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Evidence from Google Trends of a Widening Second-level Digital Divide in Brazil. Even Worse with the Covid-19

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ABSTRACT

Background: While Brazilian governmental initiatives focused on home broadband Internet access, availability of computers for students in schools has been drastically reduced since 2010. Furthermore, schools usually prohibits mobile Internet access in its premises, contrarily to the migration of students' access to smartphones. **Objectives**: This study investigates the impact of the increasing home and mobile Internet access on the existing educational inequalities. **Design**: This study made use of quantitative, locally statistical research to investigate the reproduction or closing of existing educational digital divide across already contrasting Brazilian regions. **Setting and Participants**: Child or adolescent from 9 to 17 years of age and their guardians, interviewed by CETIC.br. **Data collection and analysis**: Data was obtained from the CETIC.br data portal and the Google Trends webpage. Data were analysed by means of local geostatistical measures of spatial autocorrelation and inequality, as well as bivariate choropleth maps. **Results**: Our results suggest that the Brazilian school system is failing to cultivate in their students the more productive use of Internet access and therefore contributing to the widening of the existing second-level digital divide between regions and social classes. **Conclusions**: This digital divide was critically exacerbated by the arrival of the ongoing COVID-19 pandemic and the suspension of presential classes. Brazilian policymakers should concentrate efforts and resources in addressing this large-scale second-level digital divide, possibly by equipping educators and students with the knowledge and skills towards the educational, productive and responsible use of the Internet, as well as allowing mobile Internet access in school premises.

Keywords: Brazil; second-level digital divide; Google Trends; Internet access; Internet use.

Evidências do *Google Trends* de uma Crescente Exclusão Digital de Segundo Nível no Brasil

RESUMO

Contexto: Embora as iniciativas governamentais brasileiras tenham focado no acesso doméstico à Internet de banda larga, a disponibilidade de computadores para estudantes nas

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escolas foi drasticamente reduzida desde 2010. Além disso, as escolas geralmente proíbem o acesso móvel à Internet em suas instalações, ao contrário da migração do acesso dos alunos para smartphones. **Objetivos:** Este estudo investiga o impacto do crescente acesso à Internet residencial e móvel sobre as já existentes desigualdades educacionais. **Delineamento:** Este estudo utilizou pesquisa quantitativa estatística local para investigar a reprodução ou o fechamento do fosso digital educacional existente entre as já contrastantes regiões brasileiras. **Cenário e Participantes:** Crianças ou adolescentes de 9 a 17 anos e seus responsáveis, entrevistados pelo CETIC.br. **Coleta e análise dos dados:** Os dados foram obtidos no portal de dados CETIC.br e na página do *Google Trends*. Os dados foram analisados por meio de medidas geoestatísticas locais de autocorrelação espacial e desigualdade, além de mapas coropléticos bivariados. **Resultados:** Nossos resultados sugerem que o sistema escolar brasileiro está falhando em cultivar em seus alunos o uso mais produtivo do acesso à Internet e, portanto, contribuindo para o aumento da exclusão digital de segundo nível existente entre regiões e classes sociais. **Conclusões:** Essa exclusão digital foi agravada de forma crítica pela chegada da pandemia em curso do COVID-19 e pela suspensão das aulas presenciais. Os formuladores de políticas brasileiros deveriam concentrar esforços e recursos para resolver essa exclusão digital de segundo nível em larga escala, possivelmente fornecendo aos educadores e estudantes o conhecimento e as habilidades para o uso educacional, produtivo e responsável da Internet, além de permitir o acesso móvel à Internet nas instalações da escola.

Palavras-chave: Brasil; exclusão digital de segundo nível; Google Trends; acesso à Internet; uso da Internet.

INTRODUCTION

The so-called information and communication technology (ICT) revolution was mainly fuelled by the exponential progress of the semiconductor technology that provides us with ever more sophisticated mobile devices and faster and more affordable broadband connections, increasing the availability of personal computers and the consequent extraordinary growth of people's access to the Internet (Jorgenson & Vu, 2016).

The Internet now can be accessed from a suite of devices such as laptops, tablets, smartphones and even smartwatches and smartbands, which are increasingly marketed to children as social necessities. Consequently, the Internet has become ubiquitous in students' lives both in their homes and schools (Zhang, Trussell, Tillman, & An, 2015; Zhang, 2015), and children are exposed to the influence of the media from an early age, becoming avid consumers of digital media, primarily through the Internet (Camerini, Schulz, & Jeannet, 2018).

According to Hilbert's study (2016) on the nationally installed bandwidth potential of 172 countries from 1986 to 2014, many more individual people seem to enjoy more equitable access to global bandwidth. The "the bad news", however, is that as the result of an inevitable and intricate balance between continuous technological progress and diffusion of technology, the bandwidth divide between high- and low-income countries does not seem to be closing.

Accordingly, a 2001 OECD report showed that the access to the Internet had not been egalitarian and had even widened the gap between those who have access to information and communication technologies and those who, for socioeconomic or geographical reasons, do not have it, which is referred to by the term 'digital divide' (OECD, 2001). This unequal access to the Internet is widely considered to be the creator of a new class division between the "information-rich" and the "information poor" (Everett, 1998). It hence has attracted the attention of policymakers and researchers in social development, political change, and economic growth (Mourão & Wood, 2015).

As a result, it should not be unexpected to find digital divides in a country with as many contrasts as Brazil. If this digital divide between regions and social classes was not acceptable already, its impact on education was critically exacerbated in 2020, with the arrival of the ongoing pandemic of coronavirus disease 2019, the COVID-19, and the shutdown of transport and the closure of commerce, industry, and leisure spaces. The school doors had to be closed abruptly to avoid agglomerations, even though this suspension of classes was not foreseen in the School's planning. With no forecast for the return of face-to-face classes, the Brazilian Ministry of Education and Culture (MEC) saw no alternative but to propose an emergency remote learning, even for elementary education (Monteiro, 2020). While the most reputable and largest (in the number of students) Brazilian Federal Universities did not initially adopt any measure of continuity of studies under the exceptionality of Covid-19, opting for the simple suspension of the academic calendar (Arruda, 2020), a febricity sets in, a race of "each one for themselves" begins, with each School making use of any available tool, be it Google Classroom, some proprietary platform operated by the School, or, still, social networks like Facebook, Instagram, WhatsApp, among others (Monteiro, 2020).

However, these solutions are generally not accessible to half the population who live on informal work and live in the favelas, for whom the closure of trade and the beginning of social isolation has caused a loss of income and livelihood, increasing the limitations of students in the favelas to access and use the Internet to study (Couto, Couto, & Cruz, 2020). Although with arguments such as "education cannot stop" and "afterwards we will help the excluded", such hasty solutions end up operating in a way that implicitly admits what Nascimento and Santos call the "normality of exclusion" (2020).

To reduce these inequalities, the *Programa Nacional de Banda Larga (PNBL)* (National Broadband [Internet Connection] Program), created in 2010 (Brasil. Presidência da República, 2010), focused on the universalisation of infrastructure for home broadband Internet access, hoped to provide citizens with "means and capacity to access, use, produce and distribute information and knowledge through ICT, so that they could effectively and critically take part in the information society" (Brasil. Presidência da República. Secretaria-Executiva do CGPID, 2010, p. 17). Unfortunately, however, the term of this program expired on December 31, 2016, without any updates being implemented.

The process of including the use of computers in Brazilian educational environments, however, began much earlier in 1970. Currently, the leading national educational technology policy in the country is the *Programa Nacional de Tecnologia Educacional – ProInfo* (National Educational Technology Program), created in 1997 (Brasil. MEC, 1997) and reedited in 2007 (Brasil. Presidência da República, 2007), aiming at promoting the pedagogical use of informatics in the public primary education network. This program included subprograms aiming at connecting all Brazilian urban public schools to the Internet through broadband and at providing the purchase of laptops for teachers and students. Unfortunately, however, most of these subprojects were discontinued in 2013, after criticisms of ignoring the real needs and aspirations of teachers and schools, as well as of mismanagement of resources (Rios, Habowski, & Conte, 2018).

Meanwhile, the use of mobile phones in schools is generally forbidden in Brazil by internal regulations and even state laws (Rodrigues, Segundo, & Ribeiro, 2018). According to Yoon (2003), this attitude appears to be a form of "immobiling [*sic*] the mobile" or "re-traditionalising the mobile", in the sense of the existing power relations acting to reinforce themselves and strengthen the tradition within families and schools (Castells, Fernández-Ardèvol, Qiu, & Sey, 2009). As a consequence, even in schools where the use of mobile devices is allowed, students often end up not using it as much or in the ways as they would like (Bartholomew & Reeve, 2018).

This work intended to investigate how the increasing home and mobile Internet access impacted on the reproduction or closing of existing educational inequalities in Brazil.

BACKGROUND

Second- and third-level Digital Inequality

ICT literacy is usually defined as "the interest, attitude, and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, and evaluate information; construct new knowledge; and communicate with others in order to participate effectively in society" (Lennon, Kirsch, von Davier, Wagner, & Yamamoto, 2003, p. 8).

