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ICT and education in Brazil - NGO, local government administration, business and higher education expert perspective

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Abstract

The paper aims to present the conditions surrounding the use of ICTs in Brazilian schools. The goal of the study was to offer a wide perspective that included the opportunities, barriers, transfer of knowledge, and challenges related to introducing information technology into education. The technique used was qualitative - an expert interview with four experienced respondents. The individuals interviewed represented different areas of professional activity: the academic sector, the implementation of practical activities in schools, pedagogical supervision, and the development of commercial software. The study was conducted in 2019, as part of the expert conference CBIE (*Congresso Brasileiro de Informática da Educação* – Brazilian Conference on Computers in Education). The results of the analyses reveal that the challenges of implementing ICT in educational processes are similar to those found in the global perspective. According to these experts, Brazil faces similar issues to those found in other countries, namely: the appropriate preparation of teachers in the use of ICT, supplying schools with high-speed and up-to-date hardware and software, encouraging teachers to use ICT, the re-constitution of educational policies, and changes in administering IT resources within schools.

Keywords: *ICT; Brazil; school; computers; Internet; information society; experts; interview; SELI;*

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1. Introduction

Information and Communications Technology (ICT) has fast become a ubiquitous part of people's daily lives, whether through direct interaction such as reading the news, making purchases, exchanging messages, paying bills, or taking courses, or because, even without being direct users of these technologies, their lives are affected by their presence, for example, in areas such as technological agriculture, genetics, financial services or transportation (Gere, 2008). This digital transformation of society means rethinking pedagogical practice, which increasingly requires the incorporation of digital technologies into the school environment (CETIC.BR, 2019). ICTs, as pedagogical tools, can enhance the teaching-learning process (Machado, Kuhn, Santos Jr. & Wives, 2018; Stosic, Dermendzhieva & Tomczyk, 2020) as they provide opportunities for students to face their challenges and overcome their limitations.

UNESCO (2008) defined a set of ICT competency standards for teachers: competences in the use of available ICTs, research development, analysis and critical selection of information, problem solving, creativity in the use of productivity tools, in the production of information and knowledge, collaboration, communication, responsibility, participation and contribution to the improvement of society. In Brazil, the creation of digital culture at school is related to a set of skills that develop gradually, according to the characteristics of each school context (CETIC.BR and UIS, 2016). The heterogenous socioeconomic levels of families within and across geographic regions lead to a pattern of inequality in the school context (Martínez, Adib, Senne, Pérez & Torres, 2020). Private schools and those located in the wealthiest regions of the country have access to ICTs and trained teachers, while public schools generally have fewer resources from federal, state or municipal governments. This reflects a lack of digital technological resources (computer labs, Internet access, technological devices) for use in schools and a lack of continuing training for the teachers of such schools in the use of ICTs (Amato, Silveira, Eliseo & Martins, 2019). This lack of teacher training is due to the small amount of time devoted to training practices and their high workload in the classroom, in addition to issues and needs not addressed by teacher training (Machado, Kuhn, Santos Jr. & Wives, 2018).

In view of these patterns, the need for a diagnosis of the conditions surrounding the use of ICTs in Brazil is evident in order to obtain subsidies, and this diagnosis must include the opportunities, barriers, knowledge transfer, and challenges for the development of digital inclusion policies. Although there have been reflections on the adequacy of the school curriculum in the face of the use of technology (Almeida & Valente, 2011; CETIC.BR & UIS, 2016; CETIC.BR, 2019), there is little research that considers the use of ICT in the school environment in terms of qualitative analysis. In this context, this paper presents a qualitative study based on interviews with experienced specialists who have represented different areas of professional activity: the academic sector, the implementation of practical activities in schools, pedagogical supervision, and the development of commercial software. The respondents answered questions about ICT support in education, Brazilian ICT solutions in school support, barriers to ICT implementation in Brazilian schools, the development of human capital through ICT, the business sector and education in Brazil in the area of ICT, and technological innovations in the Brazilian educational system.

This paper is organized as follows: The next section presents the theoretical background to ICT in Brazilian education. Then, the objectives of the qualitative research are presented along with the methodology used. After presenting the interviewees' opinions, the paper presents a critical discussion about the data collected before finally reaching its conclusions.

1.1. Theoretical Framework

Transfer of solutions based on ICT in Education to countries other than Brazil

Despite the fact that investment in education in Brazil is quite scarce, there has been an effort by the federal government, in recent decades, to reduce the differences between elementary and high school education - both in public schools (which tend to have few resources) and private schools. The following are examples of these government actions (Amato et al., 2019):

- *Um computador por aluno* (UCA – One Computer per Student) Program (Brazil's version of OLPC - One Laptop Per Child program): aimed to enhance ICTs in schools by distributing laptops to public school students. It complemented previous programs which provided computer-supported educational actions in laboratories and the development of learning objects for pedagogical use in schools (Brazil, 2017a), (Lavinas & Veigas, 2013).
- *Banda Larga nas Escolas* (PBLE) Project (Broadband in Schools): offering Internet connection infrastructure to public schools all over Brazil through incentives for telephone companies (Brazil, 2017b).
- *Portal do Professor* (Teachers' Portal): a virtual platform to facilitate communication and the exchange of experiences and teaching materials among elementary school teachers (Brazil, 2018a).
- *Banco Internacional de Objetos Educacionais* - BIOE (International Bank of Educational Objects): a collection of open access learning objects for various educational levels (Brazil, 2018b).

On the other hand, there is a very significant number of actions to bring the universities closer to the community, either in extension or in research projects/programs, such as:

- Incentive programs for women in Computing: the relatively low number of women working within Information Technology is a global concern. There have been several moves aimed at encouraging women to engage with this area. In Brazil, there are several initiatives to mitigate this problem, such as “Meninas Digitais” (Project Digital Girls). This project is a Brazilian Computer Society Program that seeks to popularise the various Computer Science areas among female students of elementary and high schools in Brazil (Maciel, Bim, Figueiredo, 2018).
- Digital inclusion and accessibility projects: According to UNESCO, about 10% of the population has a disability. These people face several barriers, including within education. In developing countries, 90% of disabled children do not attend school (Hardy & Woodcock, 2015). Following the agreement of the Rights of Persons with Disabilities, adopted by the United Nations in 2006, some actions were instituted by the Brazilian government, among them the Inclusion of Brazilian People with Disabilities Law (Brazil, 2015), which requires that all students with disabilities are to be placed in mainstream education. Several projects have tried to reduce the difficulty for these students in using inaccessible teaching materials (Pletsch & Souza, 2017; Martins et al., 2019).
- Computer education for children: there has been a growing need to teach from Basic Education, fundamental concepts of Computer Science in order to improve the learning outcomes of individuals and enable the more efficient use of these technologies for the benefit of society, besides developing the ability to solve problems and to support other sciences (CSTA, 2011). In Brazil, there are a series of extension projects for the teaching of programming, using authoring tools such as Scratch (www.scratch.mit.edu/) and App Inventor (www.appinventor.mit.edu), Internet of Things with Arduino (https://www.arduino.cc/) or other computational tools within open education (França & Tedesco, 2015; Souza & Mombach, 2016; Rodrigues et al., 2019) and

open books on education through Computational Thinking, as presented by Martins and Eloy (2019).

