).

The initial 4,811 search results (N_0) were screened for duplicates, non-English sources, and non-peer-reviewed publications, leaving 2,640 studies to be screened for eligibility (N_1). Screening for eligibility was based on the article title, abstract, and keywords according to four criteria applied in the following order: (a) studies of children's digital skills; (b) using quantitative methods; (c) with children aged 12–17, and sufficient methodological rigor (e.g., small sample surveys or pilot studies were excluded). This left 351 studies to be read in full of which full text was available for 301 (N_2). A further 99 did not meet the above four criteria based on reading the full text.

The remaining 202 studies were evaluated using a weight of evidence (WoE) framework. This assessed the following:

1. **Quality of the research methods**: A global assessment based on such features as controls for confounding associations, randomized representative sampling, longitudinal designs, approach to testing hypotheses, and whether reporting distinguishes children from adults or by age group.
2. **Capacity to answer the review question**: Whether the definition of digital skills distinguished among dimensions (e.g., information, social, technical) and whether each was measured with reliability and validity; whether there is a model that explains how the dimensions fit together.
3. **Relevance for the review question**: This was operationalized in relation to how the study specifically generated evidence on the predictors or outcomes of digital skills.

Four groups of search terms were selected (...): (a) child terms (to identify research with children and young people); (b) method terms (to identify empirical studies); (c) technology terms (to ensure relevance to the digital environment); and (d) skill terms (to match the focus of the review).

[14] Find out more: https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/webofscience-platform/
[15] Find out more: https://www.scopus.com/home.uri
[16] Find out more: https://about.proquest.com/en/products-services/ibss-set-c/
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[18] Find out more: https://eric.ed.gov/
[19] Find out more: https://psycinfo.apa.org/general/where-are-you-from
[20] Find out more: https://www.embase.com/
[21] Find out more: https://www.ebsco.com/products/research-databases/socindex-full-text
[22] For a detailed description of the methodology, see Haddon et al. (2020).

Each study was given a score of 1 = poor, 2 = fair, and 3 = good for criteria a, b, and c, and then assigned an average score (D) between 1 and 3. This resulted in 92 exclusions (average WoE score below 2), leaving 110 (N_3) empirical studies to be coded for evidence regarding the predictors and outcomes of skills.

Of the 110 studies, 53 (N_4) included the outcomes of having digital skills (the remainder concerned predictors of digital skills only and are not considered here). These studies were coded according to the dimensions of digital skills measured (technical, information, communication, and creation skills) and their relationships with outcome measures. Those studies that did not include clear information about the relation between skills and outcomes were excluded. So, too, were studies that, while they described themselves as concerning digital skills, used a global self-efficacy measure,[23] inferred digital skills from a measure of online behavior[24] or other measures (e.g., treating attending lessons on digital media as a proxy for skills; Kahne & Bowyer, 2019). Also excluded was one study where the country and not the individual was the level of analysis (Picatoste et al., 2018). This left 34 studies for analysis (N_5). These 34 studies were relevant and of high quality, with WoE scores between 2 and 3 (see Table 2).

Table 2 - THE 34 STUDIES ON OUTCOMES OF YOUTH DIGITAL SKILLS

Study	Reference	Research methods	Country of data collection
6	Areepattamannil & Khine (2017)	Survey of 56,209 13- to 16-year-olds WoE: 3)	20 high-income countries around the world
10	Balea (2016)	Secondary analysis of a survey of 595 11- to 16-year-olds (WoE: 2)	Romania
11	Bernadas & Soriano (2019)	Survey of 300 11- to 25-year-olds (WoE: 2.33)	Philippines
12	Cabello-Hutt et al. (2018)	Survey of 1,694 9- to 17-year-olds (WoE: 2.66)	Brazil
13	Christoph et al. (2015)	Survey and performance test of 445 14- to 17-year-olds (WoE: 2.66)	Germany
19	Eynon & Malmberg (2012)	Survey of 669 12-, 14- and 17- to 19-year-olds (WoE: 2.66)	UK
21	Fizeşan (2012)	Survey of 1,609 9- to 16-year-olds (WoE: 2.66)	Romania, Bulgaria

CONTINUES ▸

[23] See Yu et al. (2018).
[24] See Khan et al. (2014).

▸ CONTINUES

Study	Reference	Research methods	Country of data collection
27	Helsper & Eynon (2013)	Secondary analysis of a survey of 2,057 14-year-olds and above (WoE: 3)	The United Kingdom
32	Kaarakainen (2019)	Survey and performance test of 3,206 15- to 22-year-olds (WoE: 3)	Finland
41	Kim & Yang (2016)	Survey of 238 16- to 17-year-olds (WoE: 2)	South Korea
43	Kumazaki et al. (2011)	Survey of 4,308 6- to 18-year-olds (WoE: 2.33)	Japan
46	Leung & Lee (2012a)	Survey of 718 9- to 19-year-olds (WoE: 2.66)	Hong Kong
47	Leung & Lee (2012b)	Survey of 718 9-to 19-year-olds (WoE: 2.66)	Hong Kong
49	Lin et al. (2019)	Secondary analysis of a survey of 11,997 15-year-olds (WoE: 2)	Singapore, Finland
50	Livingstone & Helsper (2010)	Survey of 789 10- to 19-year-olds (WoE: 2.66)	The United Kingdom
55	Mannerström et al. (2018)	Survey of 932 17- to 18-year-olds (WoE: 2.33)	Finland
60	Metzger et al. (2013)	Survey of 2,747 11- to 18-year-olds (WoE: 2.66)	The United States
62	Moon & Bai (2020)	Survey of 2,584 13- to 18-year-olds (WoE: 2)	South Korea
63	Neumark et al. (2013)	Survey of 7,028 12- to 19-year-olds (WoE: 2.33)	Israel
65	Notten and Nikken (2016)	Survey of 8,554 14- to 16-year-olds (WoE: 2.33)	25 European countries
79	Rodríguez-de-Dios et al. (2018)	Survey of 1,446 12- to 18-year-olds (WoE: 3)	Spain
82	Santos et al. (2019)	Survey of 808 12- to 17-year-olds and above (WoE: 3)	Portugal
83	Scherer et al. (2017)	Survey and performance test of 2,426 14- to 16-year-olds (WoE: 2.66)	Norway
86	Schorr (2019)	Survey of 134 14- to 18-year-olds (WoE: 2)	Germany
88	Shin et al. (2012)	Survey of 381 9- to 12-year-olds (WoE: 2.33)	South Korea

▸ CONCLUSION

Study	Reference	Research methods	Country of data collection
90	Sonck & de Haan (2013)	Survey of 19,406 11- to 16-year-olds (WoE: 3)	25 European countries
94	Staude-Müller et al. (2012)	Survey of 9,760 10- to 15-year-olds (WoE: 2)	Germany
95	Teimouri et al. (2018)	Survey of 420 9- to 16-year-olds (WoE: 3)	Malaysia
96	Tirado-Morueta et al. (2017)	Survey of 3,754 16- to 18-year-olds (WoE: 3)	Ecuador
99	Vandoninck et al. (2010)	Survey of 815 15- to 19-year-olds (WoE: 2.66)	Belgium, (Flanders)
100	Vandoninck et al. (2013)	Survey of 25,142 9- to 16-year-olds (WoE: 2.33)	25 European countries
101	Wegmann et al. (2015)	Survey of 334 14- to 29-year-olds (WoE: 2.66)	Germany
102	Weston et al. (2019)	Survey of 494 14- to 18-year-olds (WoE: 2.66)	The United States
110	Ziya et al. (2010)	Survey of 4,942 15-year-olds (WoE: 2.33)	Turkey

All studies used self-reported digital skills measures; some also used performance tests.