Nevertheless, Zhong's study (2011) based on PISA 2003 and 2006 data reveals that, at the country-level, increased ICT penetration rate does not ensure that adolescents have more chance to learn and use ICT while, at the school level, school ICT access is positively related to students' self-reported digital skills. On the other hand, data analysis did not support an interaction effect of school ICT access and home ICT access. Accordingly, the analysis by Lima, Lima, and Sachsida showed that the impact of those costly Brazilian governmental initiatives on the educational quality of the benefited schools "was limited to some regions, states, or stages of education," and that "the use of ICT alone does not guarantee an improvement in educational quality" (Lima, Lima, & Sachsida, 2018, p. 38).

Consequently, studies show that those individuals who are online do not necessarily fit into neat binary statistical categories such as users/non-users. Instead, it is observed a wide range of ways that individuals are interacting with, and benefiting from, the Internet (ITU/UNESCO Broadband Commission for Sustainable Development, 2019). Moreover, studies also show that supplying households with broadband access without social context beyond the family not necessarily improve the ability of the inhabitants to make meaningful use of the Internet (McConnell & Straubhaar, 2015).

A digital divide between low/high socioeconomic status (SES), white/non-white, and female/male students on all measures of the Student Tool for Technology Literacy (ST2L), a performance-based assessment of ICT literacy skills, was also observed by Ritzhaupt, Liu, Dawson, and Barron (2013) within Florida schools. However, the meta-analysis study by Scherer and Siddiq (2019) suggests that even though the relation between students' SES and ICT literacy was weaker than those reported in other educational domains, such as mathematics and reading, the existing differences still point to a gap in their domain of ICT.

In fact, recent studies (Büchi, Just, & Latzer, 2015; Camerini et al., 2018; Dolan, 2016; Eastin, Cicchirillo, & Mabry, 2015; Hohlfeld, Ritzhaupt, Dawson, & Wilson, 2017; Li & Ranieri, 2013; Tien & Fu, 2008; van Deursen & Solis Andrade, 2018; Zhang, 2014) on variances in Internet access and use amidst school-aged children show that a family's higher SES income bring about children to use the Internet more frequently for student-controlled activities such as creative activities and strategy games online, while, lacking proper parental mediation, their low-SES counterparts are accessing Internet at home more for entertainment purposes such as streaming music, clips, and videos, surfing for fun, playing multiplayer games, and gambling online, which are not in itself problematic but worsens children's school grades and have little potential for increasing "economic, social, or cultural capital" (Zhang, 2015), fuelling a "second-level digital divide" (Hargittai, 2001, 2002, 2004) , that is, an inequality in those skills and habits that make the use of the Internet more meaningful, useful and empathetic..

Drawing upon Bourdieu's capital theory (1986), Zhang (2015) further points out that individuals tend to develop practices and dispositions that accommodate their social positions and thereby reproduce existing disadvantages. As a matter of fact, the study by Van Deursen and Solis Andrade (2018) shows the Internet may act primarily as a magnifier of existing stratification, reinforcing trends of rising inequalities in society. In other words, results show that social inequalities due to children's socioeconomic status are reinforced by this second-order digital divide.

It should be noticed that this gap in what users/citizens use the Internet for results in further differences in the returning benefits of using it, which is called a "third level of the digital divide" (Ragnedda & Ruiu, 2017; Ragnedda, 2017) but is not be discussed here.

A profusion of studies, e.g. (Attewell, 2001), (Hargittai, 2001, 2002, 2004), (Riggins & Dewan, 2005), (van Deursen & van Dijk, 2014), (van Deursen and Helsper, 2015), and (Camerini et al., 2018), has been conducted on digital divides indicating that higher education and user income are positively correlated to queries about job opportunities, health, education, news, and other information related to economics and politics and negatively correlated to searches for entertainment, music, games, sports, and leisure activities.

Also of interest is the study by Tsetsi and Rains (2017) that shows that while the young people's increasing access to smartphones may act as a bridge for the first-level gap, it also acts as a barrier for disadvantaged groups to overcome the second-level divide, a result similar to the one obtained by Fairlie (2017).

Accordingly, a study by Zhang et al. (2015) using search query data from Google Trends found that, while mobile technology is more and more integrated into households and classrooms, Internet users (including parents, teachers, and students) show a significant increasing need for information on using the mobile devices for education. Nevertheless, while research on the use of new media has revealed benefits for children's cognitive development (Camerini et al., 2018), social networking activities showed negative results in relation to academic efficacy (Shank & Cotten, 2014).

Discouragingly, while "youth culture has found in the mobile phone an appropriate tool to express its demands for 'safe autonomy,' ubiquitous connectivity, and self-constructed networks of shared social practice" (Castells et al., 2009), their use in classroom settings is sometimes still seen as distractions instead of learning tools (Ott, Magnusson, Weilenmann, & Hård af Segerstad, 2018) and often dissuaded by teachers, parents, and even part of the students (Gao, Yan, Wei, Liang, & Mo, 2017).

The survey conducted by McConnell and Straubhaar (2015, p. 66) indicated that Internet access at institutional sites such as schools and workplaces appears to play a much stronger role in cultivating in their students this technological capital than domestic broadband (and, of course, mobile access), which is used mainly for entertainment purposes and does not develop such capital. Research by Swain and Pearson (2002) suggests that schools, principals, and teachers can take concrete and effective steps to shrink the digital divide gap. Henning and Van der Westhuizen (2004) argued that the support of peers, more than technology and the curriculum itself, becomes the primary scaffolding mechanism for the majority of the world's upcoming ICT learners overcome their resistance to technology and bridge the digital divide safely and trustingly.

Unlike previous studies that investigated the digital divides over quite homogeneous areas, this research used local statistical measures of spatial autocorrelation and inequality, as well as bivariate choropleth maps, to analyse geospatially the reproduction or closing of existing educational inequalities across already contrasting Brazilian regions.

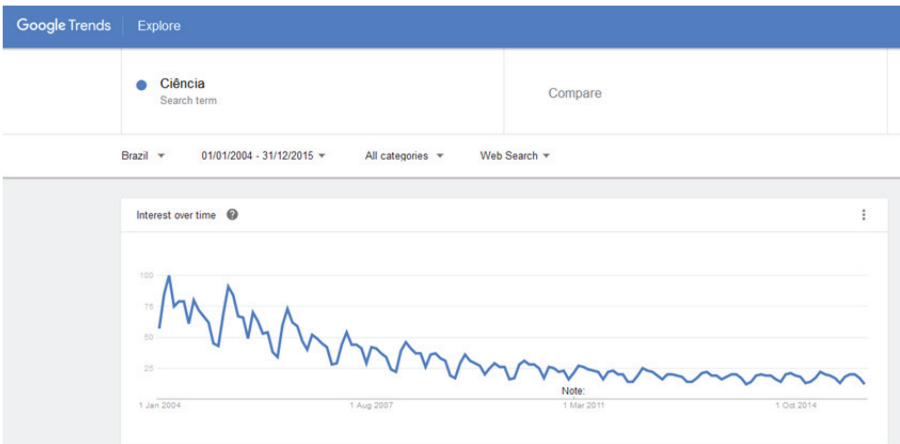
Google Trends as a Social Science Research Tool

There is empirical evidence that a person might feel at ease in the privacy and naturalness of her Google searching (Conti & Sobiesk, 2007) and explore freely the web for news, websites, discussion boards, and other sources of information related to her genuine interests (Scheitle, 2011), which may be hardly elicited by other means of data collection (Stephens-Davidowitz, 2014).

Google Trends (GT) was officially launched on May 2006 and since then allows users to sort through several years of searches done on Google Search Engine (Google Inc., 2012d) from around the world or from a particular country or state and/or period. It then provides a graphical plotting showing the popularity of particular search terms over time; see an example of the search by the word '*Ciência*' (Science) in Figure 1. A line trending downward means that the relative popularity of that search term is decreasing (Google Inc., 2012d).

Figure 1

Search by the term 'Ciência' (Science) in Brazil from 2004 to 2016 with Google Trends. (Google Trends, https://www.google.com/trends).

