

Digital technologies, current trends and the future of education

Technology and education: the legacy of the experiences of the COVID-19 pandemic for the future of schools

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Introduction

One of the health measures employed during the COVID-19 pandemic in 2020 was social isolation, which resulted in education institutions being closed and classrooms impossible to use. This decision was taken suddenly and changed the face-to-face teaching approach adopted by Basic Education schools to one called “remote teaching”, or “remote emergency teaching”.

The impossibility of using classrooms caused numerous difficulties, but also left an important legacy. The solutions that were created and implemented in some schools show that teaching and learning processes that had previously been classroom-centered can take place in other places, and that digital technologies can be important

allies in education, helping with access to information, the carrying out of the proposed activities, and interaction between students and teachers, and between students. All these lessons helped ratify and expand the initiatives that have been presented since the early 1980s, especially with regard to the integration of digital technologies in the classroom (Valente & Almeida, 2020).

The purpose of this article is to briefly discuss the legacy of the development of the projects and proposals that preceded the pandemic, and the experience of the health crisis itself, in order to consider what education and the future of the school might be like in the light of the experiences of the last couple of years, which have left indelible marks on the lives of children, young people, and adults.

A brief analysis of public technology policies in Brazilian education

The federal government's initiatives to introduce educational technologies in Brazil originated in the 1980s. Based on the EDUCOM project of 1985 (Andrade & Albuquerque Lima, 1993), different programs and projects were created that dealt with the subject, culminating with the one-on-one situation proposed by the One Laptop per Student (*Um Computador por Aluno* – UCA) project.

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/Internet Sectoral Overview



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Then came the Connected Education Innovation Program (*Programa de Inovação Conectada* – PIEC), which merged the responsibility of public authorities with that of organizations from different sectors. The actions that were developed over the decades provided for: the setting up of research centers, and the training of higher education researchers, as well as countless multipliers-teachers linked to the Educational Technology Centers (*Núcleos de Tecnologia Educacional* – NTE) that were established in most regions in the country; the introduction of a computing infrastructure, such as computer labs and an Internet network in public schools, and; other initiatives, such as the development of equipment, the creation of teacher portals, and the specialization course in Education in Digital Culture (Valente & Almeida, 2020).

A broader panorama of the information and communication technologies (ICT) policies in Brazilian education is available in the timeline shown below (Table 1). These policies, however, were never introduced in a consistent manner (Almeida, 2014; Andrade & Albuquerque Lima, 1993; Valente & Almeida, 2020). What is notable is the absence of projects that are capable of establishing actions that are balanced between their objectives, the training of teachers and managers, the creation of digital educational resources, changes in curriculums and learning assessment methods, and the technological infrastructure required to support the use of digital technologies that are integrated into curricular activities in the classroom. In this sense, analyzing the legacy of the past with regard to the gains, difficulties, mistakes, and challenges can provide the foundation needed for designing the education of the future.

Table 1 – TIMELINE: ICT POLICIES IN BRAZILIAN EDUCATION

YEAR	PROGRAM/PROJECT	COORDINATION	INSTITUTIONS INVOLVED	OBJECTIVES	RESULTS
Year created 1984 Year introduced 1985	EDUCOM	Informatics Center of the Ministry of Education (CENIFOR/-MEC)	MEC; Electronic Information System (SEI); National Council for Scientific & Technological Development (CNPq); Study & Project Funding Agency (Finep); Brazilian Educational TV Center Foundation (FUNTEVE); specialists/researchers in Informatics in Education	To encourage the development of multidisciplinary research on the use of technologies in teaching and learning	Research and Development Centers for Informatics in Education were set up; five pilot centers in public universities were implemented; researchers and professors from the universities involved and the schools where the pilot projects were carried out were trained; a culture of educational informatics was created in the institutions involved
1986	Immediate Action Program in Informatics in Basic and Secondary Education	MEC	MEC; specialists/researchers in Informatics in Education	To maintain and reinvigorate technical and financial support for pilot centers; to invest in training human resources	Nineteen Centers for Educational Informatics (Cied) were set up with the state Departments of Education, as were fifteen Centers for Informatics in Vocational Education (Ciet) in federal vocational schools, and eight Centers for Informatics in Higher Education (Cies) in public universities; the FORMAR project, aimed at preparing facilitators who are responsible for training school teachers was introduced
Year created 1989 Year introduced 1992	1st National Educational Informatics Program (PRONINFE)	General Secretariat of MEC (1989); Department of Secondary & Technological Education (SEMTEC) (1990)	MEC; General Secretariat of MEC	To carry out training actions at all three levels of education; to use computers in teaching practice; to integrate, consolidate and expand research; to share experiences and knowledge in the area	No results – no actions carried out