1.2. Suggested support in the area of ICT and Education

New methodological practices in education can be enabled by ICTs. As Amiel (2018) points out, Virtual Learning Environments (VLEs) can be used not only as repositories of materials but also in the broader context of building links among users of the virtual environment. The knowledge of teaching and its action context, and making joint decisions in the design, planning and execution of training activities should all be taken into consideration.

In this sense, digital platforms and learning ecosystems can be used to promote experiences that have the potential to enrich the teaching-learning process in the school context. Therefore, it is necessary to create pedagogical strategies to approach students and teachers synchronously or asynchronously, face-to-face, or remotely. The computational tools currently available (many are free and online) support student groups in exchanging information and making decisions together in collaborative learning (Silva & Castro Filho, 2017; Amato et al., 2019).

In Brazil, in the context of active methodologies, the use of Serious Games, Flipped Classrooms, Problem Based Learning (PBL), and Computer-supported Collaborative Learning (CSCL) can be highlighted as they look to increase student motivation for learning and they are, usually, supported by the use of ICTs.

Another critical point concerns the digital literacy of teachers and students, as outlined by Freitas (2010), Amato et al. (2019) and Guerrero et al. (2020), as this area of literacy means that they can make use of these new methodological practices that are supported by ICTs.

1.3. ICT-based solutions in Brazilian schools

In general, Brazil uses the same ICT resources as other countries. However, its use is heterogeneous, depending on the educational system (public or private), the region in question, and the schools' locations in big cities or communities. For example, although Brazil is a significant Internet consumer (Amato et al., 2019) and about 86% of the adult population had their own mobile in 2015 (Nishijima, Ivanauskas, Sarti, 2017), digital access is not equal among inhabitants.

It is also worth noting that, on the one hand, there are private schools that offer a good quality of infrastructure and on the other, there are the public schools with the most diverse arrangements (some have a computer lab that works, other schools have no more than an idle or scrapped service, and so on.) (Amato et al., 2019).

For the most part the public education system has opted for the adoption of open technology solutions. Examples include Massive Open Online Courses (MOOCs) and free software, adopted in many public elementary and high schools.

The use of MOOCs increased significantly since they rose to prominence in 2012. Although there is already a significant number of courses in Brazil, MOOCs still need to be better structured. One of the challenges pointed out by Fontana and Leffa (2018) is the paucity of courses in Brazilian Portuguese (about 10% of the total) and this leads to the problem of students having to grapple with the English language. In contrast, the use of these MOOCs is very similar to in-person courses, with the teacher taking responsibility for the teaching-learning process, and being used as repositories of support materials to traditional classes (face-to-face classes).

From a macroeconomic point of view, the adoption of free software allows for a drastic reduction in the spending on software licenses, generating more sustainability of the process of the digital inclusion of the

Brazilian society and the computerization and modernization of enterprises and institutions (Silveira, 2018).

Despite the advantages presented by ICTs in schools, the use of these tools still presents a number of problems. In the context of primary and high school education, teachers have great difficulty in adapting their teaching strategies to the new technological reality, for reasons such as: i) lack of access to suitable hardware and software infrastructure in schools; ii) resistance to changing traditional teaching methods; iii) work overload; iv) lack of proper training; v) and a lack of technical support in schools (Silva et al., 2017).

1.4. Barriers to the effective implementation of ICT in Brazilian schools

Several factors contribute to the problem of the implementation of ICT in schools in Brazil, among them being the aforementioned lack of government investment in education in the country. This creates barriers in various issues such as the lack of digital literacy among teachers and the workload of teachers in schools (Amato et al., 2019). The study presented by Borba et al. (2015) suggests that teachers in Brazilian public schools (41.5%) are more affected than teachers from private schools (26.6%) by overworking leading to burnout. This underscores how teachers lack the time to prepare suitable material and to keep up to date on issues regarding ICT.

While there has been federal investment in teacher education since 1997 through specific programs (Educational Technology National Program - ProInfo (Brazil, 2018c) and Broadband in Schools program - PBLE (Brazil, 2018b), for example), it is necessary to change the focus of the initial and ongoing training in ICT, when offered. Currently, the technical field of technology is privileged, but it does not promote the development of the necessary skills for the teacher to integrate ICT into their pedagogical activities (Amato et al., 2019).

Regarding teacher training, MEC (Ministry of Education) sets general guidelines on the use of ICT in undergraduate courses in Brazil (Brazil, 1996). According to Dorneles and Chaves (2012), the guidelines address knowledge related to information technology, for example, in the Humanities, and establishes that professionals have, as in the Physical Sciences, the appropriate skills and abilities in the field of technology. However, with a more critical look, it can be noticed that there is also the concern of combining computing with the teaching-learning process; indeed, the guidelines point more to the field of Computer Science or at least that of computer use, rather than for the use of this instrument as an integrated means through which to teach.

1.5. Development of human capital through ICT

Brazil is a country with high rates of socio-economic and cultural inequality, and these factors, coupled with its continental size and massive geographical differences, all means that the use of ICT is fundamental to supporting the development of human capital across the nation. Soares (2019) points out that the use of ICT among citizens goes beyond their political rights, becoming more proactive in the context of individual and social guarantees. The author uses as an example the online public consultation, in which the appropriation of ICTs by the state suggests an attempt to modernize the dialogue with its citizens.

Alles and Cogo (2017), in turn, present a study of the use of ICTs as a way of promoting activism by Latin American migrant women living in the city of São Paulo, Brazil.

Jóia and Santos (2018) bring us the use of ICT as a tool that can ameliorate the problem of the lack of access to the financial system among the local population of the Marajo Island, in the Brazilian Amazon, through an infrastructure solution from a traveling bank agency located in a boat.

It is also noteworthy that in the Brazilian context, the highest prevalence of illiteracy and lower educational level is among seniors. Thus, the digital exclusion that devastates this population comes mainly due to a

lack of access to basic education in the past, especially considering that most of the population was illiterate until 1950 (Nishijima, Ivanauskas, Sarti, 2017). Digital inclusion projects for seniors, in this way, become paramount. Martins et al. (2019) offer in their study a list of recommendations for teachers on how to create accessible digital material for seniors.