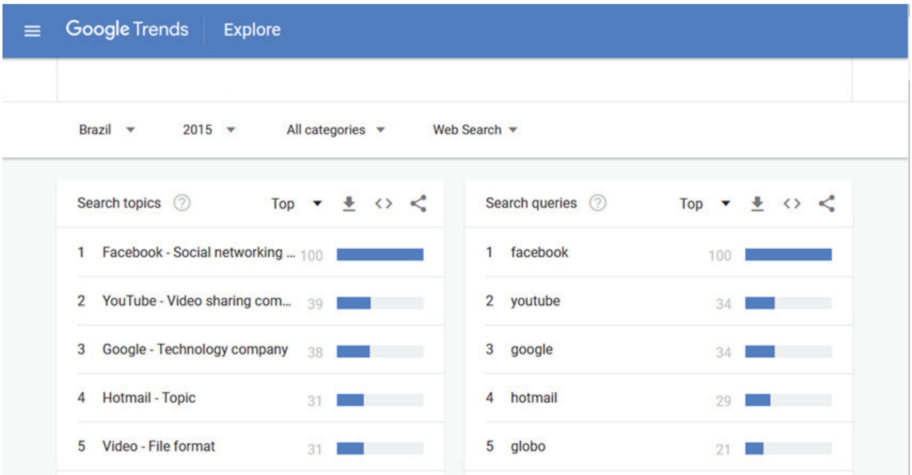


A point to take into account in these analyses, however, is that the value that appears in the ordinate of the time-charts and map graphs is not absolute but only the relative, normalised number of searches for that topic, to make comparisons between terms easier. Otherwise, places with the most search volume would always be ranked highest. For example, users in Fiji and Canada may have the same search numbers if they are equally likely to search for 'hotel' even though they may not have the same number of total searches for this term (Google Inc., 2012b). Each data point is divided by the total of searches done on Google Search Engine (Google Inc., 2012e) on the geography and time range it represents and the resulting numbers are then scaled to a range of 0 to 100 based on a topic's proportion to all searches on all topics. As such, a value close to 100 indicates that it is close to the maximum value of the current search numbers for that place and time period (Google Inc., 2012b). If, e.g., at most 10% of searches for the given region and time period were for "pizza," GT would score this '100,' and all the other points, both to all searches and other items plotted, are valued relative to it (Google Inc., 2012b). As a consequence, the relative popularity of "pizza" search term being decreasing does not necessarily mean the total number of searches for that term is decreasing.

GT also provides a list of 'top searches' (Figure 2), i.e., the most searched terms in the same country, or region and/or period (Google Inc., 2012a).

Figure 2

'Top searches' in 2015 in Brazil with Google Trends. (Google Trends, https://www.google.com/trends).



The datasets generated by these searches can be then downloaded as comma-separated-value (.csv) spreadsheet-friendly files for further processing, as is done later in this work. Notice, however, that GT only considers popular terms and, as a consequence, a search term with low search volume in a particular region appears as 0 (Google Inc., 2012e).

Many social science research studies in the past decade have utilised GT (see, e.g. Jun, Yoo, & Choi (2018) for a review). More in line with the scope of the present study, Guo, Zhang, and Zhai (2010) and Zhang et al. (2015) have used GT for the study of human curiosity, understood as a desire to acquire new information and knowledge, and its measurement, while Segev and Baram-Tsabari (2009a, 2009b), Zhang (2014), and dos Santos (2016) have used GT to explore the public interest in Science.

According to Trevisan (2014), GT presents a few advantages as a methodology over conventional survey-based methods. After all, the behaviour of individual searches online occurs in a natural environment rather than in an artificial one such as an experimental laboratory or a setting for purposeful questionnaire answering. Trevisan (2014) argues that these outcomes stem from the fact that, instead of discussing what interviewees said they do in questionnaires, data obtained from GT relied on what Internet users actually did with search engines, therefore mitigating research bias and the incidence of incomplete or false responses.

The arguable assumption here is that if people are interested in a particular theme, they will likely google the web for resources, news, websites, forums, and other types of information related to it (Scheitle, 2011). However, even if using search queries to infer users' interests by which "the topic in which the user was interested can only be imputed by the researcher," Rose and Levinson (2004) found evidence that the search term alone is sufficient to classify the presumed intent of the query.

On the other hand, GT has its well-known limitations and biases. Even if the Internet and search engines are increasingly used to find information, people might prefer going online (or, more frequently, using Google) to entertain themselves. According to Waller (2011), there is empirical evidence that, on average, "only about half of the search queries are carried out to fill an actual knowledge gap" between what a user knows and what she needs to know. Besides, as Waller (2011) puts it, an Internet search engine is not only an interface to information or a shortcut to websites; it is can equally be employed a site of leisure, which amounts to about one in six of all searches (Waller, 2011).

METHODS

Data sources

Data on the availability of information and communication technologies (ICT) in Brazil as well as on the number of people who accessed the Internet in each state was obtained from the CETIC.br[1] data portal. Data on Internet searches for various relevant topics in Brazilian was obtained from the GT webpage[2]. Data on the coordinates of the centroids, also known as the geographic centres, of the Brazilian states were obtained from the GeoNames geographical database webpage[3]. All research data was conveniently combined for further analysis into different datasets, which were deposited for reproducibility and data reuse in our GitHub repository[4].

Data analysis

As discussed above, prior research indicated a possibility that the Internet may be used to reproduce, rather than close, educational inequalities. However, few studies have examined to what degree this hypothesis may hold. Little research has examined this issue by specifically analysing the actual usage of youth-oriented educational and entertainment websites, primarily due to the lack of an effective and efficient method for tracking Internet use by millions of users. Nevertheless, GT, along with Google Correlate[5],

[1] http://data.cetic.br/cetic/explore
[2] https://www.google.com/trends
[3] http://www.geonames.org/BR/administrative-division-brazil.html
[4] https://github.com/RenatoPdosSantos/Second-level-Digital-Divide-in-Brazil
[5] https://www.google.com/trends/correlate/

are two Big Data analytic tools that offer great potential for understanding current Internet use by youth to educational researchers (dos Santos, 2016).

Data was graphically and geospatially analysed with resources from the R statistical data analysis language (R Core Team, 2019) in terms of the evolution of the availability of computers at School for students, migration of Internet access from desktop computers to personal mobile devices, Internet access in households, fixed broadband access in households, and Internet access in households by social class.

The geospatial distribution across the Brazilian states of the rate of Internet access and the rate of Internet searches for a given term in 2005, 2011, 2008, and 2013 was analysed in detail, looking for spatial inequalities across the individual municipalities. Initially, data were analysed employing measures of local spatial inequality and autocorrelation, as well as scatterplots (not presented here; see detailed analysis available at our GitHub repository[6]), and finally by *choropleth maps*. Choropleth maps are colour-coded geographic maps in which thematic values, such as demographic density or per capita income, are proportionally coded using some smooth colouring function to RGB domain and then applied as patterns or shadings to particular geographic areas of occurrence, typically administrative regions. Any singular (univariate) values related to the event can then be so projected, and the viewer can quickly get an impression of its distribution across the regions within the map. A more sophisticated, bivariate choropleth map, as provided by the with the *colorplaner* package (Murphy, 2016) for R, uses a smooth colouring function that accounts for two-dimensional variables and is suited to identifying correlations between those variables from the single displayed colour straightforwardly. Positive correlations between the variables are indicated by colours ranging from green (both variables have low values) to violet (both high), while colours such as red and blue indicate negative correlations (one is high, and the other is low or vice-versa).

RESULTS AND DISCUSSION

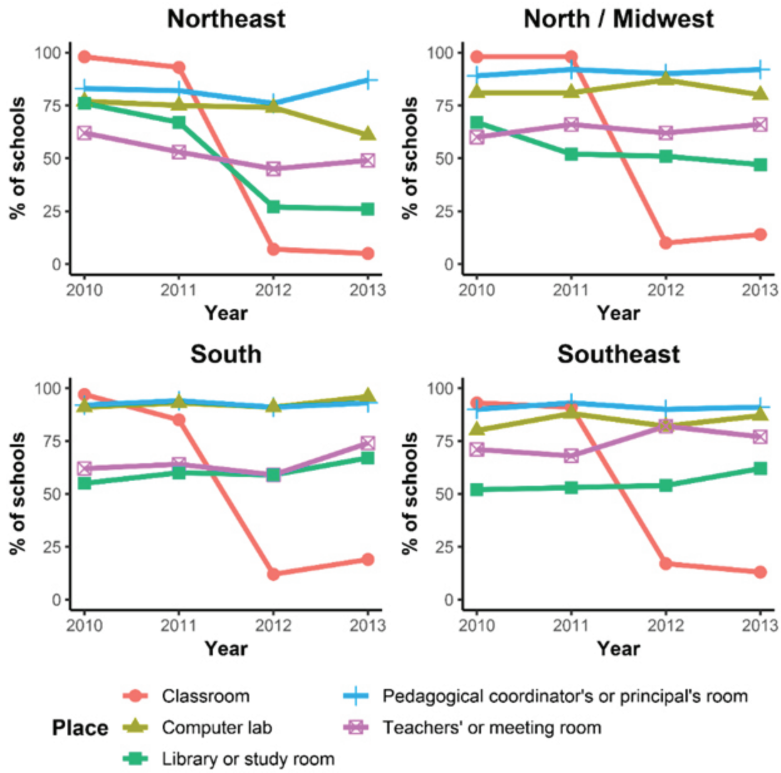
On the reduction in the availability of computers in classrooms

Contrarily to what has happened in most OECD countries, in which the percentage of classrooms with Internet access grew continuously in lasts years (Echazarra, 2017; OECD, 2015), data shows that the availability of computers access for students in schools has fallen drastically throughout Brazil since 2010 (Figure 3). In other places, such as libraries and computer labs, there has been a less pronounced drop in schools in the North, Northeast and Centre-West regions and even some growth in the South and Southeast regions. In contrast, it is observed that the existence of computers in those parts not accessible to students, such as in the principals', pedagogical coordinators', or teachers' rooms, remained reasonably high, or even increased (Figure 3).