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YEAR	PROGRAM/PROJECT	COORDINATION	INSTITUTIONS INVOLVED	OBJECTIVES	RESULTS
1997	National Program for IT in Education (ProInfo)	MEC; Department of Distance Learning (Seed); Experimentation Center in Educational Technology (CETE)	MEC; Seed	To improve educational processes; to encourage the creation of a new cognitive ecology by incorporating technologies, aimed at scientific and technological development in schools, and education for global citizenship	262 Educational Technology Centers (NTE) were set up; 2169 teacher-facilitators were prepared for training school teachers, and for monitoring and assessing actions; laboratories were introduced in 4629 schools; eight National ProInfo Meetings (1997 to 2002) were held; 4036 managers, 137,911 teachers and 10,087 technicians were trained; six million students benefited; Municipal Technology Centers (NTM) were set up; ProInfo State Coordination Offices were created in state Education Departments; a Virtual Interactive Education Network (RIVED) was introduced to produce digital learning content (120 objects created by 2003)
2007	Integrated ProInfo	MEC; Seed; programs with integrated actions: ProInfo, School TV, In-service Teacher Training Program (Proformação), School Radio	MEC; Seed; Department of Basic Education (SEB)	To provide interaction between different projects, initiatives and resources aimed at the use of technologies in school through actions to boost the implementation of ICT in public schools, involving infrastructure, training, digital content, interaction, communication and virtual communities	The Integrated ProInfo extension course was made available; the Media in Education, Rural ProInfo, Urban ProInfo, Broadband in Schools programs were introduced, and Public Domain portal and International Bank of Educational Objects (BIOE) were set up; technology devices were developed and distributed
2007	One Laptop per Student Project (UCA)	MEC		To promote the use of laptops in one-to-one teaching situations for students and teachers of some 350 public schools, with the aim of improving the quality of education, promoting digital inclusion, and having the Brazilian production chain included in laptop manufacturing and maintenance processes	A digital culture was created in those schools that had the necessary conditions for using connected laptops; teachers were trained to work with technology when developing their curricular activities; Law no. 12.249/2010 was passed, which set up the One Laptop per Student Program (PROUCA) and instituted the Special Regime for the Acquisition of Laptops for Use in Education (RECOMPE)
2017	Connected Education Innovation Program	MEC	Innovation Center for Brazilian Education (CIEB); Ministry of Science, Technology & Innovation (MCTIC); Brazilian Development Bank (BNDES); National Council of Secretaries of Education (Consed); National Union of Municipal Education Leaders (Undime)	To support high-speed Internet access; to encourage the use of digital technology in Basic Education; to train professionals; to provide digital content; to invest in equipment; to support schools and education networks in technical and financial terms	

Source: Prepared by the authors.

PHOTO: Adriana Vichi



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The mark of the COVID-19 pandemic

Despite the different programs and projects (Table 1), the absence of a consistent policy was felt during the pandemic, and there were numerous repercussions as a result (Barberia *et al.*, 2020, 2021). The lack of preparation in schools, especially with regard to the use of technologies that are integrated into curricular activities, caused problems related to teaching, technological infrastructure, and support for teachers and the families of students who were confined to their homes.

TECHNOLOGICAL INFRASTRUCTURE

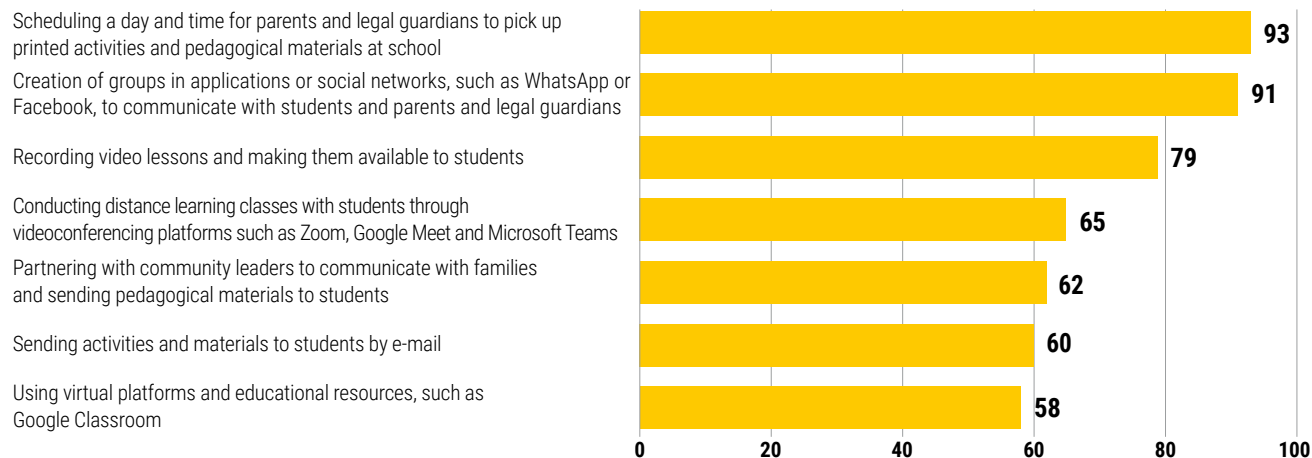
Different class formats, and a variety of uses of technological resources were noticeable, revealing inequality in terms of the technological infrastructure that exists in the more precariously-structured public and private schools, and in students' homes.