1.6. The Business Sector and Education in Brazil in the area of ICT

The financing of the Brazilian public education system is at the heart of the problems and challenges facing Brazil. Education is a duty of the state, and the form adopted in Brazil is federative (França, 2016). Thus, public schools are almost entirely financed by governments (federal, state, or local) (Cury, 2018). Among the many laws created in order to finance public education in Brazil is Constitutional Amendment no.14/96, which brought about a redistribution of federal funds to states and municipalities through the creation of the Fund for the Development and Maintenance of Elementary Education and Recognition of the Teaching Profession, known in Brazil as Fundef; there is also, the expansion of compulsory education (4-17 years) to consider, introduced respectively by Law no. 9,394 / 96; Constitutional Amendment No. 53/2006 and No. 59/2009) and Law No. 13005/2014 which approved the National Education Plan (2014-2024).

Given the above, from the understanding of the role of the state in Education, there is a lack of government incentive and a profusion of bureaucratic barriers that prevent (or do not attract) the business sector to invest financial resources in public schools, a problem highlighted by Adrião (2018).

However, it is possible to find some private investments in education in Brazil. The Virtual School of Fundação Bradesco (https://www.ev.org.br/), the Ayrton Senna Institute (https://institutoayrtonsenna.org.br/pt-br.html) and the Lemann Foundation (https://fundacaolemann.org.br/) can be cited among the companies that promote education through ICT.

1.7. ICT and innovations in the Brazilian education system

The disparity between public and private schools in Brazil is clear and decisive concerning the innovation of ICT in these two contexts. Private schools have financial capital that allows investment in technological innovation in their classrooms. On the other hand, the lack of government investment in public schools across the country has brought disastrous results. However, some initiatives in the public education sector can be highlighted. Silva et al. (2017) describe the project "Promoting digital inclusion in public schools of basic education through the integration of innovative technologies of low cost in teaching Hard Sciences," which, since 2008, has been carried out by the Remote Experimentation Laboratory (RexLab) at the Federal University of Santa Catarina.

For many years, some initiatives have also provided innovation in schools. For example, in addition to school science fairs at regional, state, national and international levels, in the city of São Paulo, the Brazilian Science and Engineering Fair (FEBRACE) has been held since 2003. This scientific event is focused on Basic Education students and has a nationwide scope; it is sponsored by the Laboratory of Integrated Systems (LSI) at the Polytechnic School of the University of São Paulo (USP) (Silva & Infante-Malachias, 2016).

2. Methods

2.1. Research objectives

The general objective of the study was to present the opportunities, limitations and present status of the use of information and communication technology (ICT) in Brazilian schools from the distinct points of view of experts with different backgrounds. The main research problem was: What are the conditions for developing IT-supported education in Brazil? This problem included the following specific research questions: What are the ICT solutions that distinguish Brazil from other countries in terms of exporting

know-how? To what extent does Brazil's education system require support from other countries in implementing ICT? Which ICT-based solutions are most commonly used by Brazilian educators? What are the limitations related to the implementation of modern ICT in education for educators? To what extent does ICT develop human capital in Brazil? What is the link between the business sector and ICT education? In which areas is Brazil's education system innovative?

By showing the positive and the negative aspects connected with ICT, we might also present the present state of the development of media pedagogy in Brazil. The study was also motivated by a practical goal, that is, the transfer of knowledge about system conditions in European and Latin American countries, as part of an international joint research SELI.

2.2. Research tool

The study was performed using qualitative pedagogical analysis. For this purpose, the technique of the direct expert interview was employed. The tool consisted of seven open-ended questions addressed to persons who possess advanced knowledge about the use of ICT in education. The tool was evaluated by an international research team, members of which represented universities from Latin America and Europe. The tool included the following questions:

- Which solutions related to ICT in education could be transferred from Brazil to other countries?
- What type of support from other countries does Brazil need in the area of ICT in education?
- Which applications, websites or devices are used most often in Brazilian schools?
- What is the greatest barrier to the effective implementation of ICT in schools in Brazil?
- To what extent does ICT support the development of human capital in Brazil?
- To what extent does the business sector support schools in Brazil?
- What innovations are most often present in Brazilian schools?

2.3. Research procedure

The study was conducted in 2019, as part of the expert conference CBIE (*Congresso Brasileiro de Informática da Educação* – Brazilian Conference on Computers in Education) held in the capital of Brazil, Brasília. The research was one of the stages of the project SELI - Smart Ecosystem for Learning and Inclusion - ERANet17/ICT-0076. It was part of the WP2 working package - stakeholder dialogue on the opportunities of introducing the best ICT-related solutions to education. The research problems and procedure were planned by an international Polish-Brazilian team which was responsible for designing the tool and conducting the interviews. The Brazilian party was engaged in the sampling process, the preparation of the theoretical framework of the study, and the discussion of the research results. The Polish team was responsible for developing the research questionnaire, conducting the research during the CBIE conference, the transcription and analysis of the results, and writing the research report in the form of an academic paper. The study was carried out in English.

2.4. Sampling and characteristics of the respondents

The sampling was intentional rather than randomised, and was performed by the Brazilian team. The respondents had to meet several criteria: be available during the CBIE expert conference, have advanced knowledge of using ICT in education, be recognized by other researchers and practitioners (the recommendation system is commonly used as part of “snowball” sampling), and speak English. In this way, four in-depth expert interviews were performed. Out of the six experts invited, two did not agree to

participate due to the circumstances (lack of time, stress resulting from insufficient language proficiency). The synthetic characteristic of the sample is presented below.

Respondent 1 (R1): Female, a teacher, ICT specialist, leads research and implementation projects. Responsible for the implementation of solutions to support computational thinking in public schools. She has been working in the educational sector for 6 years. She seeks to develop educational strategies to improve logical and algorithmic thinking.

Respondent 2 (R2): Male, a professor in IT, received his doctorate in Spain, his professional focus is on using data in education and experiments related to data mining, statistics and data evaluation. He has over 20 years of professional experience in the higher education system and for 2 years he has been working in the education department.

Respondent 3 (R3): Male, a representative of the local government administration in Rio De Janeiro, works in the City Hall. He is responsible for supervising the education sector and has experience in training teachers and researchers whose focus is on education.

Respondent 4 (R4): Male, a researcher whose focus for the last 20 years has been on using technologies in education. He worked as a postdoctoral fellow in Stanford University and for the last 6 years has been working on developing computational thinking in primary schools. A member of the scientific and organizational board of CBIE - the biggest conference on ICT and education. He works in a private university and also has experience in the private business sector.