[6] https://github.com/RenatoPdosSantos/Second-level-Digital-Divide-in-Brazil

Figure 3

Computers installed by school place by region in Brazil from 2010 to 2013. (CETIC.br data portal, http://data.cetic.br/cetic/explore).



We were not able to find in the literature reasons for this reduction of the number of computers in classrooms in Brazil since 2010; we can only conjecture that it is a consequence of changes of objectives in the subsequent official projects of computerisation of the schools and the resistance of ill-prepared teachers (Brasil. CGU, 2013). Nevertheless, it might be worth remembering Papert's colourful metaphor about schools' administration attitudes towards "computers inside classrooms." Papert says that when there were only a few computers in the School, the Administration had no problem in leaving them in the classrooms of a few enthusiastic teachers. However, as computers became status symbols, Schools' conservative "immune system" reacted to neutralise, "digest and assimilate" this "subversive instrument of change," by moving them together into one separate room — deceptively named "computer lab" — to where the students could come only in groups and occasionally, to attend a new subject, "study computers," therefore reinforcing School's old good ways (Papert, 1993, pp. 39–41).

On the migration to personal mobile phones

Whatever the official reasons for the reduction of the number of computers in classrooms in Brazil displayed in Figure 3, one could speculate that this change stems from a migration of students' Internet access from desktop computers to personal mobile devices.

Analysis of data shows an extraordinary increase in the home Internet access in all regions of Brazil (Figure 4), with a simultaneous proportional reduction in fixed Internet access, being substituted by access through the highly available and used portable devices in all regions of Brazil, especially cell phones (Figure 5).

Figure 4

Households with Internet access by region in Brazil from 2006 to 2019. (CETIC.br data portal, http://data.cetic.br/cetic/explore).

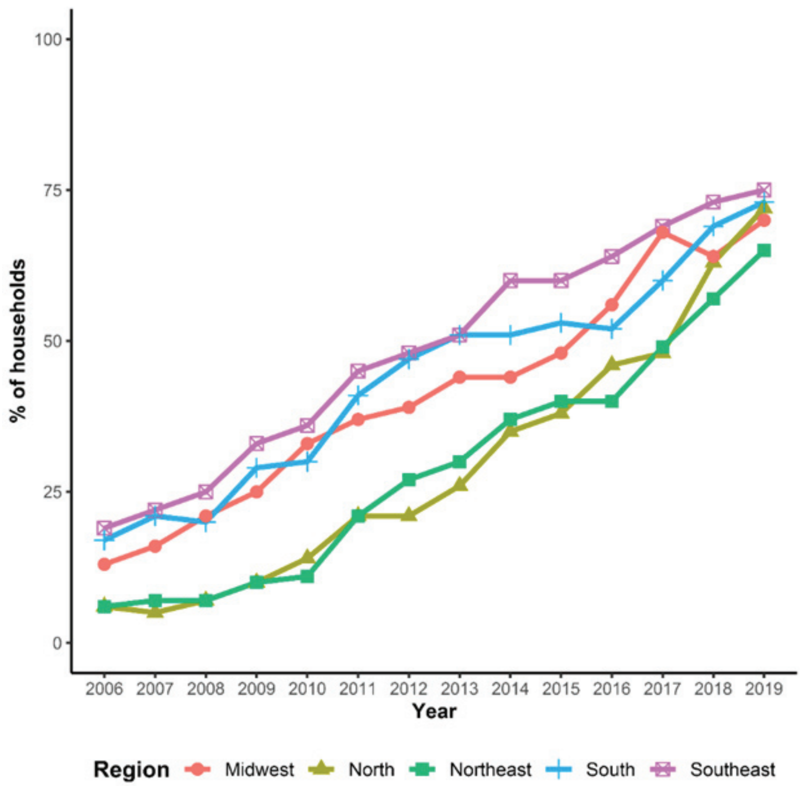
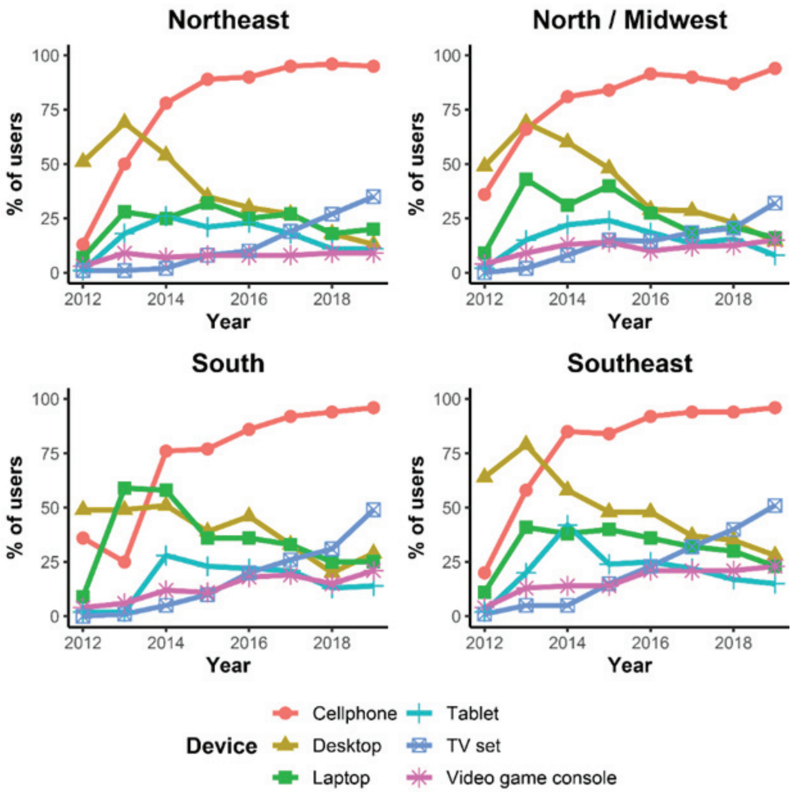


Figure 5

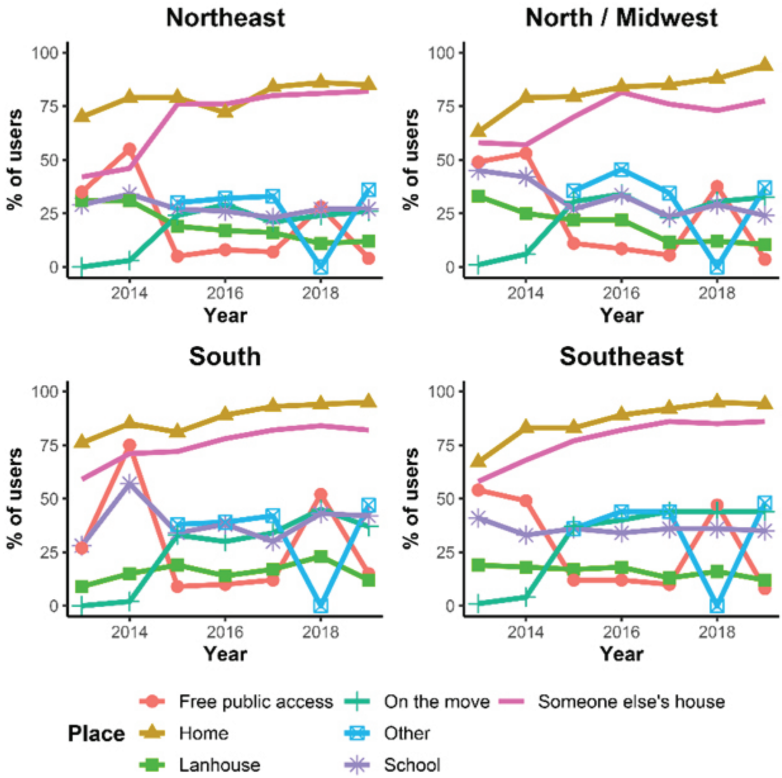
Youngsters (11–17 years old) Internet access by device and region in Brazil from 2012 to 2019. (CETIC.br data portal, http://data.cetic.br/cetic/explore).



Furthermore, graphs in Figure 6 shows a dramatic predominance of young people's Internet access at own or someone else's home.

Figure 6

Most frequent location of youngster individual access to the Internet, by region in Brazil from 2013 to 2019. (CETIC.br data portal, http://data.cetic.br/cetic/explore).