Results and discussion

THE OUTCOMES OF DIGITAL SKILLS FOR CHILDREN AND YOUNG PEOPLE

In answer to research question 1, approximately two-thirds of the studies examined the association between digital skills and online opportunities and other benefits, while another third examined online risks of harm.

- **Online opportunities**: The breadth of digital activities is considered an important measure of digital and social inclusion. Some studies measured a broader set of activities (n. 12, n. 21, n. 27, n. 50, n. 79) while others took a more specific focus (n. 6 on social activities, n. 10 on creative activities). In all studies, the association with digital skills was positive: Greater digital skills are associated with more online activities. Since these studies include a diversity of different measures of both skills and opportunities, the absence of null or contradictory findings suggests a consistent and robust result. The evidence offers empirical support for the promotion of digital skills by policy programs, education curricula, and parental investment, all aiming to provide children and young people with the digital skills that support diverse forms of digital

engagement, bringing direct benefits and encouraging the development of additional digital and life skills. Previous research has hypothesized that online activities are ranked in terms of accessibility and appeal, such that children first gain basic skills by beginning with everyday activities (e.g., watching videos or playing games online). Then, as they gain skills, they progress up the so-called ladder of online opportunities towards more complex activities, such as creative content creation and civic participation (Livingstone et al., 2019). However, we found a little research examining which activities were mainly linked to gaining digital skills or the order in which they were undertaken.

- **Informational benefits**: Particularly in relation to informational benefits, studies made discernible efforts to match the dimension of digital skill to relevant learning outcomes. For instance, study n. 19 found that children's ability to seek information online predicted seeking online information for homework (although not for more everyday life purposes). In study n. 60, children with better Internet skills were found to think more often about information credibility and, possibly in consequence, more likely to believe that the information they find online is credible. Relatedly, study n. 96 found that having greater information and evaluation skills benefited children's academic performance. The authors also found that information skills are supported by operational information skills, suggesting a learning pathway from access through operational skills to information skills and thence to creativity and improved academic grades. Study n. 63 focused on seeking health information as an outcome, again finding a positive association with digital skills. Somewhat puzzlingly, since its methods included performance testing, study n. 83 found no relation between basic or advanced digital skills and a standard educational measure of "computer information literacy."
- **Orientation to technology**: While research has shown that young people with better access to ICT at home or school, or with more positive attitudes towards ICT, have greater digital skills (Haddon et al., 2020), fewer studies ask whether greater digital skills are linked to a more positive orientation to technology. Four studies (n. 13, n. 32, n. 86, n. 102) found that technology skills bring such benefits, albeit in ways that are differentiated by gender. Two of these studies measured digital skills using performance tests: Study n. 13 found that greater digital skills are associated with interest and competence in using computers; study n. 32 found that "the likelihood of students choosing the ICT field increased significantly along with greater competence in both medium-related skills and programming skills" (Kaarakainen, 2019, p. 120). In study n. 86, like most other studies based on a self-reported measure of digital skills, the association found between greater computer skills and ICT-related career aspirations is stronger for girls than boys. The authors suggest that gaining digital skills, including through educational interventions, can partially compensate for gendered socialization practices that tend to dissuade girls from such aspirations. Study n. 102, relatedly, shows how improving young women's technical digital skills improves their chance of persisting in computer science and technology-related majors.

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(...) more digitally literate children were more likely to delete messages and block senders when experiencing cyberbullying or unwelcome sexting. Moreover, children with fewer skills were more upset and less able to cope with sexual images and cyberbullying.

- **Academic grades**: A primary rationale for educating children to improve their digital skills is to enhance their learning outcomes. Arguing that digital skills today are akin to reading, writing, and arithmetic – the so-called fourth "R" of basic literacy – schools increasingly include digital skills in the curriculum. Therefore, it is surprising that we identified only three studies that addressed the relation between digital skills and learning outcomes (n. 46, n. 82, n. 110). The results were equivocal. In studies n. 46 and n. 82, greater digital skills were associated with better academic grades, albeit varying by the dimension of digital skills (as discussed later). One study mainly found negative results, suggesting that greater programming skills can undermine children's mathematical ability (n. 110) – here, the authors suggested that adverse outcomes arise when the skills are both time-consuming to learn and unrelated to the desired learning outcome.
- **Coping behaviors**: Given the prevalence of online risks in children's everyday experience, a few studies inquired into how children and young people cope with actual or potentially harmful experiences (Dodge et al., 2012). Digital skills were positively linked to coping behaviors online (such as privacy behavior, deleting unwelcome messages, blocking senders – studies n. 11 and n. 100). For example, study n. 100 showed that more digitally literate children were more likely to delete messages and block senders when experiencing cyberbullying or unwelcome sexting. Moreover, children with fewer skills were more upset and less able to cope with sexual images and cyberbullying. Indications that skills can support better coping with risk surely merit further exploration.
- **Civic participation**: Both the policy agenda and academic debate anticipate that Internet use facilitates youth participation in community, civic, and political life (Cortesi et al., 2020), even countering young people's declining political participation (Loader et al., 2016). Two studies (n. 41, n. 62) examined this relationship, and the results were complex. In study n. 41, "Internet information literacy" was significantly and positively associated with measures of alternative participation (such as boycotts, rallies, and joining online campaigns) and with political efficacy but was not associated with institutional participation (such as voting, civil complaints, or visits to government websites). Furthermore, "Internet skills literacy" measures were unrelated to participation and negatively related to political efficacy. Study n. 62 reported a positive relationship between digital skills and online civic engagement activities but mediated by interest in the news. Such findings hint at a promising direction for future research, namely, identifying factors (of digital or non-digital nature) mediating between digital skills and participation outcomes.
- **Miscellaneous benefits**: Completing the picture for beneficial outcomes, we note that study n. 49 found a positive association between digital skills and environmental awareness in Singapore but not in Finland, and study n. 55 examined the relationship between digital skills and life satisfaction, finding none.