2.5. Ethics

The study was performed using qualitative pedagogical analysis. This means that the researcher (interviewer) has direct contact with the respondents. The research problems included an evaluation of: situations, education system stakeholders, solutions introduced by the government, and administrative conditions. Therefore, the respondents presented their individual opinions, often very critically. All the statements were subject to data anonymization. This is a typical data analysis procedure in qualitative pedagogical research where personal feelings, opinions and experiences referring to certain institutions are presented.

3. Results

3.1. Transfer of solutions based on ICT in education

According to one of the experts, Brazil struggles to equip schools with modern hardware but despite this challenge and its attendant limitations, analogue solutions and teacher creativity yield results. New products are developed, in line with the global trends to promote algorithmic thinking, coding and robotics. Many of these solutions are available as free teaching tools.

I am not sure because we face some difficulties in Brazil. Many schools have no computers or professional labs. We do not have much funds but we try to develop strategies to improve the use of ICT in education. I think Brazilians are very creative, children in particular. So we try, as much as possible, to develop creativity for example by using robots, small robots, analogue techniques. (R1)

Other experts also referred to coding and emphasized the importance of the national language to introduce the youngest generation to the coding languages. R4 points out that not everyone has a sufficiently advanced knowledge of English and they cannot use applications with more complex interfaces. Therefore, there are solutions in Brazil which successfully remove these barriers. According to the business sector representative, such products are unique and can be transferred from Brazil to education systems in other countries.

For example, we have a tool constructed by our team. It can be used by both children and adolescents. It is made in the national language so the applications can be used by people who speak Portuguese. Our application is for users who are not fluent in English. It allows students to learn logical programming faster than through other software. We also have software to program robots addressed to preschoolers. It is not typical robotics but rather configuring robots, we call it toy programming. We experienced that minimalist interface which facilitates teaching programming to the youngest kids. There are similar solutions in other countries but ours is dedicated to the youngest children and is extremely easy to use. (R4)

Brazil also follows the global trend of supporting small businesses which offer modern solutions to facilitate learning. R2 emphasized the importance of the national exams and opportunities to prepare for this type of key educational event through the websites which were launched for Brazilians. Many students use different platforms to move to the next stage of education.

I am not sure if we have something really great that could be introduced in other countries. We have different platforms created by companies here, in Brazil. Many startups as well as businesses have been operating for some years now. Some of them may be useful in other countries but they are not free of charge. For example, MyTutor platform. It is a great, complex site which offers, among others, access to the research results. This may be useful as a learning source. Such a platform can help students prepare for national exams and get to the university. (R2)

According to the local administration representative, the potential of Brazilian solutions is found primarily in those analogue methods which are then moved to the digital space. R3 said that combining digital and analogue practices with students' potential generates new, quality methods. Proven, successful case studies may turn out to be valuable solutions other countries can benefit from.

I do not know if we have technologies others countries do not have. For sure, we have some practice that can be transferred. And we have great projects with students. They learn faster through participating and using different technologies like tablets. There is also a group which does not do it. By combining the solutions used in both groups, one can accelerate development. It is a very interesting and effective solution. Each of these students have different experiences and this is valuable, when they meet, they can share their experiences. (R3)

According to the respondent who represents both the academic and business sectors, Brazil is a country with still unsatisfactory income and very diverse revenues. This limitation makes Brazil a country that faces the typical global problems associated with an underinvested education sector. In the opinion of R4, some solutions in the education sector can be transferred to those countries with similar economic conditions.

This is not a standard situation. We usually look for research results and solutions in other countries. Usually, the challenges in Brazil are similar to the problems other countries face. We have many solutions which can be introduced to indigent countries as Brazil is considered a low income region. (R4)

3.2. Suggested support in the area of ICT and education

One of the key factors in improving the effectiveness of teaching are the teachers themselves. Teaching staff are the key persons responsible for the implementation of ICT in learning and teaching. However, given the heterogenous level of digital literacy in this group, one of the experts suggested that special methodological support should be provided.

In my perspective, work with teachers is the greatest challenge. Pedagogues are not ready to work in this new world. In my opinion, we should change public policies ensuring methodological support for the teachers in the first place. Thanks to that we can reach the higher level of educational advancement. (R1)

According to the research sector representative, a lack of innovation is the main barrier. This factor is connected with the purchase of both hardware and software. In most cases, the implementation of new ICT-based solutions depends on proven hardware and software bought from foreign institutions. The same respondent points out the problem of poor Internet access in some remote villages (away from the bigger cities) where there are no basic educational resources like an Internet connection.

It depends on the technology. We are good at developing technology. We have many technologies. But most often we consume hardware. We do not create our own hardware solutions, just software. We slowly begin to consume not only the equipment but also software. More and more often, we also import software e.g. machine learning. It is not directly related to education but it shows the direction, the trends. This is a big issue because I feel we are still one step behind other countries. Another problem is the Internet access, for example in different schools. Our schools are underinvested, not all have good infrastructure. (R2)

When it comes to the trends in developing algorithmic thinking or coding, Brazil does not differ much from other countries. The representative of the government administration emphasized the key role of importing solutions from the regional leader, the United States of America.

We have learned a lot using knowledge and skills from the United States. It is the USA we take the most proven solution from, because this country has the best technology. We learn all the time and we take many solutions from the U.S. At present, we use SCRATCH most often. (R3)

In addition to the aforementioned issues of the lack of openness to innovations, the low digital literacy of some teachers and the trend of importing foreign solutions into Brazil, R4 emphasized the limitations connected with the lack of cooperation between the sectors which, by definition, should be responsible for the quality of education. The respondent said that only advanced cooperation between researchers, commercial institutions and schools could result in the synergistic development of new and valuable educational solutions.

I feel that in Brazil we are not ready to create ICT and education products based on the methods proven by scientific research. Many solutions to support developing students' competencies are very expensive. It would be very interesting to import visions of the market and education from other countries. At present, the narrative in our country is dominated by the group which is not very open to market innovations. We should be more open to the university-market-education relationship, like in other countries. This proves some maturity and it is related not only with the material aspects of ICT. (R4)

3.3. ICT-based solutions in Brazilian schools

According to the first respondent, Brazil fits into the global trends of teaching coding in schools. Usually, schools use free software, not only because they are popular solutions but also to minimize the costs associated with edu-software. Despite their positive evaluation, many applications and solutions are not included as teaching methods due to financial limitations.