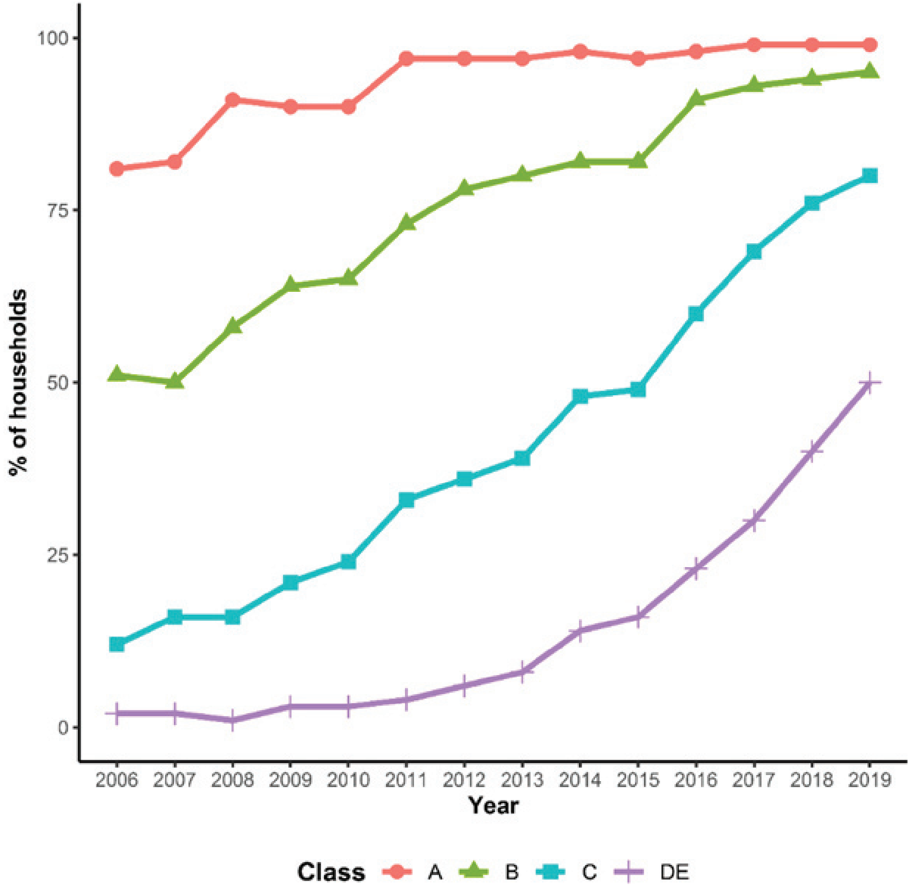


These observations, taken together, seem to support the suggestion above that these changes stem from a migration of Internet access from computers to personal mobile devices, such as smartphones and tablets.

On the other hand, with relation to the digital divide, graphs in Figure 4 show that this increase in Internet access was not the same in all regions of Brazil. The rhythm of growth appears to be approximately the same, but a regional digital divide is observed since the access is still considerably higher in the South and Southeast compared to the Northeast, North and Central West regions. The divide is also still seen in social terms since Internet access by social classes C, D and E is still much lower than classes A and B, although this difference is shrinking over time (Figure 7).

Figure 7

Households with Internet access by social class in Brazil from 2006 to 2019. (CETIC.br data portal, http://data.cetic.br/cetic/explore).



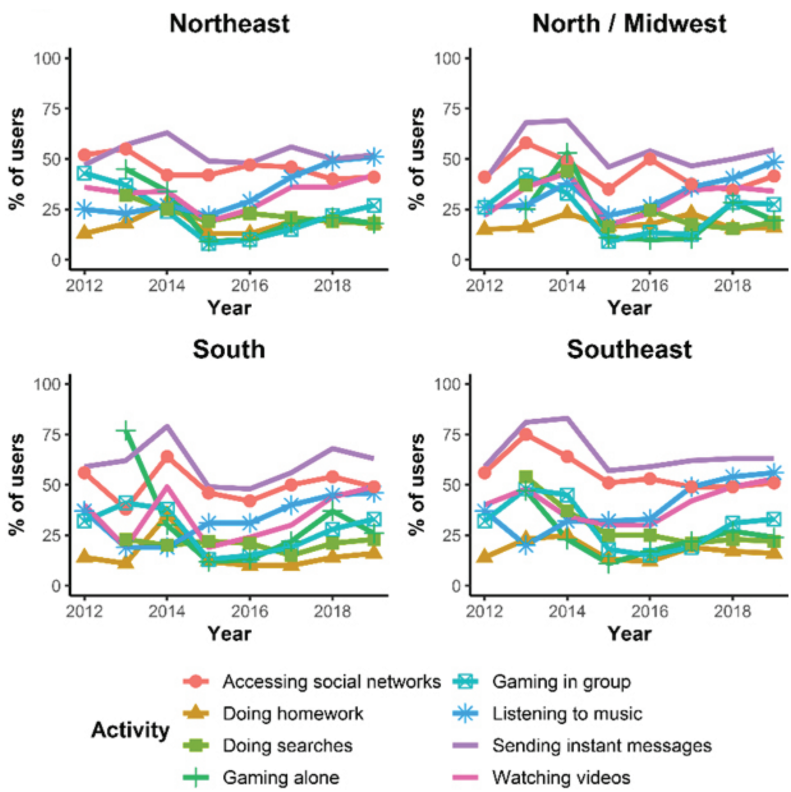
Although the above results are reassuring at first sight in indicating a reduction in the quantitative inequality of access to the Internet through a substitution of Internet access from computers to personal mobile devices (Figure 5), this migration of students' Internet access did not occur within the school environment. While access to the Internet using desktop computers was formerly provided in classrooms, libraries, and computer labs (Figure 3), the use of and access to the Internet through mobile devices is now usually prohibited in the classroom and even in the entire school building, as discussed in Introduction.

On the change in the use of the Internet

Most importantly than the migration of students' Internet access from computers to personal mobile devices, however, there was also a significant qualitative replacement in that process outside of School, namely in the finality of the Internet access, as shown by the graphs in Figure 8, with a considerable predominance of entertainment activities over 'doing homework'. As Dolan (2016) argues, the "use of technology at home and in school is not equitable for all students."

Figure 8

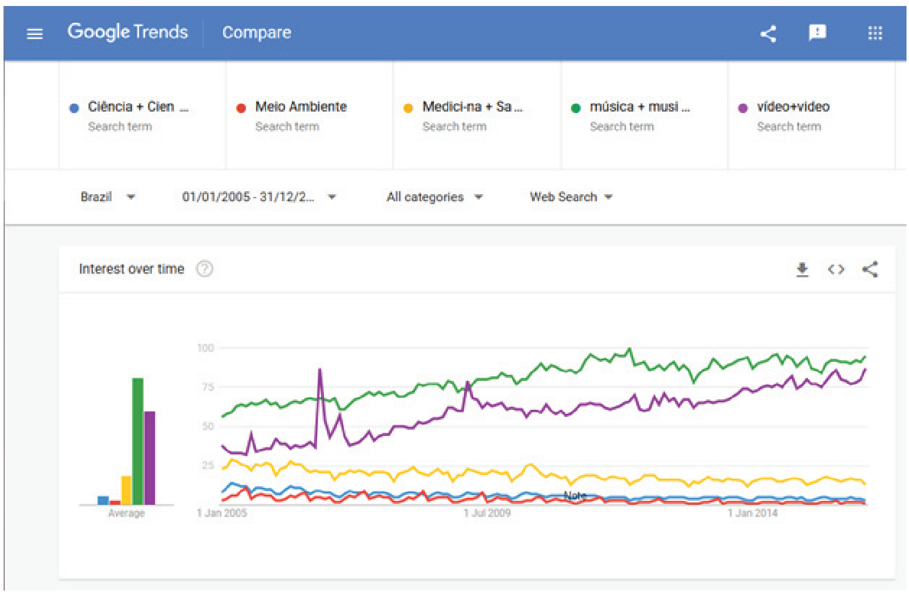
Youngsters' (11–17 years old) use of the Internet by activity, by region in Brazil from 2012 to 2019.(CETIC.br data portal, http://data.cetic.br/cetic/explore).



The designation 'doing searches' in Figure 8 is ambiguous and deserves further investigation as to the actual object of those searches. Making use of GT data to understand current Internet use, graphs in Figure 9 shows that the primary interests, as suggested by the Internet searches, in the period 2005–2019 clearly shifted from educational themes such as 'Medicine & Health' (*Medicina + Saúde + Saude*)[7], 'Science & Technology' (*Ciência + Tecnologia*), and 'Environment' (*Meio Ambiente*), to others, such as 'music' (*música + musica*) and 'video' (*vídeo + video*), more related to leisure activities and considered of "scarce social prestige", "futile", and "less noble" (Vogt & Castelfranchi, 2009, p. 23).

Figure 9

Rates of Internet searches in Brazil in the period 2005–2019 by the terms corresponding to 'Science & Technology', 'Environment', 'Medicine & Health', 'music', and 'video'. (Google Trends, https://www.google.com/trends).



Dos Santos (2016) argues that these results seem to contradict those from recent national surveys on public's interest in Science and Technology in Brazil (Brasil. MCT, 2010; Brasil. MCTI, 2007, 2015) because those might have suffered from a "social desirability bias" (Berinsky, 1999; Edwards, 1953) that may have led respondents to inform a preference for more "socially desirable" responses and, therefore, been overestimated. Table 1 from (dos Santos, 2016) shows that the most searched terms in these periods were related to leisure, including social networks, videos, search engines, games ('*jogos*'), music ('*musicas*'), lyric ('*letra*'), and '*Globo*' (The name of the dominant Brazilian free-to-air television network). Furthermore, the results from Table 1 resonate with Segev & Ahituv's (2010) transnational study that demonstrated that most popular search queries in Brazil are about entertainment.