The ICT in Education 2020 survey (COVID-19 Edition – Adapted methodology), carried out by the Regional Center for Studies on the Development of the Information Society (Cetic.br|NIC.br), shows that the percentage of schools that reported difficulties for the continuity of education in the pandemic as a result of the lack of digital devices in students' homes was higher among public institutions (93%) than private institutions (58%) (Brazilian Internet Steering Committee [CGI.br], 2021).

The survey also indicated that the technological solutions adopted during the pandemic to carry out pedagogical activities were fairly diverse (Chart 1). Some 91% of schools created groups on apps or social networks, such as WhatsApp or Facebook: 79% video-recorded classes and made them available to students; 65% of schools conducted distance classes through videoconferencing platforms; 60% sent activities and materials to students by email; and 58% used virtual platforms such as Google Classroom. On the other hand, 93% of schools created the conditions necessary for parents to pick up printed activities and pedagogical materials for students (CGI.br, 2021).

Chart 1 – MEASURES ADOPTED TO CONTINUE PEDAGOGICAL ACTIVITIES

Total number of schools (%)



Source: CGI.br, 2021.

According to Cavalcante *et al.* (2020), the differences in technological infrastructure and the inability of teachers and students to adapt to using digital technologies in teaching meant that students from public institutions, from more vulnerable socioeconomic groups, and from states that performed worse in standard tests faced more difficult conditions for continuing their studies. Comparative analyses carried out by Agência Senado (Araújo, 2021), which were based on the results achieved by students in the 5th year of Primary Education in 2021 in the state of São Paulo in the Basic Education Assessment System (*Sistema de Avaliação da Educação Básica – Saeb*) tests, show a significant decline in their proficiency in Portuguese and Math compared to 2019. The Young People and the Coronavirus Pandemic survey, carried out by the National Youth Council (*Conselho Nacional de Juventude – Conjuve*) with young people aged 15 to 29, points out that between 2020 and 2021 the contingent of young people who considered not going back to studying after the pandemic increased from 28% to 43% (Conjuve, 2021).

These results indicate the importance of carefully examining the difficulties, losses, lessons, and legacies of the COVID-19 pandemic for supporting the re-configuration of education in the post-pandemic scenario, considering the contributions and potential demonstrated by the proper use of digital technologies.

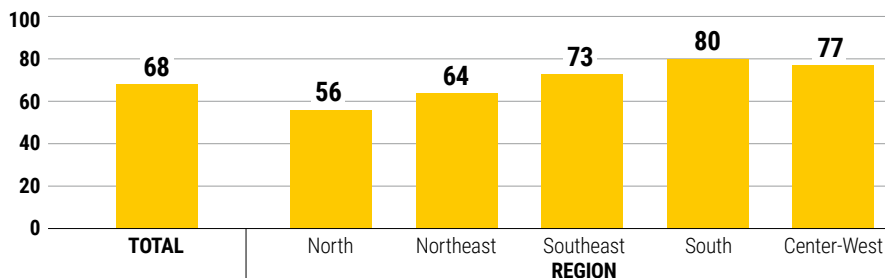
TEACHERS' PREPAREDNESS

For teachers who were adapting to remote teaching, digital competence and training opportunities for developing it were fundamental (Nascimento, 2020). This means that those teachers who already had digital resources and were familiar with their use in teaching were clearly in a more favorable position when schools closed. Furthermore, several publications – including Pesce and Hessel (2021), and Almeida (2021) – record that teachers felt at a loss when faced with the new challenges involved in carrying out remote activities, and sought to develop skills in the field of technologies in education on their own initiative, via online courses.

The ICT in Education survey found that in the 12 months prior to it being carried out, teacher training on the use of technologies in pedagogical activities was provided in 68% of the public schools, reaching 80% in the South and 56% in the North (Chart 2) (CGI.br, 2021). These data corroborate a study carried out by *Instituto Península*, according to which 88% of teachers had never taught remotely, and 84% did not feel prepared to do so (Ferraz *et al.*, 2021).