In Brazil, Scratch is now very popular. But it's worth pointing out that ScratchJr is not often used because it requires tablets. Our schools do not have many tablets. In our schools, we often use "serious games" but it is important that this content is free of charge. This technology is of value but, unfortunately, our schools do not have much financial resources to buy all effective solutions. (R1)

The problem of limited finances affects the extent to which ICTs are used to teach different courses, not only those focusing on introduction to information technologies or IT. Aware of these limitations, teachers use free equivalents or try to move educational content to the applications that are available in their schools. Financial barriers translate into the means by which ICT is used by the teachers and students.

I think the best solution is to combine analogue and digital methods because it really works. One of the examples is programming, algorithmic thinking. Brazil faces many economic and social problems. Unfortunately, not everyone can buy good computers and smartphones. If we want to do a good job in education, we have to think about some limitations. Therefore, we very often use simple and free software, websites and applications. It is free applications and websites that are used most often due to the limits resulting from the economy. Teachers use what they have at hand. For example, mathematicians use spreadsheets. Visual art teachers use free graphics editors. We use different available software, depending on the lesson content. (R3)

The global nature of modern education is also recognisable when it comes to the use of selected websites. Some websites are used in a similar way both in Europe and Latin America as well as on other continents. Not only are some websites popular globally, but some issues connected with robotics, ready modules to teach robotics, 3D printers or applications to support the improvement of other key competencies (like foreign languages or mathematics) are also growing in popularity all over the world.

KhanAcademy is getting more and more popular. Many people use it. Teachers use YouTube very often, they also use Lego to develop robotics. They also begin to work according to the "hands-on" concept, trying to include different elements into the learning process, for example 3D printers. There are also quite a few applications which are used to teach Portuguese and math. They are not widely used applications, only some use them. (R2)

In R4's opinion, ICT use in Brazilian schools is limited due to the several factors already mentioned. First, there is the low level of digital literacy. Very often, methods of instruction are transferred into digital didactics but they do not generate new value. Many researchers, including R4, point out that most frequently, teachers use multimedia presentations and other elements of the office package. However, these are classic solutions. What can convince teachers to use certain software is its inherent usefulness and those functions that can relieve them in specific areas.

I think teachers do not use technologies very often "in the real world". This is tragic but very true. ICT is mainly used to create PowerPoint presentations. It is very hard to find a public school with good results in this area. Of course, there are exceptions but this is the general tendency. We have data from two years back, saying that 80% of schools have laboratories and Internet access. In these laboratories, teachers use text editors, spreadsheets and presentations. It seems that if there is a technology which teachers find convincing, they automatically implement it. If something is considered as a facilitator of the teacher's life, they will use it because teachers are in general overwhelmed by their responsibilities and are searching. (R4)

3.4. Barriers to the effective implementation of ICT in Brazilian schools

The teachers' workload is a key issue mentioned in the narratives of the education experts. In addition to didactic classes, teachers are obliged to perform administrative and educational activities. Their main responsibilities, however, involve didactic activities which require different amounts of time depending on the country or region. The first respondent points out the problem of too many teaching hours, which is an obstacle to the professional self-development of teachers, in ICT as well as more generally.

Our teachers do not have time to learn new things during the day. They work 30 hours a week teaching. This is too much to invite teachers to engage in professional development. The only solution is to reduce didactic hours so they have time to learn, for example how to use new software or devices. (R1)

Other respondents see the preparation of the prospective teachers as one of the factors that blocks the effective implementation of ICT in schools. Academic teachers and researchers who train future educators do not use ICT themselves, thus leading by negative example. In some cases, limitations result from

outdated academic curricula in which courses like information technology or media in education have an insufficient number of hours or the content does not match the challenges faced by modern schools.

My experience shows that also the academic staff who prepare the prospective teachers have big problems using ICT. They have little knowledge of how to use Google Drive, discussion lists, spreadsheets. They have many problems with ICT in education. (R2)

The same respondent also refers to teacher education and professional development. Given that the study was conducted during the biggest Brazilian conference on computers in education, it was perhaps surprising that so few teacher-practitioners took part in the event. According to R2, this proves that there is insufficient engagement among teachers in lifelong learning.

I think that the greatest barrier is the gap between teacher preparation and activities implemented as part of teacher training, for example this conference. At CBIE, we have many researchers of ICT but very few participants responsible for training the future teachers who should use ICT. (R2)

The respondent continued by pointing out that preparing teachers to use modern technologies in teaching and learning is not considered a priority. This aspect is ignored in the official narratives or strategies addressing the improvements in the academic curricula. With his experience in didactic work with prospective teachers (students of educational sciences), the respondent emphasized that digital literacy in this student group is low. Digital literacy and motivation are the starting point for a discussion about the barriers that affect the implementation of ICT.

We should pay more attention to the official curricula which prepare teachers to work. Teacher training system has some serious gaps. I do not see too much discussion in this subject. It is a taboo. I had seen it when I worked in the education department. My pedagogy students lacked basic competence, for example they did not know how to create a website. (R2)

According to the experts interviewed, the training prospective teachers is a major challenge. The third respondent also referred to this area. He also pointed to the teacher-student relationship. R3 said that the lack of key competencies in the effective and creative use of ICT decreases the quality of education, in terms of student achievement as well as in other areas. Of course, such a relationship consists of many factors beyond those mentioned by R3.

Preparation of teachers and prospective teachers and economic conditions are the greatest challenges. Our teachers are not ready enough to use ICT in school. It is a simple relation, if you do not have a good and creative teacher, you will not be a good student. This relation is an important barrier not only in the area of ICT implementation. (R3)

Each of the four respondents highlighted the insufficient preparation of teachers to use ICT. R4 added that in his opinion, this is a global challenge. We may also connect this fact with the changes brought about by the rapid development of technology and, consequently, the development of the information society. However, the main differentiating factor appears to relate to how ICT is used by students and their teachers.

Teacher preparation is a global problem which exists not only in Brazil. During their studies or training to become teachers, this group is not ready to use technologies. Also, within lifelong learning, teachers do not have access to enough quality courses supporting them through ICT tools. Another problem is the way laboratories are used. (R4)

According to the academic and business sector representative, there are major discrepancies between schools. The education system in Brazil is not homogeneous due to divisions between the private and public sector. The first receives more investment, in terms of computer laboratories as well as in other

regards, whereas the latter struggles with the aforementioned financial and administrative limitations. What they have in common is the low level of digital literacy among teachers.