[7] As Google differentiates misspellings as well as spelling variations in the search terms (Google Inc., 2012c), these alternatives were included in the search as, for example, 'Medicina+Saúde+Saude'.

Table 1
Top 10 searches on 2006, 2010, and 2015 in Brazil, according to GT.

2006		2010		2015	
Queries	Volumes[a]	Queries	Volumes[a]	Queries	Volumes[a]
orkut	100	jogos	100	Facebook	100
brasil	75	orkut	70	Youtube	35
fotos	75	youtube	50	Google	35
jogos	60	globo	45	Hotmail	30
download	60	hotmail	35	Globo	20
musicas	40	musicas	35	Jogos	15
letras	35	uol	30	Tradutor	15
videos	30	msn	30	Vídeos	15
musica	30	tradutor	30	Filmes	15
uol	30	google	30	Uol	15

[a] These volume figures are relative and normalised, as discussed in Section 2.2.

Note. Reprinted from "Are our students really interested in Science? Or does Google Trends show a socially desirability bias in Brazilian public opinion surveys?," by Renato P. dos Santos, 2016, *Acta Scientiae*, *18*(2), 531–549. Copyright 2016 by Renato P. dos Santos.

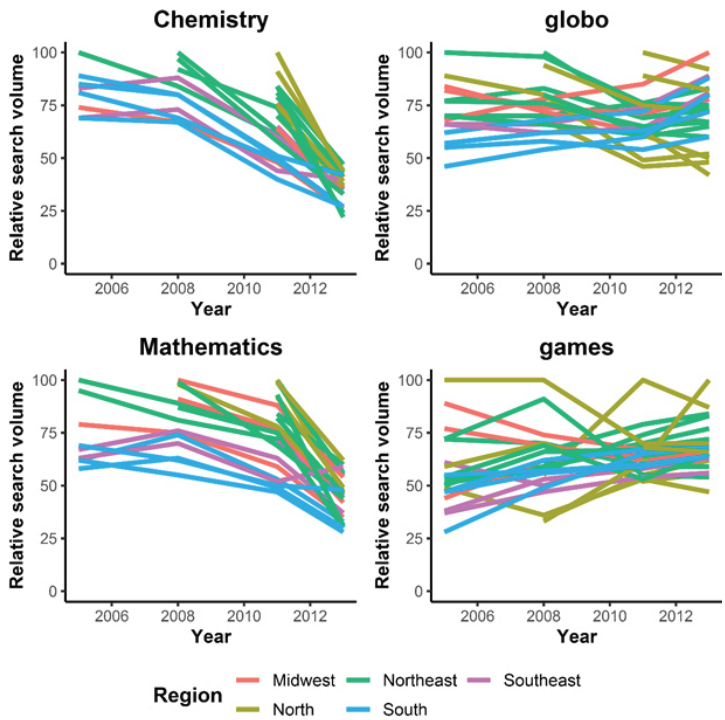
On the effect of Internet penetration on changing interest in searches

Taking into account that the penetration of the Internet was not the same across the regions in Brazil (Figure 4), we proceeded to investigate how Brazilian users' interests evolved, as indicated by changes in their actual Internet search behaviours, with the increasing familiarity with the Internet.

Graphs of the volume of Internet searches in Brazil for relevant terms 'Química' (Chemistry), 'Globo', 'Matemática' (Mathematics), and 'jogos' (games) in the period 2005–2013, as provided by downloaded GT data, are displayed in Figure 10.

Figure 10

Graphs of the relative search volumes[a] in the period 2005–2013 for the terms 'Química' (Chemistry), 'globo', 'Matemática' (Mathematics), and 'jogos' (games). (Google Trends, https://www.google.com/trends).



[a] These volume figures are relative and normalised, as discussed in Section 2.2.

It is noticeable from the graphs of Figure 10 that while the search volumes for '*Química*' (Chemistry) and '*Matemática*' (Mathematics) (and similarly for Biology, not shown) decreased along the period 2005–2013 for all Brazilian states, the search volumes for 'Globo' and '*jogos*' (games) increased in some states and decreased in others.

This difference can be interpreted as evidence of a "second-level digital divide" between those regions, a divide between some Brazilian regions regarding actual users' interests, as suggested by their Internet searches, as the result of a general inequality in the skills and habits of their inhabitants that make the use of the Internet different in terms of meaningfulness, usefulness and empathy, an inequality in the digital capital necessary to complete tasks essential to contemporary educational opportunities and jobs.

Finally, an analysis was made of any spatial inequalities of the distribution of the relation between the rates of access to the Internet and relative search volumes for the relevant terms across the individual Brazilian states. Bivariate choropleth maps for the variables themselves were built, leaving the correlations between those variables to be identified visually directly from the single displayed colour in each state, instead of applying local correlation coefficients to the particular states they correspond. It is worth remembering that, as indicated on the guides, positive correlations are indicated by colours ranging from green (both variables have low values) to violet (both high), while colours such as red and blue indicate negative correlations (one variable is high, and the other is low or vice-versa).

Figure 12

Choropleth maps of the values of relative search volumes for 'Biology' and the rates of access to the Internet for each Brazilian state in 2005, 2008, 2011, and 2013. (Google Trends, https://www.google.com/trends).

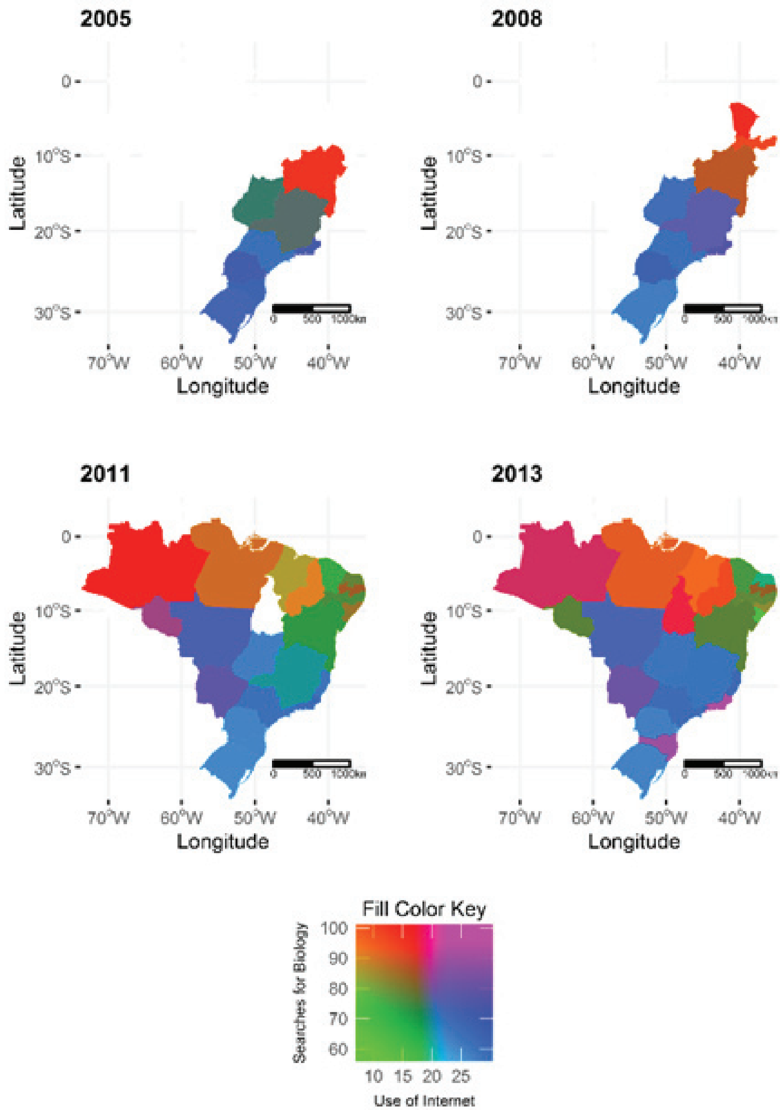


Figure 13

Choropleth maps of the values of relative search volumes for 'Chemistry' and the rates of access to the Internet for each Brazilian state in 2005, 2008, 2011, and 2013. (Google Trends, https://www.google.com/trends).