- **Online risks of harm**: Children and young people's exposure to potentially harmful online content, contact, conduct, or contract risks attracts attention from researchers, policymakers, and the public alike (Livingstone et al., 2018). Many call for digital skills education to build children's resilience to mitigate online or offline vulnerability to risks of harm, as well as to encourage their coping behaviors, as discussed earlier. However, does gaining digital skills act as a protective factor, reducing experiences of harm? Thirteen studies addressed this question. As with online opportunities, a standard method is to count how many and how often children have encountered a wide range of different risks. Other studies tend to focus their attention on just one or a few risks.

Taking the former approach studies n. 47, n. 79, n. 88, n. 95, and n. 99 reported a broadly positive association between digital skills and online risks, suggesting that greater digital skills are related to more online risks being encountered, with some qualifications (e.g., study n. 47). Study n. 43 also found a positive association, focusing on the perpetration of cyberbullying among secondary school students. In study n. 88, greater digital skills were linked to a greater willingness to disclose personal information than adopting more self-protective behavior. The authors suggest that more digitally skilled young people explore more widely online, encountering opportunities that require information disclosure as well as more online risks. Furthermore, the main finding of a positive association between skills and risks may arise because, as discussed earlier, more skills are linked to more online opportunities (as discussed in studies n. 12 and n. 50), including risky opportunities (such as looking for new friends online, sending personal information or photos, adding "strangers," pretending to be someone else; Livingstone, 2008, 2013); as shown by studies n. 95 and n. 65.

Study n. 90 not only found a positive link between digital skills and online risks, but also that children with more skills reported less harm after exposure to risks compared with less skilled children. However, this finding disappeared when statistical controls were applied, and the overall variance explained was low even with individual and country factors included in the statistical model. Study n. 94 pursued the theme of harm, finding that more digitally skilled young people experienced less distress (such as feeling frightened or depressed) after online victimization. The possibility that gaining digital skills might reduce harm while not restricting children's online experiences needs further testing.

Two studies considered Internet "addiction," with contradictory findings. Study n. 46 found a complex but broadly positive association, with particular outcomes (preoccupation, withdrawal, loss of control) correlated with particular dimensions of digital skills. Study n. 101 finds the reverse: Greater digital skills reduced the negative consequences of excessive social media use. The authors suggest a link between digital skills and self-regulation in the digital environment, which seems worthy of further investigation.

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THE RELATIONSHIPS BETWEEN THE DIMENSIONS OF DIGITAL SKILLS AND OUTCOMES

The outcomes of children's and young people's digital skills appear complex, encompassing both positive and negative relationships. While the public expectation is that gaining digital skills enables young people to minimize the risks and optimize the benefits of Internet use, facilitating overall well-being (Dienlin, 2020; Ryff, 1989), the evidence suggests that it results in both online opportunities and risks. Given the diversity of digital skills measures employed in the literature, research question 2 asked whether a more nuanced picture could emerge if we examined outcomes according to specific dimensions of digital skills.

Ten studies, including two that used performance tests (n. 13, n. 32), examined technical and operational ("tech") skills separately from other skill dimensions. The results are mixed, with as many apparently undesirable as beneficial outcomes. Specifically, these skills were associated with a positive orientation to technology (n. 13, n. 32) and online opportunities (n. 27) but also more online risk (n. 46, n. 47). They were unrelated to life satisfaction (n. 55) or civic participation (n. 62), even showing a negative link to civic participation (n. 41), and either a positive (n. 46) or negative (n. 110) link to academic grades.

The seven studies examining the distinctive associations of information skills found them to be generally linked with beneficial outcomes. They were linked to more civic participation (n. 41), online opportunities (n. 27), higher academic grades (n. 46, n. 110) and more information-seeking for homework (although not everyday life information needs; n. 19); and to reduced online risk (n. 47) and more privacy-enhancing behavior online (n. 11). Finally, they were unrelated to online addiction (n. 46).

While communication skills appear rarely to be examined separately, the evidence suggests positive outcomes – on online opportunities (especially social engagement; n. 27) and coping with online risks (n. 101), although there was no association on academic grades (n. 110). The results from the few studies of creative skills were mixed: Positive associations on online opportunities (especially creative engagement; n. 47) but also increased online risk (n. 46, n. 47) and a null (n. 46) or negative (n. 110) association with academic grades.

It is harder to conclude from the studies that construct a composite skill measure, as we cannot know if the different skill dimensions work additively or interact somehow. Two studies grouped information, communication, and creative skills into a single measure, finding a positive relationship with civic participation (n. 62) and no relation to orientation to technology (n. 32). All other measured combinations included technical skills together with one or more of the others. This decision appears unwise given the mixed profile of outcomes linked to technical skills.

Eight studies combined technical and information skills, finding both a positive association with online opportunities (n. 12, n. 21, n. 50, n. 63), information benefits (n. 62), and academic grades (n. 82), as well as greater online risk (n. 12, n. 65, n. 88). A more consistent and positive pattern is observed from the combination of technical, information and either communication or creative skills – with positive links to online opportunities (n. 6, n. 10, n. 79), information benefits (n. 83), and civic participation (n. 62). However, study n. 79 also shows a link with online risk (possibly for reasons noted earlier).

By contrast, technical skills combined with communication or creative but not information skills have more mixed outcomes. Five studies combined technical and communication skills, finding more online risks (n. 90, n. 95) yet less harm associated with risk (n. 90, n. 94), better coping with online risk (n. 100), and information benefits (n. 96). We cannot be sure, but it is noteworthy that, when tested separately, communication but not technical skills are linked to coping with online risk. Finally, four studies suggested that the combination of technical and creative skills is linked to both a positive orientation to technology (n. 86, n. 102) and to more online risk (n. 99, n. 43).

EXPLAINING THE OUTCOMES OF DIGITAL SKILLS

Eleven studies tested specific pathways from the predictors of digital skills to their outcomes, using statistical models that vary in complexity, while all relying on cross-sectional survey research methods. The predictors variously include personal attributes (age, gender, and personality); social context (socioeconomic status [SES], parental education, parental mediation, teacher or peer support); and ICT environment (diversity of connectivity, availability at home, age of first Internet use). These are usually linked to one or two outcomes, with digital skills positioned in the models as a predictor, mediator, or outcome, depending on the authors' approach. Age, SES, parental education, parental mediation, and ICT availability at home are generally strongly associated with digital skills.

Model building reveals important interrelations that studies reliant on univariate statistical analysis can miss (research question 3). For instance, several studies found that age, gender, and SES are associated with children's digital skills and then show how these factors explain online opportunities (n. 12, n. 21, n. 27, n. 50). Specifically, boys, and those who are older or more advantaged, report greater digital skills and enjoy better online opportunities. While demographic factors themselves offer little prospect of change, they can help target interventions, aiming digital skills education at younger girls and those from economically disadvantaged backgrounds to help compensate for entrenched digital inequalities (Helsper, 2021).