Chart 2 – TEACHER TRAINING ON THE USE OF TECHNOLOGY IN PEDAGOGICAL ACTIVITIES IN THE LAST 12 MONTHS

Total number of public schools (%)



Source: CGI.br, 2021.

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From a pedagogical point of view, teachers had to reinvent themselves during the pandemic in order to: reconfigure the face-to-face classes they had already planned; develop new support materials, including the use of media such as videos and podcasts; create channels on social networks to interact with students and their families; develop strategies to engage students in remote activities, and; try to involve families in the educational process. These efforts came mainly from the teachers themselves, whose aim was not to lose students or harm their learning process. On the other hand, as Zaidan and Galvão (2020) state, the decisions taken to introduce sudden changes were made without the knowledge of the teachers, who were not consulted, nor were possible alternatives discussed.

These changes resulted in different types of problems. First, a considerable percentage of the teachers were not prepared to carry out most of the activities relating to the pedagogical changes that were required. Second, teachers started performing two main tasks: on one hand, they corrected the activities carried out by students online asynchronously and in printed format; on the other, they provided regular feedback and support for their students. This was a major about-turn for those whose job it was to provide direct, oral instruction to the whole class.

Third, these changes implied alteration to routines, such as the “insidious penetration of work in all spaces and every moment of their daily lives” (Zaidan & Galvão, 2020), as well as a reduction in salaries, using their own resources to pay for the Internet and electricity, and using their own personal technology equipment. According to the *Instituto Península* study, public education systems offered little emotional support to teachers (14% of municipal and state schools), and both the support and training for distance teaching were insufficient and only offered by 30% of municipal schools and 47% of state schools (Ferraz *et al.*, 2021).

FAMILIES' PREPAREDNESS

Some teachers had to deal with the difficulties faced by the families in transmitting activities to the children, such as a lack of academic conditions and a lack of time because of excessive work, especially among those most affected by social inequality. This situation led to changes in teachers' lives and work routines, which generated emotional impact, stress, and exhaustion (Silva *et al.*, 2020). The challenges are corroborated by the description by da Rosa and Martins (2021) on the perceptions of school managers with regard to the processes of implementing remote teaching and its consequences in relation to the organization of work in the schools in the seven municipalities that make up the ABC Paulista, in the São Paulo Metropolitan region.

STUDENTS' PREPAREDNESS

Remote teaching was even more problematic for students, especially those at the beginning of Primary Education, who lack the self-control, motivation, and attention needed to take part in remote classes. According to the *Instituto Península*, 56% of Preschool teachers and 60% of Primary Education teachers found it difficult to keep students engaged (Ferraz *et al.*, 2021). There were even challenges with Lower Secondary Education and Secondary Education students.

The ICT in Education survey found that 65% of Brazilian public and private schools experienced difficulties in dealing with students coming from a so-

cially vulnerable background (CGI.br, 2021). It also detected that social and educational inequalities were increasing – albeit at different rates – in the education systems of those states that are at different stages in their economic development, such as Rio de Janeiro (Cunha *et al.*, 2020) and Paraíba (Nascimento, 2020).

Losses in education during the pandemic occurred in all dimensions of the teaching and learning processes. In the assessment of the Economic Policy Department (*Secretaria de Política Econômica – SPE*), of the Ministry of the Economy, from the point of view of student learning, the closing of schools may have a profound and long-lasting impact (about 15 years) on the Brazilian economy, which reinforces the analyses made by *Agência Senado* (Araújo, 2021). According to the SPE study (Barberia *et al.*, 2021), this effect will be felt in the Gross Domestic Product (GDP), in learning, in labor productivity, and in the increase in social inequality, since remote teaching was unequal in terms of age, and socio-economic and regional conditions.

As a possible approach to dealing with these impacts, the SPE suggests coexisting with this hiatus, which can have disastrous consequences for the national economy. Another way aims to mitigate the problem by increasing the number of hours or years of teaching post-pandemic. This increase will be ineffective, however, if the teaching and learning processes that were practiced in the pre-pandemic period are maintained.

Alternatives for overcoming the fragility of the technological infrastructure and preparing teachers to deal with the digital technologies that emerged during the pandemic include: improving the technological conditions of public schools; creating learning opportunities for the professional development of teachers; training future teachers (Arruda, 2020); implementing new educational approaches; and reconfiguring curriculums by integrating digital technologies (Almeida, 2020), considering the legacy of the experiences of the pandemic.

Innovative experiments in Brazilian education

In view of the contradictions that were evident in the country's educational panorama and that intensified during the COVID-19 pandemic, it is important to highlight the experiences that signal changes in ways of developing teaching and learning processes by way of teaching that focuses on the participation, engagement and authorship of the student, outlining the potential for contributing to the future of the school.