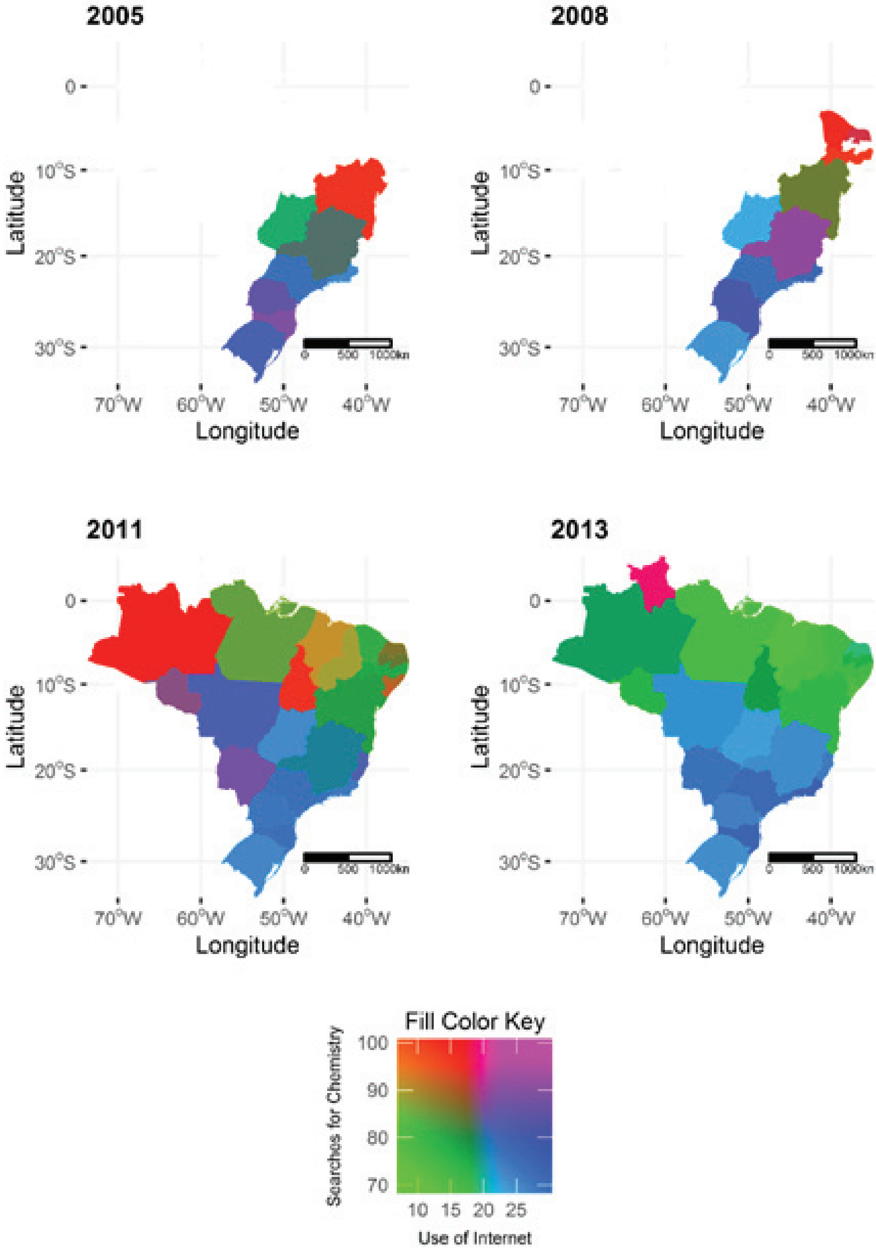


Figure 14

Choropleth maps of the values of relative search volumes for 'Mathematics' and the rates of access to the Internet for each Brazilian state in 2005, 2008, 2011, and 2013. (Google Trends, https://www.google.com/trends).

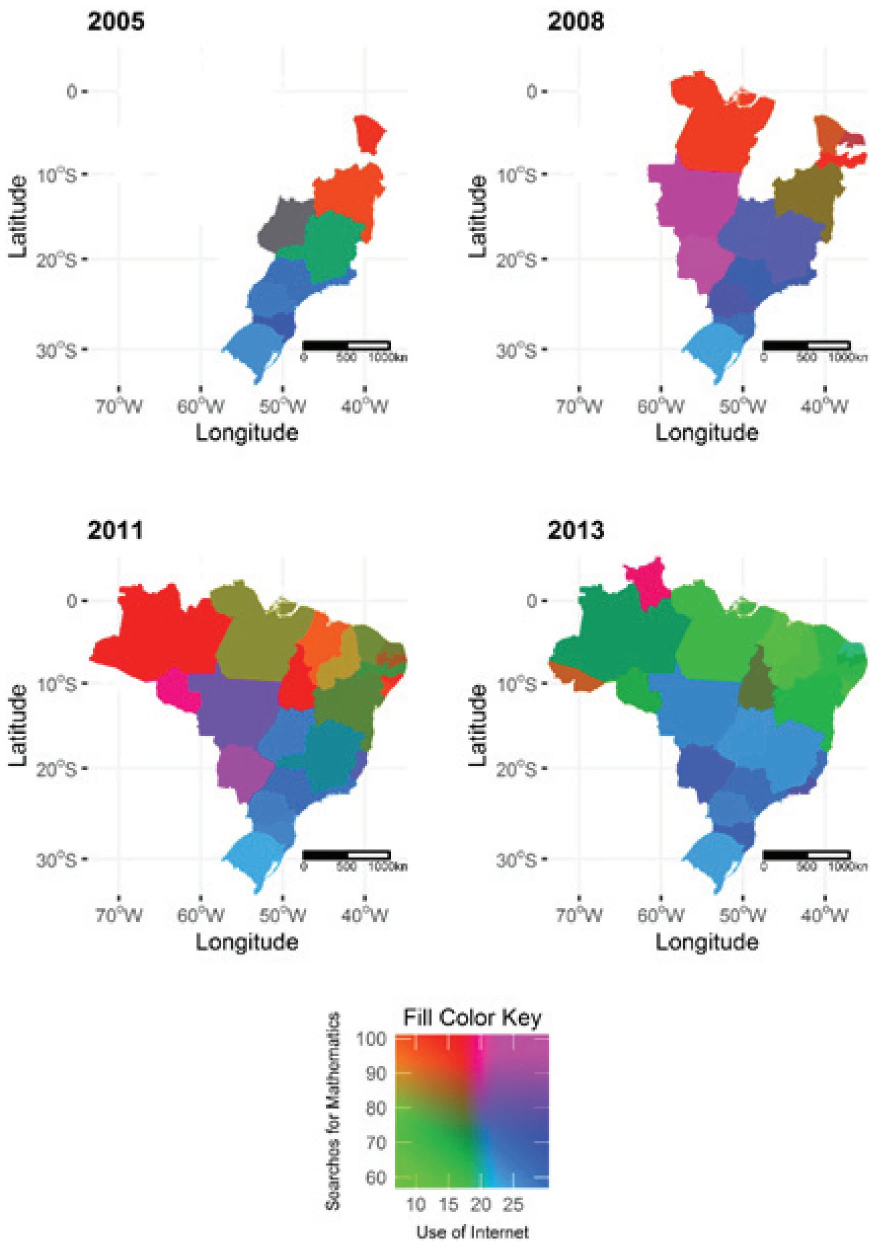


Figure 15

Choropleth maps of the values of relative search volumes for 'Globo' and the rates of access to the Internet for each Brazilian state in 2005, 2008, 2011, and 2013. (Google Trends, https://www.google.com/trends).