Studies that measure the differential influence of separate dimensions of digital skills on online opportunities (n. 27, n. 96) suggest further nuance, with possible relevance for educators teaching digital skills. For example, study n. 96, which operationalizes digital skills as a progression from basic operational skills to more advanced skills, shows that the role of operational skills and academic outcomes is both direct and indirect (mediated by advanced digital skills). Study n. 27 reveals variations in how digital skills mediate the influence of sociodemographic factors on different online opportunities, depending on the dimension of digital skills and the type of opportunities examined.

Also promising for policymakers and practitioners are findings that point to malleable predictors of digital skills. Study n. 79 showed that parental mediation engenders better skills and, thereby, more online opportunities, while the study n. 82 found a similar pathway leading to better academic grades. Studies n. 12, n. 21, and n. 50 found that an ICT-richer home (variously measured) benefits digital skills and, in turn, online opportunities. As study n. 50 further shows, the relationship between use and opportunities is indirect, mediated by that between

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use and skills. In other words, those who use the Internet more and are higher in skills take up more opportunities than those who use it an equivalent amount but are lower in skills. Study n. 11 also found that better digital access benefits skills, with benefits in turn for children's online coping. Study n. 19 confirms both these findings: Both parental mediation and ICT availability at home were linked to informational benefits for children, mediated by information-related digital skills. Since both parental mediation and domestic access to technology can be enhanced through awareness-raising and digital access policies, these studies point the way to improving children's outcomes by supporting their digital skills. Without such interventions, however, study n. 96 shows how the digital divide might become more entrenched. It found that higher SES combined with a richer ICT environment at home leads first to better digital skills and thence to more online information-seeking that, doubtless, brings further academic benefits for the already advantaged.

Study n. 27 develops a complex model, finding not only a linear path from demographic factors to digital skills and from digital skills to outcomes but also that inequalities such as the child's gender and parental education predict changes in outcomes when digital skills are taken into account. Notably, when digital skills were included in the model, some relationships lost strength, but the relationship between SES and online opportunities was unchanged. This suggests that, if ways are found to improve children's digital skills, they will likely benefit from greater online opportunities, even though structurally, they remain disadvantaged (because there is a direct association of inequality on outcomes unmediated by digital skills). In other words, it may be that the digital divide can be overcome, even if social divisions are harder to change.

Can the models illuminate the general and, arguably, problematic positive association between online opportunities and online risks? In studies n. 12 and n. 50, statistical analysis suggested that digital skills only predict risks indirectly through their direct link to online opportunities. Specifically, study n. 12 found that the relationship between skills and risks was mediated by online opportunities, while study n. 50 found that opportunities precede risks — children are online and engage in various activities before they encounter risks. Relatedly, study n. 79 found that the relationship between skills and risks was weaker than that between skills and opportunities. Study n. 99 did not include online opportunities as an outcome. Only one study (n. 50) measures the frequency of Internet use and time spent online, finding that both are positively associated with online opportunities, but the link between use and risks is indirect, through opportunities.

However, the present analysis suggests qualification of its finding that multiple predictors (demographics, personality, and parental mediation) lead first to better digital skills and then to more online risk.

What of the role of parental mediation? Study n. 12 found that digital skills mediate between active parental mediation and online opportunities; specifically, active parental mediation in the form of co-use, talk, and support has only an indirect relationship with online opportunities through its relationship with digital skills, but it has a direct negative link to exposure to online risks. Conversely, restrictive mediation — rules aimed at limiting the time spent online or prohibiting certain online activities — is negatively correlated with both digital skills and online opportunities

but has a weaker negative link to risks. This suggests that not only does restrictive mediation narrow online opportunities; it also appears to be of a little efficacy in reducing exposure to online risks. Parents' ability to mediate their child's Internet use effectively is influenced by other factors, including parents' education, age, and own ICT use, thus demonstrating the importance of variables related to the child's family environment. These findings have implications for parental awareness-raising campaigns which could focus on the benefits of enabling mediation.

Conclusion

Although many studies have examined the outcomes of children's and young people's digital skills in recent years, it has proved difficult to draw conclusions because the plethora of definitions and methodologies create challenges in comparing study findings. We found that most research on the outcomes of digital skills concerns the range of online opportunities or risks encountered by children and young people, leaving much to be explored regarding specific outcomes such as academic grades. Greater digital skills are linked to more online opportunities and information benefits, with some different findings by gender. For other beneficial outcomes (e.g., orientation to technology, academic grades, coping behaviors, and civic participation), the findings are mixed, with too few studies to draw reliable conclusions. However, a fair body of research also suggests that greater digital skills are linked, directly or indirectly, to more exposure to online risks, although the implications for harm remain unclear. Although not examined here, it should also be noted that outcomes in one domain are not necessarily correlated with outcomes in another (van Deursen et al., 2017), so more research is needed that examines multiple outcomes, and for research designs that can go beyond correlations to examine causal relationships. Note, too, that all the studies measured proximal outcomes, with none that examined longer-term outcomes or that used holistic measures of well-being (except for one study that found no relationship between digital skills and overall life satisfaction; n. 55).

Second, we asked whether the different dimensions of digital skills are linked to distinct outcomes. The findings suggest that these dimensions are indeed linked to different outcomes, and not always beneficially. Indeed, teaching or promoting technical skills alone emerges as a problematic strategy. This is particularly worrying given the substantial focus on technical skills in IT education in many countries, especially if coupled with an insufficient emphasis on critical or evaluation aspects of digital skills.[25] By contrast, the findings for gaining information skills alone are much more promising, for these are found to be generally linked to beneficial outcomes. Also positive for young people's outcomes, the review found, are certain combinations of digital skills dimensions, provided that gaining information skills is included in the mix. However, more research is needed to examine the association of specific skills dimensions on different outcomes. Given that different outcomes are linked to different skill dimensions, the future use of composite digital skill measures is not recommended.

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[25] See, for example, Polizzi (2020) for a discussion of the United Kingdom curriculum.

(...) weak measures of digital skills are a concern, and future research should use stronger measures of digital skills.

Third, we sought to understand how the research literature explains the outcomes of digital skills. On examining the subset of studies that constructed multivariate models linking predictors to digital skills and thence to outcomes, we found no common approach or agreed hypotheses guiding such models. Taken together, the results of these studies show that digital skills play a decisive role in mediating the relation between predictors (generally factors relating to digital and social inequality) and the outcomes discussed earlier. They also suggest ways in which future interventions could seek to enhance and equalize beneficial outcomes for children, notably through enhanced access to ICT resources at home, and by raising public awareness of enabling parental mediation strategies.