We have two separate worlds here. Private and public education sector. The private sector employs new technologies very often, the schools are well equipped, teachers have excellent working conditions though they do not always use ICT in the right way. Thus, they have freedom to create and experiment. In the private schools they have many problems with funds and teacher training. Teachers in public schools have big difficulties using ICT. Many pilot projects have been implemented but none of them have been introduced permanently as a mass solution. Most often, schools build a laboratory and there is always a person responsible for offering teachers some ICT-based solutions. But all this is somehow limited and poor if we think how it is supposed to work. (R4)

3.5. The development of human capital through ICT

The expert researcher (R2) had mixed feelings about the present state of ICT development. He emphasized that apart from the positive aspects, advances in ICT generate many challenges. Such challenges include problematic online behaviors, among them manipulation and misinformation. This is a valuable point in the context of developing digital literacy, which is defined not only as the constructive use of ICT but also as the development of digital safety competencies.

People should think more critically about what is behind the technology. I am a bit scared by what is happening. Today, technology creates many bubbles connected for example with misinformation. Technology may help us look more skeptically at what is now going on, especially in the younger generation. I am not sure how to do it using ICT but I know it is possible to develop basic skills using IT devices and websites. (R2)

In Brazil, there are people who have no basic key competencies, and this creates social divisions. According to R3, learning how to use ICT may facilitate social inclusion, increased employment, and general personal development. Thus, ICT becomes an attractive tool in advancing the wider concept of social inclusion.

There are many people who cannot read and write. For these people ICT may become a window to the world. Many poor people may use ICT for self-development or to find employment. (R3)

Another respondent added that the development of the information society forces people to become more digitally literate. Like the previous respondent, he also believed that in this case ICT provides an opportunity to create inclusive solutions. But the recurring question is the problem of the frequency and direction of the application of ICT.

I think that technology creates many opportunities related to work. I believe technology may be useful for inclusion and levelling the inequalities. Plus, technology should be used much more often. Many of the existing jobs will be replaced by ICT and this gives us different opportunities. It is not the question of choice but the necessity that is coming. (R4).

3.6. The business sector and education in Brazil in the area of ICT

According to the first respondent, cases of commercial institutions investing private funds in education are not numerous. The main goal of the business sector is to generate profit; however transfers of this type do occur in private schools.

We do not have many examples of business supporting schools. Sometimes and mainly private schools are supported by private institutions. It is estimated that about 30% of students in Brazil learn in private schools. These institutions receive much more financial support from parents and not only. (R1)

Sometimes, following the principles of corporate social responsibility and tax optimization, public trust institutions in Brazil invest in equipping schools. But, like in other countries, this is also the focus of the representatives of the third sector - associations and foundations.

There are different foundations and projects launched, for example by banks. They use taxes to develop projects. These organizations provide access to devices, computers, tablets for our students. The work of schools is supported mainly by NGOs. (R2)

According to the representative of the research sector, one problem is the quality of the support offered to schools as part of centralised interventions. In his opinion, the quality of software, its adaptation for those with special educational needs, its compliance with the core curricula, and validation during the learning and teaching process are the principles the business sector should focus on when creating educational solutions for schools. The eventual implementation of proven solutions should take into account the heterogeneity of students and the current needs of the teaching staff.

The previous government tried to establish an organization which was supposed to transfer proven, modern solutions to schools. But due to political reasons, this is a very wide issue. It is a difficult topic because it is hard to simply transfer some solutions as no one knows fully the present prices of educational products and also very few people know what works well and what does not in the context of education. There was an option that institutions which offer ICT-based solutions for education would send their products to the government which, in turn, would distribute the resources among the schools. Thinking of collaboration, other aspects of transfer should be considered such as: usability, interoperability or general quality of the products. In case of technology transfer, it is also worth evaluating the quality, adequacy and relevance of the content and its compliance with the Ministry guidelines. Unfortunately, big companies hardly ever focus on the issue of availability of their equipment for people with deficits (e.g. impaired sight or hearing). Businesses do not help schools directly but they should cooperate with them closely as they design and develop certain technologies. (R2)

R3presented an interesting point of view by emphasizing that schools prepare future business staff. Thus, the business sector should be interested in supporting educational institutions. But, as R3 then points out, every sector is responsible for its own domain. School support should be the focus of the local authorities and the central government (ministry) rather than institutions whose main goal is to gain profit.

Business and schools should prepare students to perform their profession. Helping schools is rather the role of administration and the government than business. Businesses are private institutions which focus on something else. (R3)

The business-education relationship brings with it many concerns and critical comments. R4 points out that solutions implemented in schools are not always adequate or proven. There are many cases where due diligence in purchasing hardware is lacking, and where software was bought and then was not used properly by the teachers. According to the respondent who knows the business sector, schools or administration choose solutions which are promoted effectively. Presenting such solutions as if they were surrounded by a kind of 'aura' of modernity results in schools or institutions being led to choosing solutions that do not fit their context.

We have quite many companies in Brazil, which produce great educational software. Unfortunately, these businesses are not in close contact with the people responsible for creating social policies and researchers. There is a communication gap between these important players. It would all work better if there was a common ground for communication between business, education and politicians. We have many technologies which are in schools not because they are really good but because they are well promoted and marketed, their websites are attractive. Such products sell. Many government institutions buy

educational products because they are successfully promoted not for their educational value. The government buys and shows how modern they are. (R4)

3.7. ICT and innovations in the Brazilian education system

As for innovation, the division into private and public schools is also mentioned as being relevant. According to R1, private schools can afford to experiment more than public schools. This results from the better equipment they have at their disposal, among other factors. As innovations, R1 lists Google tools and tools supporting coding competencies.

Private schools have many computer laboratories. I know examples where Google tools are used very often. Also external applications to develop "computational thinking" are popular. The main innovative activities are undertaken in the private schools, public ones are much behind. (R1)

Brazil does not differ from other countries in many aspects of using open educational resources. One of the examples of innovative approaches is integrating OER, like Khan Academy, into the official curricula. But we must point out that the respondents understood the term 'innovation' in different ways.

Schools use mainly platforms like Khan Academy and similar. (R2)

Innovation in education is a complex issue. According to the university representative, the incorporation of new solutions into learning depends on the individual. Teachers who are not afraid to experiment and hold basic digital competencies are open to new solutions which can be the chance to introduce new ICT-based means, forms and methods into their own working environment. Innovative thinking is a very individual aspect.

Brazilian education is very poor compared to other countries. We are not quick in introducing innovations. But we can identify many teachers who are innovative. In every school there is someone who introduces new things. It is easier to introduce innovations in the cities than in remote locations. But this is not a fixed tendency. Not everyone is innovative, not everywhere. (R3)

R4 presented an interesting perspective when he said that change in education may begin with technology. The implementation of new solutions facilitates modernization. This is even more the case because in the common and scientific narrative, the transformation of the school systems is still an ongoing and relevant challenge. R4 also points out that innovations in education in the area of ICT vary depending on the region as in Brazil there are networks of schools and areas with higher levels of innovation than others.