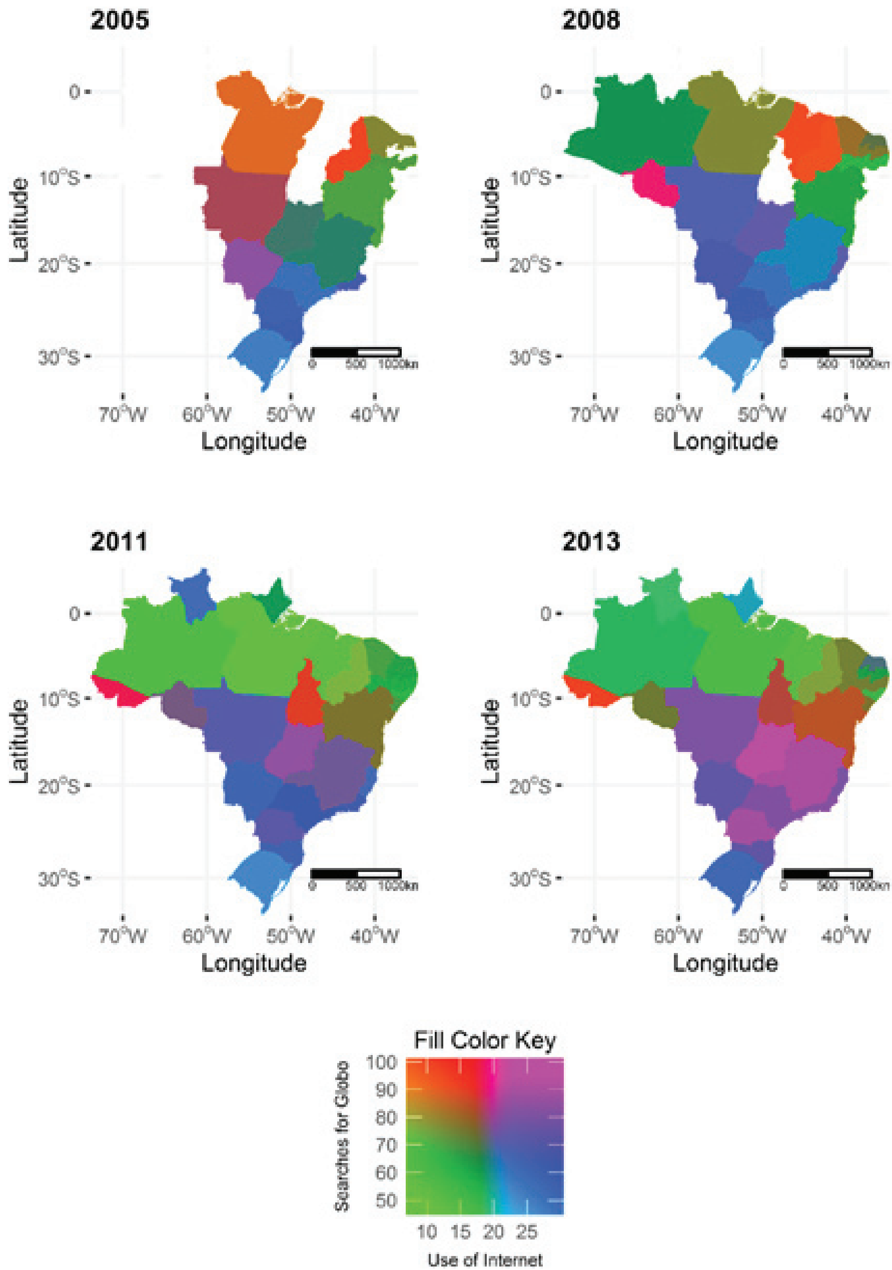
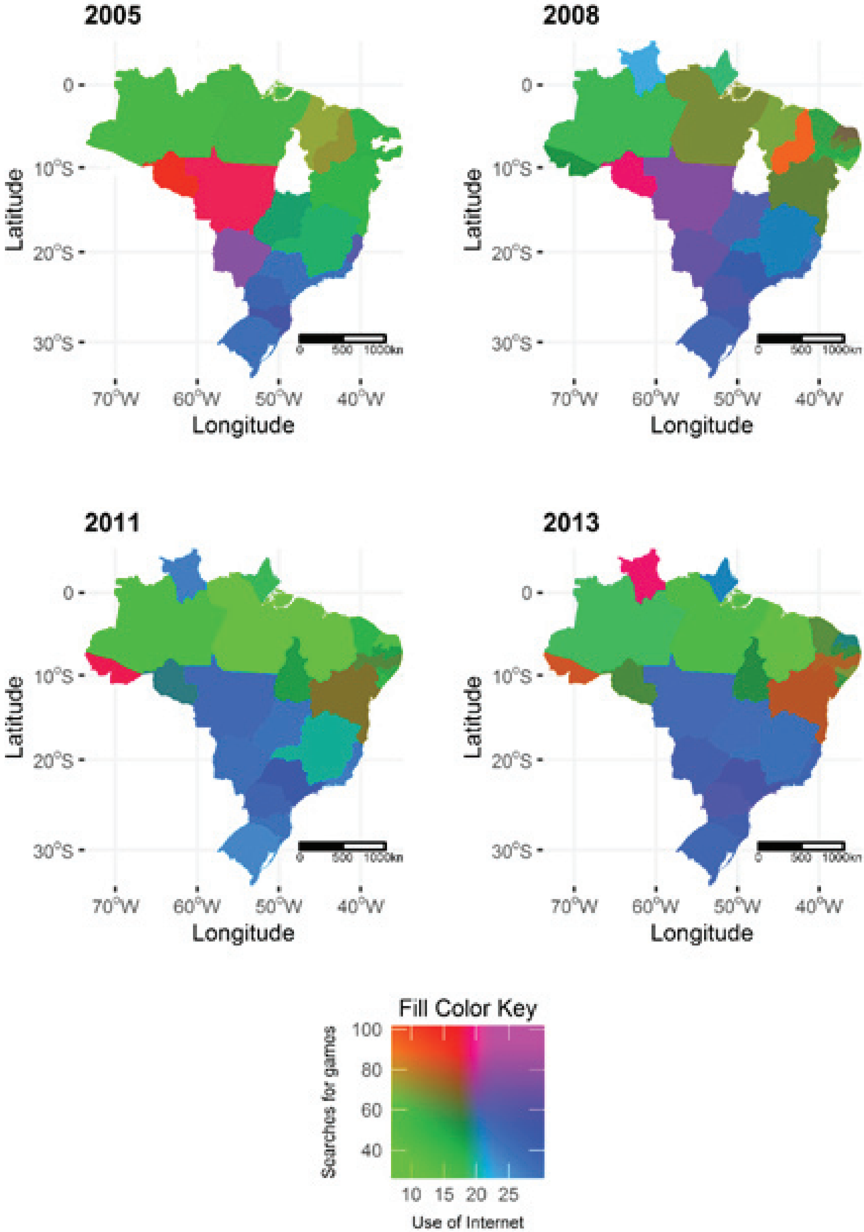


Figure 16

Choropleth maps of the values of relative search volumes for 'Biology' and the rates of access to the Internet for each Brazilian state in 2005, 2008, 2011, and 2013. (Google Trends, https://www.google.com/trends).



From the choropleth maps in Figure 16, it is visible that in the south and south-eastern states, which acquired access to the Internet before the northern, north-eastern, and mid-western states, the interest for terms related to entertainment, and of "scarce social prestige" (Vogt & Castelfranchi, 2009, p. 23), were increasing sharply (orange to dark red), while searches by terms more related to themes of higher "social prestige" were falling drastically (dark blue). Apparently, people in these less-connected regions were still learning how to access and use the Internet and, therefore, still interested in more 'serious' terms. During the period 2008–2013 (R), inhabitants of those other states also seem to have 'evolved,' in the sense of using the access also as a source for leisure, rather than learning only, as they become more used to the Internet.

On the possible role of schools in the digital divide

More serious still is the observation that this significant change in the inequality happens from the period 2005–2011 to the 2008–2013, precisely when there was a drastic reduction in the availability of computers to students in classrooms across Brazil, not accompanied by migration to personal mobile devices, as discussed in Section 5.2.

Relying on the similar results from the survey conducted by McConnell and Straubhaar (2015), as discussed in Section 2, we interpret ours as possible evidence of a causal relationship between the schools beginning to prevent institutional access to the Internet and the reduction in its meaningful use by their students.

However, it is worth remembering, that wireless communication and mobile communication technologies are only the latest in a long line of technological changes, from books to television and Internet, that have successively driven hopes and fears about the impact of technology on the young (Castells et al., 2009).

As pointed out by Rodrigues et al. (2018), the mobile media existing in the school space is a reality that has no turning back and the directions to be drawn are of construction of paths abundant in possibilities. The extensive and regular use of mobile phones by young people indicates that most of them have already adopted this innovation. Thus, as Nagumo and Teles (2016) argue, the School must also reinvent itself as a social space for the young "connected" and generate a positive and productive relationship with these students for the conscious use of technology that can create a foundation for a more collaborative, intelligent, and creative society. Furthermore, the defining features of ubiquity, flexibility, ease of access and diverse capabilities of mobile technologies should be more explored than it happens today (Bano, Zowghi, Kearney, Schuck, & Aubusson, 2018).

As Francisco admonished, however equipped a society is, if it produces a legion of functional illiterates, mere consumers and reproducers of low educational and scientific content, it becomes a "disinformation society" (2004, n. 6).

CONCLUSIONS

If this digital divide between regions and social classes discussed above was not acceptable already, its impact on education was critically exacerbated in 2020, with the arrival of the ongoing pandemic of coronavirus disease 2019, the COVID-19 and the closure of schools, practically throwing out of the emergency remote education system the significant part of the students that does not have access to minimally acceptable housing and sanitation, let alone a stable Internet and adequate equipment for its access.

Our results above show that costly governmental initiatives of merely increasing the home broadband Internet access ended up simply providing its entertainment use and contributing to the widening of the achievement gaps and educational inequalities, rather than closing it. Results also suggest that, by negating their students institutional access to the Internet and the social support from 2011 on, the Brazilian school system failed to play its crucial role in cultivating in their students the more productive use of Internet access that could help them to achieve life goals and bring about life changes.

Therefore, Brazilian policymakers should concentrate efforts and resources in addressing the more nefarious large-scale second-level digital divide in Internet use found in this study. One possible solution would be "equipping educators with the knowledge, skills, and behaviours as digital citizens in the current digital and global age" (Choi, Cristol, & Gimbert, 2018) through the educational use of mobile devices, especially smartphones, and taking into account UNESCO (2013) recommendations for updating policies related to allowing and improving connectivity options for mobile Internet access in school premises while teaching their students the digital skills that promote the productive use of the Internet.

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AUTHORS' CONTRIBUTIONS STATEMENTS

RPdS supervised the project. RPdS, MŞB, and ILL conceived the idea presented, discussed the methodology, and organised the theoretical discussion. ILL collected the data. All authors analysed the data and discussed the results and contributed to the final version of the manuscript.

DATA AVAILABILITY STATEMENT

The data files and the R code used to support the results of this study are openly available at our GitHub repository[8]. Data was derived from the following resources available in the public domain:

CETIC.br data portal http://data.cetic.br/cetic/explore,

GeoNames geographical database http://www.geonames.org/BR/administrative-division-brazil.html, and

Google Trends webpage https://www.google.com/trends .

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[8] https://github.com/RenatoPdosSantos/Second-level-Digital-Divide-in-Brazil

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