In the light of substantial societal investment in children's and young people's access to ICT and the digital skills (or digital literacy education) to use technologies for present and future benefits, we recommend that future research examining the relationship between children's digital access, activities and outcomes should include measures of digital skills. In this regard, weak measures of digital skills are a concern, and future research should use stronger measures of digital skills (Helsper et al., 2021), including greater use of performance tests, and measures that differentiate among different dimensions of digital skills. This could guide policy interventions that encompass and look beyond short-term outcomes to address the future needs of an increasingly digital society, while also helping to prevent those in a more disadvantaged position from being "systematically more likely to suffer harm due to the digitization of society" (Helsper, 2021, pp. 179-180). Finally, while this study has concentrated on a fairly narrow age range, future research could usefully disaggregate the digital engagement of children of different ages, to examine the possible learning and other benefits of digital skills in tandem with an account of how digital skills unfold across the full span of child development.

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Interview I

Technologies in education: Connectivity in schools and the development of digital skills in Brazil

Photo: Ricardo Matsukawa

Ana Dal Fabbro
General coordinator for Technology and Innovation in Basic Education, at the Secretariat of Basic Education (SEB) of the Ministry of Education (MEC).

In this interview, Ana Dal Fabbro, general coordinator of Technology and Innovation in Basic Education at the Ministry of Education's (MEC) Secretariat of Basic Education (SEB), discusses how education can advance through the use of digital technologies, outlines the challenges of ensuring schools have adequate connectivity, and assesses the importance of consolidating public policies that foster skills for the development of students' digital citizenship.

Internet Sectoral Overview (I.S.O.)_ In your opinion, why is progress in education through the use of technology essential for promoting digital inclusion and citizenship in Brazil? In this context, how relevant is the National Strategy of Connected Schools (Enec)[26]?

Ana Dal Fabbro (A.F.)_ The advancement of education, not only through the use of digital technologies but also about digital technologies, is essential for promoting digital citizenship in Brazil. There is a clear difference between being a digital native and competent enough to take an active role in the digital culture. The ICT Kids Online Brazil survey[27] showed that in 2015, for instance, 79% of children and adolescents had accessed the Internet in the three months prior to the survey, while in 2023, this percentage reached 95%. In other words, our children and youth are overwhelmingly present in the digital world, but this does not mean they are able to use these digital technologies ethically, safely, critically, responsibly, or reflectively. Nor does it mean they have developed the ability to create technologies and take charge of their lives and interactions with society. Both the critical use of technology and the ability to create it are included in Competency 5 of the Brazilian National Common Curricular Base (BNCC), which states: "Understand, use, and create digital information and communication technologies critically, meaningfully, reflectively, and ethically in various social practices (including schooling) to communicate, access and disseminate information, produce knowledge, solve problems, and take leadership and authorship in personal and collective life."[28] This intention to support students in developing digital skills is especially important in the context

[26] Available at: https://www.gov.br/mcom/pt-br/acesso-a-informacao/acoes-e-programas/programas-projetos-acoes-obras-e-atividades/estrategia-nacional-de-escolas-conectadas-enec
[27] Available at: https://www.cetic.br/en/pesquisa/kids-online/
[28] Available at: https://www.gov.br/mec/pt-br/escola-em-tempo-integral/BNCC_EI_EF_110518_versaofinal.pdf

"Among the challenges to ensuring that all schools have adequate connectivity, we can mention: (a) challenges related to the absence or poor quality of telecommunications infrastructure in some regions of the country; (b) the costs of investing in Wi-Fi infrastructure; and (c) the sustainability of the policy."

of fighting inequalities, so as that a gap is not created between students who are merely technology users and those students who develop the foundations to become technology creators and problem-solvers. It is crucial to keep this commitment to public education in mind. In this context, the Enec not only aims to enhance connectivity for pedagogical purposes but also focuses on teacher training and curriculum development, recognizing that progress in connectivity infrastructure must be accompanied by educational policies to ensure its use for pedagogical purposes. Finally, the Enec is also relevant for promoting the inclusion of students and teachers who still lack Internet access. The connectivity infrastructure in different Brazilian regions varies greatly. Evidently, while addressing the structural adversities is a major challenge, reducing such inequalities must be pursued, which is why many of the schools benefiting from Enec are in the North and Northeast of the country.

I.S.O._ What are the biggest challenges to ensuring that all schools in the country have adequate connectivity? And what actions have been implemented to overcome these challenges?

A.F._ Among the challenges to ensuring that all schools have adequate connectivity, we can mention: (a) challenges related to the absence or poor quality of telecommunications infrastructure in some regions of the country; (b) the costs of investing in Wi-Fi infrastructure; and (c) the sustainability of the policy.
Regarding the challenges related to telecommunications infrastructure, the Enec Executive Committee determined that schools outside the coverage area of fiber optics would be the primary focus of the Monitoring and Spectrum Control Station (Eace), the School Connectivity Project Funding Monitoring Group (Gape), and the 5G Auction. In other words, the possibility of mobilizing public investment to expand fiber optic networks was opened, to provide terrestrial connections to schools that were not yet reached by fiber. Of course, there are very remote schools that can only be served by satellite Internet; in this context, the Enec Executive Committee set minimum speed parameters for this type of Internet connection.
Secondly, there is a challenge related to the costs associated with improving the internal network infrastructure for distributing the Wi-Fi signal. In this context, in an innovative move, the policies coordinated under Enec have also begun to include providing Wi-Fi Internet networks for the beneficiary schools. Until now, federal connectivity policies only covered Internet access itself, so this will be a big leap forward in improving school connectivity.
Lastly, there is an issue to be addressed regarding the sustainability and long-term maintenance of the policy. It is important to highlight that Enec's initiatives were included in the Growth Acceleration Program (PAC), precisely because they represent investments in improving both fiber optic expansion and Wi-Fi infrastructure in schools. It is therefore understood that the challenge after 2026 will focus on the maintenance and funding of Internet connectivity services. To this end, the MEC supports direct transfers to schools through the Direct Money to Schools Program (PDDE)[29] – Connected Education.[30] These resources can be used for both Internet

[29] Find out more: https://pddeinterativo.mec.gov.br/#opdde
[30] Available at: https://pddeinterativo.mec.gov.br/educacao-conectada

service contracts and Wi-Fi solutions. To conclude, it is important to emphasize the inter-federative collaboration that will be essential for the long-term sustainability of the connectivity policy. In order for the education secretariats to also consider public connectivity policies for their regions, the MEC is offering technical assistance to the states in 2024; and will extend this support to municipal education departments in 2025.

I.S.O._ What are the MEC's initiatives to promote the development of digital skills among both students and professionals in basic education? And, in your opinion, what aspects should be considered when assessing the development of these skills?