One of the first examples of this is Sesc³ Sao Paulo's project, *Juventudes*⁴ (Youths), with activities that were carried out in the Technology & Arts Spaces (*Espaços de Tecnologias e Artes – ETA*)⁵. Because Sesc São Paulo's physical units were closed during the pandemic, this informal education program sought

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³ The Social Service of Commerce (Sesc) is a non-profit Brazilian private institution that makes available education, health, culture and recreational programs and events and well as provides social assistance to workers and their dependents. Find out more: <https://www2.sesc.com.br/portal/internacional/us#:~:text=This%20is%20the%20Mission%20of,to%20workers%20and%20their%20dependents>

⁴ Aimed at teenagers and young people between 13 and 29, the program promotes "activities for young people, with young people and about young people, intending to help expand their cultural repertoire, and encourage coexistence, autonomy, and respect for differences". Find out more: <https://www.sescsp.org.br/o-primeiro-espaco-juventudes-do-sesc-sao-paulo/>

⁵ Available in more than 35 units of Sesc São Paulo, they are dedicated to research into digital culture, issues related to ethics and to relations between art and technology, with an emphasis on human development and citizenship. Find out more: <https://www.sescsp.org.br/da-internet-livre-ao-espaco-de-tecnologias-e-artes/>

By associating art, media, technologies, and territories, these creations are evidence of the potential for expanding the curriculum beyond the subjects recommended in curricular proposals and teaching plans.

new strategies for continuing with their activities. At the Itaquera unit, teachers gradually resumed their activities by way of social networks, especially WhatsApp, and broadcast materials such as podcasts and productions by the teachers themselves. Sesc Radio was reactivated, and a partnership was established with neighboring schools in order to engage young people, thereby creating a space for their leadership in expressing their identity, culture, and diversity of voices.

There was adherence to the actions adopted by the *Juventudes* space: Art & Territory⁶, which has become virtual, with socio-educational approaches that are dedicated to valuing and disseminating the cultural productions of adolescents and young people, recognizing the dialogue they establish with their territories and expanding an understanding of the diversity prevailing among them through music, image, sound, and audiovisual production. The partnership between Sesc São Paulo teachers and public schools also made it possible to support activities that incorporate the use of digital technologies in student cultural production, and the integration of the school curriculum and their cultures, the representation territories of their thinking in artistic creation. By associating art, media, technologies, and territories, these creations are evidence of the potential for expanding the curriculum beyond the subjects recommended in curricular proposals and teaching plans.

Another interesting experiment took place at the Badra Perus Municipal Primary School in São Paulo. The institution's website⁷ has fundamental guidelines for distance classes, such as support materials, the use of Google Classroom and other channels of communication with teachers, and a freely accessible video with the complete content of the textbooks of the Learning Trails from 1st to 9th grade, and for Youth and Adult Education (*Educação de Jovens e Adultos - EJA*). Created with the collaboration of teachers from the school system itself, the video includes activities relating to all curricular components.

Management teams and the school teaching staff came together in search of strategies that would enable students to take part in school activities, even if they were at home. Citing some of these actions, WhatsApp groups were created for each teacher and academic year, and a timetable was published with links for each year showing when teachers would be available to help students and when doubts could be raised with them. What students produced relating to the integrated projects was published on the school's website or on its Facebook page⁸, which at this point in time has 1,600 followers.

Teachers also visited students' homes to distribute books and strengthen the bond with the families, many of them suffering from enormous food shortages and living in inadequate housing conditions. Despite the reality that made the pandemic more painful for disadvantaged social groups, in sharing their feelings of solidarity, and offering help and hope, the school management and teaching staff made a remarkable effort to build bridges with students and their families by way of dialogue.

The projects developed by the Badra Perus School show the potential of activities that emphasize active methodologies, in which students are the subjects

⁶ Find out more: <https://www.sescsp.org.br/juventudes-arte-e-territorio-traz-palavra-movimento-som-imagem-e-muita-resenha/>

⁷ Available at: <https://sites.google.com/view/emef-badra/p%C3%A1gina-inicial>

⁸ Available at: <https://www.facebook.com/emefbadra>

of their own learning through doing. This is provided, on the one hand, by the teacher's role as a creator and manager of learning contexts and, on the other, by the contribution that technologies make in bringing the processes and production of students to the world.

The experiences cited are powerful references for different school situations, in the sense of providing students with the ability to explore digital information and communication technologies in: doing, and reflecting on doing; dialoguing with people from other contexts who are able to help them achieve the desired goals; and expanding their understanding of the world beyond the school's workspaces and surroundings.

If the infrastructure exists, then schools and teachers are able to create innovative situations.

What school for the post-pandemic period?