I know schools which provide great learning environments. Not to consume but also to use technologies in creative ways. There are also schools which employ ICT to encourage entrepreneurship. I know many such schools in northern Brazil. I also know great schools in Curitiba and Parana. There is a network of schools which have their own system to train teachers and carry out classes. These schools, functioning in the "S" network, may inspire others how to work with technology. In general, now is a good time to change education in Brazil because people are tired with the existing state of schooling. Technology becomes the first opportunity to change education. (R4)

4. Discussion

As pointed out in the Theoretical Framework (Amato et al., 2019), investment in education in Brazil is relatively scarce; there have been some efforts by the federal government to change this, and there are some examples of useful initiatives in ICT in Brazil that have been led by the government (Brazil, 2017a), (Lavinas, Veigas, 2013), (Brazil, 2017b), (Brazil, 2018a), (Brazil, 2018b) or actions to bring the universities closer to the community (Maciel, Bim, Figueiredo, 2018), (Pletsch & Souza, 2017), (Martins et al., 2019), (França & Tedesco, 2015), (Souza & Mombach, 2016), (Rodrigues et al., 2019), (Martins & Eloy 2019).

This is corroborated by the respondents to the interviews, who point out that despite the government's efforts, many schools still lack the infrastructure for digital inclusion, and sometimes public schools have to make use of free solutions or integrate digital and analogue practices.

Below, the main aspects related to the theme are presented.

Table 1. Main points about the transfer of solutions based on ICT in education to other countries from Brazil

- The effort by the Brazilian government in ICT in education is not sufficient.
- Many schools still lack infrastructure for digital inclusion.
- There are some projects (by the Federal government or by universities) that seek to improve ICT in education.
- Public schools use free solutions.
- A combination of digital and analogue practices can be seen in public schools.

Regarding the suggested support in the area of ICT and education, according to the literature (Amiel, 2018; Silva & Castro Filho, 2017; Amato et al., 2019), new methodological practices in education can be enabled through ICTs such as Virtual Learning Environments (VLEs), which are a link between students and teachers and enable active teaching-learning methodologies. On the other hand, and this is true mainly in public schools, there is a lack of lack of digital literacy on the part of the teachers themselves, impacting the use of new methodologies.

The respondents' opinion supports the idea that there is a lack of digital literacy, in addition to the fact that, as might be expected in such a large country, many isolated schools do not even have access to the internet. Finally, there is the pessimistic view of one of the interviewees that Brazil is not prepared to create ICT and educational products. In Table 2, there are the main aspects discussed here.

Table 2. Main points about suggested support in the area of ICT and education

- Virtual learning environments can be used.
- Some Brazilian schools use active teaching methodologies that incorporate ICTs.
- There is a lack of digital literacy on the part of teachers
- Some remote schools don't have an internet connection.
- Brazil is not ready to create ICT and educational products.

On the topic of ICT-based solutions in Brazilian schools, Brazil uses the same ICT resources as other countries, but the situation is heterogeneous, being dependent on the educational system (public or private), the region and the school's location (Amato et al., 2019).

In the public education system, there are actions to adopt open technology solutions, such as MOOCs. Here, the lack of digital literacy appears to be a problem along with overloaded teaching timetables and a general resistance to the use of ICT (Amato et al., 2019), (Silveira, 2018), (Silva et al., 2017)..

The respondents also understand that there is a lack of infrastructure for the use of ICTs in public schools, as well as that public education has been moving towards the adoption of free technological solutions and

the lack of digital literacy and work overload. They also highlight the financial barriers to the implementation of ICT solutions in public schools.

On the other hand, they also report the underutilization of ICT in schools, these resources being used only for the creation of digital didactic material such as PowerPoint presentations or other resources in the Office package. In Table 3, these main aspects are summarized.

Table 3. Main points about ICT-based solutions in Brazilian schools

- Brazil uses the same ICT resources as other countries, but in a heterogeneous way.
- Adoption of free technological solutions in the public schools.
- Digital literacy, work overload and financial barriers.
- Underutilization of ICT in schools

Educational agents, from governments to students, face many barriers in the effective use of ICT-based solutions in Brazilian schools. The absence of digital literacy among teachers is often perceived by respondents as an important point to be addressed - this is also consistently mentioned in literature, as in Freitas (2010) and Guerrero et al. (2020). This is due mainly to the lack of governmental funds designated for teacher training, but also to the workload for teachers who choose to take on longer hours to supplement their low incomes, especially in the public educational system, which means that many work simultaneously in two, three or even more schools. As a result, such teachers lack the spare time to invest in lifelong learning programs.

The low-level of self-confidence among teachers about using ICT in schools was present both in the literature and in the respondents' feedback. These stem from the gaps in many teachers' initial training and ICT-related experiences, and the, perhaps unfounded, notion that the students would deal better with digital technologies than they could themselves. This causes a sense of discomfort, since this situation is still a challenge, defying the traditional roles commonly established in regular classrooms. Qureshi et al. (2009) and Chikasha et al. (2014), for instance, mention this uncomfortable zone in different contexts, making clear that this situation is not exclusive to Brazil.

Table 4 presents a synthesis of the above-mentioned aspects.

Table 4. Main points about the barriers to the effective implementation of ICT in Brazilian schools

- Insufficient governmental investment in education
- Lack of teachers' digital literacy
- Teachers overloaded with work.
- Lack of time for teachers to invest in continuing ICT training.
- The federal government establishes general guidelines on the use of ICTs in undergraduate courses in Brazil, but there is still no move to combine information technology with the teaching-learning process, mainly in the Humanities
- The insufficient preparation of prospective teachers is one of the factors that block ICT implementation in schools

- The teachers are not sufficiently prepared to use ICT in school
- The lack of key competencies in the effective and creative use of ICT decreases the quality of education.

The development of human capital through ICT is considered by the respondents to be a key aspect of capacity-building actions in the Brazilian context. The respondents all consider ICT to be an extremely important supporting tool for inclusion, leveraging formation and empowering people to face the quotidian difficulties . All of them point out ICT-supported human development as a way to reduce inequalities.

ICT as a means of providing more inclusive educational opportunities appears, more or less explicitly, in all of the interviews. All of the respondents mentioned ICT tools as potential resources for helping people with different disabilities or those facing a disadvantageous situation regarding access to formal education as well as other different learning opportunities. The key aspects found both in the interviews and literature are summarized by Table 5.