A.F._ To guide the development of teachers' digital knowledge, MEC has published the Teacher Digital Knowledge Framework (*Referencial de Saberes Digitais Docentes*)[31] for the use of digital technologies in the teaching and learning processes. In addition to this framework, the MEC has made available a self-diagnosis tool on its Virtual Learning Environment (Avamec) aimed at basic education teachers. This tool helps teachers reflect on their digital teaching knowledge and directs them to appropriate continuing education courses based on their skill levels on the platform. In addition, in 2024 alone, a total of 29,234 participants completed courses on technology and innovation via the platform, and 13 new courses were launched on Avamec to support teacher training in topics related to digital technologies and innovation. There is also an open call for courses for Avamec[32] for applications until September 28th.

Still intending to support teachers, the SEB, in partnership with the Federal University of Paraná (UFPR), launched the redesign of the MEC Educational Resources platform (Plataforma MEC de Recursos Educacionais Digitais [Mecred]),[33] in order to facilitate the search and earmaking of open and quality educational resources with the skills outlined in the BNCC, as well as with curricular components and educational stage. The platform offers over 300,000 open educational resources for teachers and allows for creating communities of practice. Finally, it is worth mentioning the launch of the More Science in Schools (Mais Ciência na Escola) program, in partnership with the Ministry of Science, Technology and Innovation (MCTI), which has a budget of BRL 100 million for scientific and digital literacy projects, which is expected to benefit 1,000 schools in 2024.

From the perspective of supporting the development of digital skills among students, the implementation of the BNCC, through its Computing in Basic Education Supplement (Complemento Computação na Educação Básica) (BNCC Computer Science [BNCC Computação]) and the digital education curricular component, as outlined by the National Policy of Digital Education (PNED) (Law No. 14,533/2023)[34], has been a priority for the MEC. Throughout 2024, the ministry

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[31] Find out more: https://www.gov.br/mec/pt-br/escolas-conectadas/20240822MatrizSaberesDigitais.pdf
[32] Available at: https://www.in.gov.br/en/web/dou/-/edital-n-2/2024-580947211
[33] Find out more: https://mecred.mec.gov.br/sobre
[34] Available at: https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2023/lei/L14533.htm

"Regarding the assessment of students' digital skills, in 2025, the Programme for International Student Assessment (Pisa) will evaluate these skills for the first time. This will be an important experience to inform the development of Brazil's strategy, as outlined as a responsibility of the ministry in the new National Plan of Education (PNE)."

organized four workshops during the regional meetings of the National Union of Municipal Education Leaders (Undime) and six seminars focused on the digital education curriculum. It also included, in an unprecedented way, a digital education textbook in the National Textbook and Teaching Material Program (Programa Nacional do Livro e do Material Didático [PNLD]) for upper secondary education, supporting schools in implementing the digital education curriculum. The intention is to replicate this for other educational stages, based on their specific needs. Finally, in 2024, technical advice was given to state departments to review the curriculum and development teacher training strategies for the use of technology in teaching and learning processes. This support has proven to be particularly important in the context of updating the upper secondary education curriculum guidelines and incorporating digital education as a curricular component. The intention is to expand this support to municipalities in 2025 through a specialization course.
Regarding the assessment of students' digital skills, in 2025, the Programme for International Student Assessment (Pisa) will evaluate these skills for the first time. This will be an important experience to inform the development of Brazil's strategy, as outlined as a responsibility of the ministry in the new National Plan of Education (PNE).

I.S.O._ In 2022, the National Education Council (CNE) approved guidelines on computing in basic education,[35] structured around three main axes. Could you explain what these axes are and how important it is to consolidate public policies guided by them?

A.F._ The three axes outlined in the BNCC Computing[36] reiterated in the PNED, are:

- **Computational thinking**: This refers to the ability to understand, define, model, compare, solve, automate, and analyze problems (and solutions) in a methodical and systematic manner, through the construction of algorithms. Computational thinking involves the abstractions and techniques necessary for describing and analyzing information (data) and processes, as well as for automating solutions.
- **Digital world**: This refers to the ability to understand the coding, processing, and distribution aspects involved in the operation of software and hardware.
- **Digital culture**: This refers to the analysis of new behavior patterns and emerging moral and ethical questions in society resulting from the digital world. Digital culture encompasses the interdisciplinary relationships of computing with other areas of knowledge, aiming to promote fluency in using computational knowledge for expressing solutions and cultural manifestations in a contextualized and critical manner. It also involves media education to engage critically, meaningfully, reflectively, and ethically with the set of information, behaviors, and social practices in the digital environment.

[35] Find out more: https://www.gov.br/mec/pt-br/assuntos/noticias/2022/mec-aprova-parecer-que-define-normas-sobre-o-ensino-de-computacao-na-educacao-basica
[36] Read more: https://www.computacional.com.br/#EducacaoBasica

The consolidation of public policies that encompass these axes is important not only to enable the development of students' digital citizenship, allowing them to interact with the digital world in an ethical, critical, responsible, and reflective way but also to foster a new way of thinking about the world through computational thinking, enabling them to take on a proactive role as technology developers, competing in this space and fulfilling their social functions.

Domain Report

Domain registration dynamics in Brazil and around the world

The Regional Center for Studies on the Development of the Information Society (Cetic.br), department of the Brazilian Network Information Center (NIC.br), carries out monthly monitoring of the number of country code top-level domains (ccTLD) registered in countries that are part of the Organisation for Economic Co-operation and Development (OECD) and the G20.[37] Considering members from both blocs, the 20 nations with the highest activity sum more than 94.01 million registrations. In September 2024, domains registered under .de (Germany) reached 17.68 million, followed by the China (.cn), United Kingdom (.uk), and Netherlands (.nl), with 9.81 million, 9.13 million and 6.21 million registrations, respectively. Brazil had 5.39 million registrations under .br, occupying 6th place on the list, as shown in Table 1.[38]

[37] Group composed by the 19 largest economies in the world and the European Union. More information available at: https://g20.org/

[38] The table presents the number of ccTLD domains according to the indicated sources. The figures correspond to the record published by each country, considering members from the OECD and G20. For countries that do not provide official statistics supplied by the domain name registration authority, the figures were obtained from: https://research.domaintools.com/statistics/tld-counts. It is important to note that there are variations among the date of reference, although the most up-to-date data for each country is compiled. The comparative analysis for domain name performance should also consider the different management models for ccTLD registration. In addition, when observing rankings, it is important to consider the diversity of existing business models.