The knowledge built up over more than forty years on programs and projects for using digital technologies in education, the lessons learned during the COVID-19 pandemic, and the interesting solutions for mitigating the problems faced by educational institutions during the health crisis indicate that all the conditions necessary for rethinking the future of schools already exist. Today's challenges are complex and there is no single solution.

From the examples described, we can identify very effective approaches that can be incorporated in schools in general, such as: introducing local solutions; dialogue and partnership between schools, other educational institutions, and the community; and "hands-on" activities. In this sense, according to Hargreaves (2003), transformations in schools are possible when governments provide the infrastructure and support, and allocate resources based on local criteria, in addition to shifting the emphasis from the simple use of ICT to the development of creative communities based on disciplined self-management, innovation, and sharing. If the infrastructure exists, then schools and teachers are able to create innovative situations.

In this way, instead of proposing centralized policies and homogeneous actions, it is possible – and perhaps less costly – to create conditions for teaching networks and school units to generate solutions within their own contexts, thus favoring different starting points and development processes. Decentralization makes it possible to establish new practices from within the school, in collaboration with the external community, considering the cultural, ethnic, and social diversity inherent in its reality. Transformation is not achieved by way of system directives; it is important to minimize prescriptions and regulatory legislation, reduce the degree of intervention, and create the conditions needed for diversity to flourish.

The establishment of partnerships between schools and other educational institutions makes it possible to establish networks for learning and sharing experiences so that schools can "own" the innovation proposal and contextualize it to fit their reality in a process of "epidemic contamination" (Hargreaves, 2003). Central elements for creating innovation are the networks and communities of committed teachers who share their experiences horizontally.

Creative schools work with projects and other dynamics that are centered on active learning, which allows the student to solve problems related to their particular interests and own reality.

Finally, carrying out “hands-on” activities, followed by the reflections and challenges that are jointly proposed by teachers and students, creates opportunities for changing the instruction-based teaching approach to one of developing practices that engage students, making them more active and the protagonists of their own learning. Creative schools work with projects and other dynamics that are centered on active learning, which allows the student to solve problems related to their particular interests and own reality. This results in integration between theory and practice, reason and emotion, and scientific and everyday knowledge, thus reversing the more instructional processes that are normally adopted in traditional teaching.

We must bear in mind, however, that the fact that students have built an object or a product does not necessarily mean that they have understood the concepts involved in the construction process. As Jean Piaget identified in his investigation of the process by which children and adolescents develop what he called “conceptual understanding”, there is a distinction between being able to perform a task successfully and conceptually understanding what has been performed (Piaget, 1977, 1978). Such an understanding can be developed by teachers and their students reflecting together on the products that the latter have built.

The proposed activity must also be associated with the curricular topics that are covered in the discipline. The project or problem to be solved cannot be a random one. It should preferably be related to the curricular activities that the teacher is working with. If it is not, then the project/problem will be meaningless to the students, and it will be difficult to engage them with its development.

From the losses, gaps, and opportunities set out in this article, it is clear that, given the unusual reality of the COVID-19 pandemic, education is faced with never imagined challenges. In addition to awaking a feeling of isolation, confinement also induced an awareness of the urgency of recombining different means, technologies, spaces, and ways of acting for human survival. Consequently, the experiences, production, and transformations that occurred during the pandemic will last (Latour, 2021) and will profoundly influence educational processes, resulting in a re-signification of the curriculum and of public policies.

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Interview I



Liane Margarida Rockenbach Tarouco

Professor and researcher on the post-graduate program in Informatics in Education at the Federal University of Rio Grande do Sul (UFRGS)

Digital technology and innovative pedagogical practices

Liane Margarida Rockenbach Tarouco, an Internet pioneer in Brazil, is the author of the first book on computer networks in the country. She is currently a professor and researcher on the graduate program in Informatics in Education at the Federal University of Rio Grande do Sul (UFRGS). In this interview, she comments on the use of digital technologies for innovating pedagogical practices, trends, and paths to the future.

Internet Sectoral Overview(I.S.O.)_ How can digital technologies be used for implementing innovative pedagogical practices in Brazilian education? Could you share any successful experiences with us and comment on what the student's role should be in these approaches?

Liane Margarida Rockenbach Tarouco (L.T.)_ Traditional teaching methods, in which the emphasis is on the transmission of information by teachers, made sense when access to information was difficult. The digital technologies that are available today, however, allow the opportunity of offering interactive and multimedia educational resources that have a profound impact on learning. Student interaction with content is extremely important. A huge amount of research suggests that students learn best when they are active in their learning process. Interactivity in learning is a fundamental mechanism for acquiring knowledge and developing cognitive skills. Using an interactive resource, students are encouraged to think and react to the information they receive, since they need to make choices throughout the process. Reaction is part of an active learning approach.