It is important to highlight that the respondents' views about development of human capital through ICT strongly agree with the supporting scientific literature - Alles and Cogo (2017), Jóia and Santos (2018) and Soares (2019), for instance. Additionally, Pillai (2011) and Jiang et al. (2019) show that similar approaches have been adopted in other underdeveloped and in-development countries in Asia and Africa.

Table 5. Main points about the development of human capital through ICT

- The use of ICTs is fundamental in supporting the development of human capital in different Brazilian regions and contexts
- ICT provides an opportunity to create inclusive solutions.
- Learning how to use ICT may facilitate social inclusion, employment, and general personal development.
- The development of the information society forces people to gain digital literacy.
- Technology may be useful for inclusion and levelling inequalities.

Regarding the relationship between the productive and educational sectors in Brazil in the area of ICT, all respondents coincide with França (2016), mentioning that the financing model and bureaucracy are the main barriers to the wider participation of enterprises and actors from the productive sector in public schools. Even in private schools, those that are maintained by individuals or companies, the presence of the productive sector is not so relevant in educational actions, even though they tend to be more frequent contributors than in public schools. Table 6 synthesizes the main elements raised by the respondents regarding this question, along with those found in the literature, mainly França (2016) and Adrião (2018).

Table 6. Relationships between business and educational sectors in Brazil

- Public schools are almost entirely financed by governments (federal, state, or local).
- There is a lack of government incentives and bureaucratic barriers that prevent (or do not attract) the business sector to invest financial resources in public schools.
- There are some examples of private investment in education in Brazil.
- Some private schools are supported by private institutions.
- School support should be the focus of local authorities and the central government (e.g., Ministry of Education) rather than institutions whose main goal is to turn a profit.
- Many government institutions buy educational products because they are successfully promoted and not for their educational value.

On the topic of ICT and innovations in the Brazilian education system, the respondents were not unanimous in their considerations. Two respondents mentioned that private schools were more open to innovative initiatives, as a consequence of having more direct access to supporting funds. However, innovation is also seen at public schools, though most initiatives are pushed by the teachers, many of whom have innovative attitudes even though the school itself does not. In any case, ICT plays an essential role in facilitating the implementation of innovative practices.

The role of teachers in stimulating innovation in schools is also present in the literature, even in different contexts. In Moreira et al. (2019) and Moreira-Fontán et al. (2019), for instance, the proactive attitude of Spanish teachers in proposing innovative approaches in their schools is discussed in detail.

Table 7 presents a summary of the central points listed by the participants about innovation in the Brazilian educational system.

Table 7. Main points about ICT and innovations in the Brazilian education system

- Private schools have financial capital that allows investment in technological innovation in their classrooms.
- Some initiatives in the public education sector provided innovation in schools.
- Private schools can afford to experiment more than public schools
- Although Brazilian education does not have many innovations, many teachers are innovative.
- Change in education may begin with technology.

5. Conclusion

This paper presented a qualitative analysis of the panorama of use of ICTs in Brazilian schools. From the interviews with four experts linked to education, but working in different areas (the academic sector, the

implementation of practical activities in schools, pedagogical supervision, and the development of commercial software), it became apparent that Brazil faces similar problems to other countries: the preparation of teachers in the use of ICT, supplying schools with high-speed and up-to-date hardware and software, encouraging teachers to use ICT, the re-constitution of educational policies, and changes in administering IT resources in schools (Arteaga et al., 2020).

Although Brazil has the resources to develop new products in the area of technology, mainly software aimed at education, and which respects Brazilian culture, such as the local language, there is a tendency to seek out the results of research and solutions in other countries. Generally, schools that have programming teaching or computational thinking in their programs use imported authoring tools such as Scratch (www.scratch.mit.edu) and App Inventor (www.appinventor.mit.edu) or for the Internet of Things make use of Arduino (https://www.arduino.cc/).

Regarding the support of ICTs in education, one point to be highlighted regards the knowledge about the use of technologies among teachers. Despite the development of technological skills, Brazilian educators are not yet prepared to support a digital culture in schools. This denotes the need for initial and continuing teacher training in digital literacy. Another point that interferes with the support of ICTs in education concerns the poorly distributed infrastructure in the country. While in large urban centres schools concentrate resources such as internet access, laboratories equipped with computers and / or tablets, this reality is not the same in poorer and more remote or rural areas, which highlights the gap in the public policies of universal access to the Internet, the provision of devices, and digital inclusion (Ziemba, 2019).

Some Brazilian schools, mainly private schools, use technological resources, such as specific applications to support classroom learning in different subjects such as Mathematics, Portuguese or Foreign Language. However, in most public schools with limited technological resources, ICT use extends only as far as PowerPoint, text editors, and spreadsheets. Some schools make use of free technological solutions, such as massively open online courses (MOOCs) and free software.

One of the barriers to the effective implementation of ICTs in Brazilian schools is the high number of hours that teachers spend working in the classroom. Many of them, to supplement their income, have three work shifts (morning, afternoon and night), which makes continuous training in the use of ICTs particularly difficult. It is worth remembering that teachers were not instructed in the use of ICT in their pre-service training. Despite policies for digital inclusion in academic curricula and programs for teacher training (such as the National Educational Technology Program - ProInfo), preparing teachers to use technologies in teaching and learning is not considered a priority (Tomczyk & Oyelere, 2019).

Technological advances generate many challenges such as problematic online behavior and the manipulation of information, both of which must be considered in the development of digital literacy, requiring more critical thinking about what is behind the technology before adopting its use in school. That is why teacher monitoring is essential to guide and monitor the use of technology among students. When used well, ICTs offer an opportunity to create job opportunities and inclusive solutions (Stosic, 2017).

Although the school has the role of preparing future business employees, private Brazilian companies do not invest in technological resources in Education. Sometimes, some large commercial institutions do support schools, especially private ones, providing students with access to devices, computers and tablets in exchange for relief from tax payments to the federal government.

Regarding ICT innovation in the Brazilian educational system, due to socioeconomic differences, private schools have greater potential to experience new challenges. The incorporation of new solutions in learning depends on the individual: in this context, that involves teachers who are not afraid to experiment, have basic digital skills, and are open to new solutions.

Finally, it is important to note that despite the efforts of public and private institutions in Brazil to promote the use of ICTs to support the teaching and learning process, there is still much to be done to strengthen the role of the school in digital culture. This must likely start with the initial and continuing training of teachers, the adaptation of the curriculum, and changes to the administration of IT resources, and must lead to the development of internet access infrastructure and the implementation of computer labs in the poorest regions of the country (Tomczyk et al., 2019; Stosic, 2015).

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