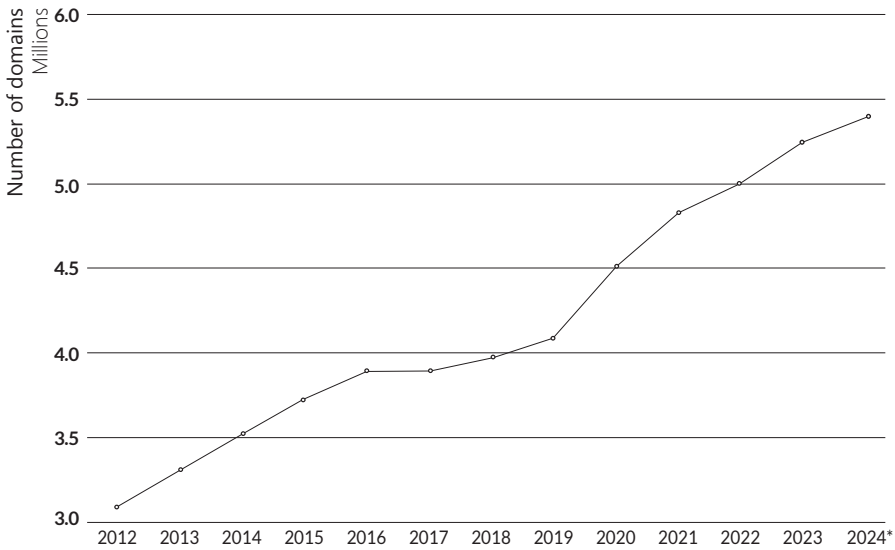
Table 1 – TOTAL REGISTRATION OF DOMAIN NAMES AMONG OECD AND G20 COUNTRIES

Position	Country	Number of domains	Date of reference	Source (website)
1	Germany (.de)	17,684,768	01/10/2024	https://www.denic.de
2	China (.cn)	9,810,793	01/10/2024	https://research.domaintools.com/statistics/tld-counts/
3	United Kingdom (.uk)	9,132,329	31/07/2024	https://www.nominet.uk/news/reports-statistics/uk-register-statistics-2024/
4	Netherlands (.nl)	6,210,367	01/10/2024	https://stats.sidnlabs.nl/en/registration.html
5	Russia (.ru)	5,814,265	01/10/2024	https://cctld.ru
6	**Brazil (.br)**	**5,396,926**	**30/09/2024**	**https://registro.br/dominio/estatisticas/**
7	Australia (.au)	4,258,045	01/10/2024	https://www.auda.org.au/
8	France (.fr)	4,190,107	30/09/2024	https://www.afnic.fr/en/observatory-and-resources/statistics/
9	European Union (.eu)	3,636,483	01/10/2024	https://research.domaintools.com/statistics/tld-counts/
10	Italy (.it)	3,488,408	30/09/2024	https://stats.nic.it/domain/growth
11	Canada (.ca)	3,390,249	01/10/2024	https://www.cira.ca
12	Colombia (.co)	3,342,808	01/10/2024	https://research.domaintools.com/statistics/tld-counts/
13	India (.in)	3,022,922	01/10/2024	https://research.domaintools.com/statistics/tld-counts/
14	Switzerland (.ch)	2,569,317	15/09/2024	https://www.nic.ch/statistics/domains/
15	Poland (.pl)	2,499,842	01/10/2024	https://research.domaintools.com/statistics/tld-counts/
16	United States (.us)	2,107,147	01/10/2024	https://research.domaintools.com/statistics/tld-counts/
17	Spain (.es)	2,077,052	31/08/2024	https://www.dominios.es/es/sobre-dominios/estadisticas
18	Portugal (.pt)	1,890,044	01/10/2024	https://www.dns.pt/en/statistics/
19	Japan (.jp)	1,767,741	01/10/2024	https://jprs.co.jp/en/stat/
20	Belgium (.be)	1,724,653	01/10/2024	https://www.dnsbelgium.be/en

Collection date: October 1, 2024.

Chart 1 shows the performance of .br since 2012.

Chart 1 – TOTAL NUMBER OF DOMAIN REGISTRATIONS FOR .BR – 2012 to 2024*



*Collection date: September 30, 2024.
Source: Registro.br
Retrieved from: https://registro.br/dominio/estatisticas

In September 2024, the five generic Top-Level Domains (gTLD) totaled more than 185.34 million registrations. With 154.61 million registrations, .com ranked first, as shown in Table 2.

Table 2 – TOTAL NUMBER OF DOMAINS AMONG MAIN gTLD

Position	gTLD	Number of domains
1	.com	154,615,515
2	.net	12,616,606
3	.org	10,968,024
4	.xyz	3,612,747
5	.info	3,535,889

Collection date: October 1, 2024.
Source: DomainTools.com
Retrieved from: research.domaintools.com/statistics/tld-counts

Internet markers in Brazil

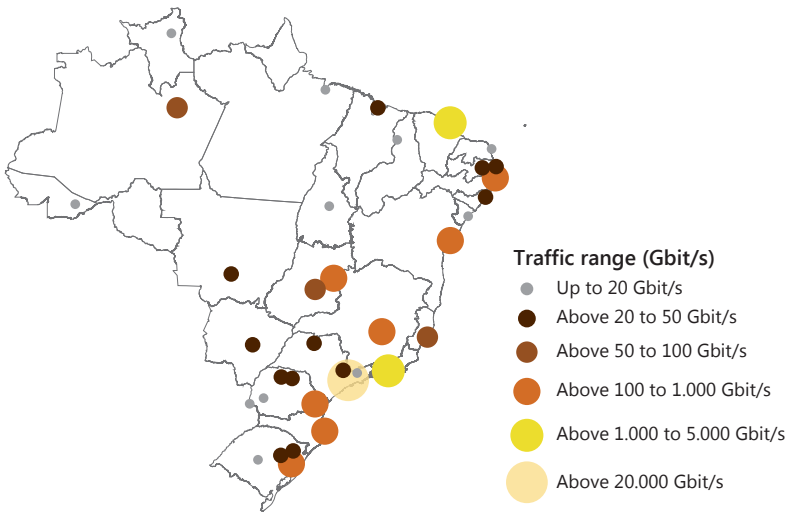
IX.br: Data on Internet Exchange Points

IX.br (Brazil Internet Exchange) is an initiative of the Brazilian Network Information Center (NIC.br), supported by the Brazilian Internet Steering Committee (CGI.br), which promotes and implements Internet Exchange Points (IXP), the necessary infrastructure for direct interconnection between the networks, also known as Autonomous Systems (AS), which make up the Internet in Brazil.

The interconnection of several AS in an IXP simplifies Internet transit, establishing more direct traffic to a given destination. This improves quality, reduces costs, and increases network resilience.