Basic interactivity is valuable in helping acquire equally basic knowledge. In order to promote learning that is capable of developing a greater cognitive ability, however, educational products need to be on a higher and richer level in terms of the reactions required of students working with interactive content. This reaction can be on different levels, as in Bloom's taxonomy, which proposes the following hierarchical structure of educational objectives: remember (describe, report); understand (discuss, explain); apply (use, solve); analyze (explain, categorize); evaluate (assign an evaluation, justify); and create (design, carry out). The higher the level, the more complex the production of feedback.

The increased use of artificial intelligence (AI) in education has favored the production and analysis of student reactions. An example of this type of application is chatbots, which are built to simulate a person's responses to user questions and statements that are presented in natural language. Another technology whose use has grown rapidly is immersive virtual worlds (metaverses), which enable virtual environments to be created, where stu-

dents enter by way of avatars that represent them, and that interact with other users or manipulate virtual artifacts that simulate real objects.

The use of tools that facilitate authorship results in both teacher and student becoming involved in creating digital educational content, which opens up a huge range of possibilities for active and motivating learning that is capable of fostering thinking on a higher level. Multimedia resources offer better chances of capturing the attention of students and increasing their motivation.

I.S.O._ Digital technologies, and digital platforms, in particular, applied in education increasingly enable the personalization of learning. What are the advantages and challenges arising from this trend?

L.T._ Personalized learning takes each student's specific strengths, interests and needs into account, which creates a unique learning experience based on these individual characteristics. In this learning environment, teaching strategies and practices are changed to include:

- the student's characteristics in terms of learning style, issues related to accessibility, and other aspects;
- learning and teaching objectives that harmonize the requirements of the curriculum with the student's interests and context;
- flexible learning support activities that can be adapted to fit the student's progress;
- assessment strategies that allow learning to be monitored and measured.

The term "personal learning environment" refers to the tools, communities, and services that make up a student's support infrastructure, the aim being to direct student learning in such a way as to achieve the educational goals. This infrastructure may include applications, Web-based services, links to other Web tools, social networks, and resources for supporting their research activities.

The personalized learning environment should be enriched with a system for monitoring student performance that makes learning activity recommendations and suggestions. Monitoring students makes it possible to:

- identify what they know and what they have not yet learned;
- revisit only what is necessary for them to fill any gaps in their learning;
- offer the next steps for them to continue making progress.

The personalized learning environment that offers advantages by optimizing student time implies the development of basic elements such as: questionnaires for diagnosing preferred learning styles; tests that allow for a formative and summative assessment; and instruments for monitoring and analyzing activities. In this context, learning analytics strategies are used for collecting and analyzing access data, thus helping to compose a description of the pattern of use of the resources that are available to students. Such information feeds into recommendation systems that can interact directly with students and suggest the activities and resources to be used in their learning path.

"Personalized learning takes each student's specific strengths, interests and needs into account, which creates a unique learning experience based on these individual characteristics."

" (...) equipping teachers with the skills they need (...) implies diagnosing the current situation and planning actions to address the gaps that are identified."

I.S.O._ How can teachers be properly trained and provided with the necessary resources for using information and communication technologies (ICT) in teaching?

L.T._ Given the increasing adoption of technologies in education, there is considerable interest in equipping teachers with the skills they need for fully exploiting the potential of digital technologies for improving teaching and learning. This implies diagnosing the current situation and planning actions to address the gaps that are identified.

The DigCompEdu framework⁹, which was developed within the scope of the European Commission's Joint Research Center, was recently adopted by the European Union to categorize the stage of teacher development with regard to the use of ICT as an educational resource, and serves as a reference for assessing the current situation and the training needed. The framework proposes categories with indicators that classify the digital competences of teachers in six areas:

- Professional engagement: using digital technologies for communication, collaboration and professional development;
- Digital resources: sourcing, creating and sharing digital resources;
- Teaching and learning: managing and orchestrating the use of digital technologies in teaching and learning;
- Assessment: using digital technologies and strategies to enhance assessment;
- Empowering learners: using digital technologies to enhance inclusion, personalization and learners' active engagement;
- Facilitating learners' digital competence: enabling learners to creatively and responsibly use digital technologies for information, communication, content creation, well-being and problem solving.

The DigCompEdu framework includes an online questionnaire for teachers, with a series of reflective questions that aim to assess their confidence and experience in using digital technologies, tools and resources to teach, communicate, and collaborate with their colleagues, and support the digital skills of students. An automated report is generated from the answers that analyzes the situation of teachers in each area and makes suggestions for improvements. It is thus possible to identify areas of competence that are weaker or less weak, and the appropriate training responses.