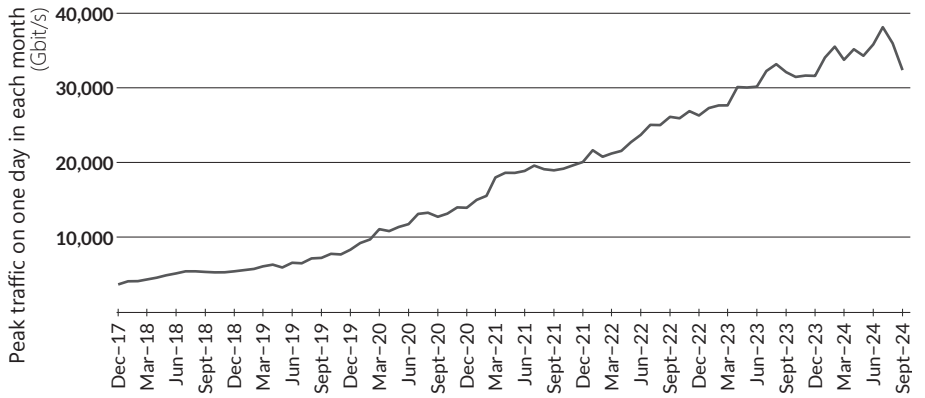
The initiative currently encompasses 36 independent IXP, distributed throughout Brazil (Figure 1), and is one of the most important clusters of IXP worldwide. Chart 1 shows the continuous traffic growth of the IXP cluster that comprises IX.br over the past five years.

Figure 1 – TRAFFIC EXCHANGE POINTS (IXP) IN BRAZIL, BY TRAFFIC RANGE



Reference period: September 2024.
Source: IX.br | NIC.br
Retrieved from: https://ix.br/trafego/agregado/

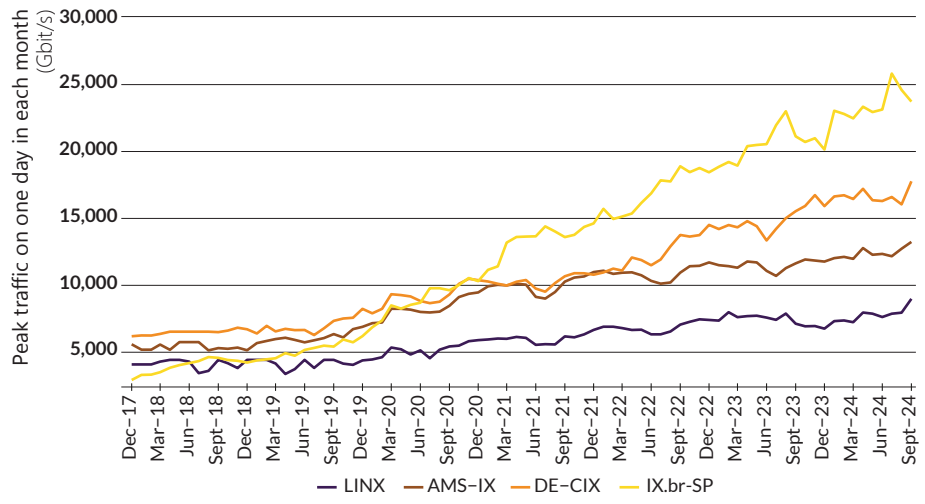
Chart 1 – TRAFFIC PEAK FOR THE IX.br INTERNET EXCHANGE POINT CLUSTER – 2017 to 2024



Source: IX.br | NIC.br
Retrieved from: https://ix.br/agregado/

Chart 2 compares the peak traffic of the São Paulo IXP, the largest in Brazil, with the three largest in Europe: LINX (London, England), AMS-IX (Amsterdam, Netherlands), and DE-CIX (Frankfurt, Germany), between 2017 and 2024.

Chart 2 – LONDON (LINX), AMSTERDAM (AMS-IX), FRANKFURT (DE-CIX) AND SÃO PAULO (IX.br-SP) IXP, BY TRAFFIC PEAK - 2017 to 2024



Source: IX.br | NIC.br
Retrieved from: https://www.de-cix.net/en/locations/frankfurt/statistics; https://www.ams-ix.net/ams/documentation/total-stats; https://portal.linx.net/services/lans-snmp; https://ix.br/trafego/agregado/

Here you can find more information about IX.br's activities and statistics.

DIGITAL SKILLS
AMONG CHILDREN AND YOUTHS

The development of digital skills allows for greater use of Internet opportunities, as well as managing online risks. The data from the ICT Households 2023[39] survey shows that less than half of children and young Internet users reported having digital skills investigated.[40]

INTERNET USERS AGED 10 TO 15 YEARS OLD, BY TYPE OF DIGITAL SKILL

TOTAL NUMBER OF INTERNET USERS (%)

43%

Verifying the reliability of information found online.

44%

Adopting security measures, such as strong passwords or two-factor authentication, to protect devices and online accounts.

41%

Using copy and paste tools to duplicate or move content, for example, within a document or message.

33%

Installing computer software or mobile apps.

27%

Changing privacy settings on your devices, accounts, or apps to limit the sharing of personal data, such as your name, contact information, or photos.

13%

Attaching a document, image, or video to instant messages, e-mails, or SMS.

[39] Data from the ICT Households 2023 survey by Cetic.br | NIC.br. Available at: https://cetic.br/en/pesquisa/domicilios/

[40] Other digital skills of Internet users collected by the ICT Households 2023 survey are available at: https://cetic.br/en/tics/domicilios/2023/individuos/I1A/

/Credits

TEXT

DOMAIN REPORT

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PUBLISHING

Grappa Marketing Editorial

ENGLISH REVISION AND TRANSLATION

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ACKNOWLEDGMENTS

Sonia Livingstone (LSE), Giovanna Mascheroni (Unicatt), and Mariya Stoilova (LSE)

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ABOUT CETIC.br

The Regional Center for Studies on the Development of the Information Society – Cetic.br (https://www.cetic.br/en/), a department of NIC.br, is responsible for producing studies and statistics on the access and use of the Internet in Brazil, disseminating analyzes and periodic information on the Internet development in the country. Cetic.br acts under the auspices of UNESCO.

ABOUT NIC.br

The Brazilian Network Information Center – NIC.br (http://www.NIC.br/about-nic-br/) is a non-profit civil Entity in charge of operating the .br domain, distributing IP numbers, and registering Autonomous Systems in the country. It conducts initiatives and projects that bring benefits to the Internet infrastructure in Brazil.

ABOUT CGI.br

The Brazilian Internet Steering Committee – CGI.br (https://cgi.br/about/), responsible for establishing strategic guidelines related to the use and development of the Internet in Brazil, coordinates and integrates all Internet service initiatives in the country, promoting technical quality, innovation, and dissemination of the services offered.

*The ideas and opinions expressed in the texts of this publication are those of the respective authors and do not necessarily reflect those of NIC.br and CGI.br.

STRIVING FOR A BETTER INTERNET IN BRAZIL

CGI.br, MODEL OF MULTISTAKEHOLDER GOVERNANCE

www.cgi.br

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