The training of teachers to use ICT as an educational resource needs to consider both those who are already working and those who are in training. Teacher training courses must include this content in their curriculums, and this is just beginning. Schools, universities, public bodies, and private institutions have to offer continuing education to fill this gap and improve in-service teacher education.

⁹ Available at: https://joint-research-centre.ec.europa.eu/digcompedu_en

I.S.O._ What are the future trends with regard to the use of emerging technologies in education? Considering the digital inequalities that persist in Brazil, how can we prepare for this scenario?

L.T._ The COVID-19 pandemic has put mobile learning in the spotlight. Portable devices and 'Bring Your Own Device' (BYOD) strategies have enabled the adoption of an approach that makes it possible for students to access support where and when they need it. This shift in mindset was essential for enabling remote and hybrid ways of working. The reduction in the cost of mobile devices led to them to become available also to the less favored classes. On the other hand, the federal government's effort to expand connectivity in public schools makes it possible for students to seek educational resources through the technology they have at their disposal: their cell phone.

Other emerging technologies in education are AI and Virtual Reality (VR), whose use has been made possible in the context of mobile learning. In the case of AI, there is a rapid shift from "if" to "how". Many educational technologies employ at least basic AI capabilities, such as natural language processing, content recommendations by way of automated assessment, and the personalization of learning paths. It is not always possible, however, to implement the technology available for AI in the short term, since this depends on technological evolution and the speed with which usable results become available.

An example of this is the use of chatbots to answer questions asked by students in written or spoken natural language. Although quite widespread, this technology is still limited in terms of its ability to understand what was asked, either because it does not accurately recognize the question, or because of semantic aspects that are inherent to the question asked. The sophistication of recognition algorithms has a lot to evolve, and research and development is needed in this area, as well as the expansion in the use of existing solutions.

VR and Augmented Reality (AR) are technologies that promote an immersive learning experience. They allow, for example, interaction and collaboration in virtual environments between geographically dispersed students who are represented by their avatars; the simulation of a virtual laboratory that allows the manipulation of artifacts and fills the gap between theory and practice; and augmented visualization that is only possible virtually, as in the case of electromagnetism. This requires the development of content (scenarios and digital artifacts), and must be made available in the form of an open educational resource. Increasingly popular, the term "metaverse" refers to this new way of designating the use of VR, which involves elements of context permanence, which support the continuity of identity, objects, and scenarios that an appreciable number of users can experience, either synchronously or asynchronously.

"Virtual reality (VR) and augmented reality (AR) are technologies that promote an immersive learning experience."

Article II



Axel Rivas

Researcher and dean of the School of Education at the University of San Andrés

The platformization of education: a framework to map the new directions of hybrid education systems¹⁰

By Axel Rivas¹¹

Introduction

We live in a new educational world. After a decade of exponential growth in educational platforms, students are spending more and more hours learning online. The painful experience of the COVID-19 pandemic expanded this process in a rapid and uneven way. Education turned towards totally virtual models and new hybrid models that combine face-to-face with digital learning.

This forced migration to the digital educational cloud has led to defrosting and is suddenly showing the forms that education can take in increasingly technology-driven societies. Not only is the digital consumption of screens and educational algorithms changing. There are also more profound transformations: the expansion and diversification of curriculums; the opening of new routes of autonomous learning; the redesign of pedagogies in more diverse, fragile and dynamic cultural environments. The advance of new digital technologies is changing the form, meaning, and control of education.

This process can only be understood within the logic imposed by the platforms. As a recent text by Decuyper *et al.* (2021) points out:

An online platform is a programmable digital architecture designed to organize interactions between users – not just end-users but also corporate entities and public bodies. It is geared toward the systematic collection, algorithmic processing, circulation, and monetization of user data.

Platforms increasingly mediate all forms of production and distribution of economic and cultural goods. Education is part of this paradigm shift. As different studies have indicated, the educational platformization process is underway (Van Dijck *et al.*, 2018). Furthermore, "the worldwide growth and ubiquity of digital education platforms have greatly accelerated since

¹⁰ Edited version of the paper "The Platformization of Education: A framework to Map the New Directions of Hybrid Education Systems," published on May 2021 by the United Nations Educational, Scientific and Cultural Organization's (UNESCO) International Bureau of Education (IBE). Available at: <https://unesdoc.unesco.org/ark:/48223/pf0000377733/PDF/377733eng.pdf.multi>
The original paper was published in the scope of IBE's Hybrid Education Learning and Assessment (HELA) flagship program, aimed at guiding countries with regard to the most effective modes of education, based on evidence of the integration and combination of face-to-face and distance-based education. Find out more: <http://www.ibe.unesco.org/en>

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the outbreak of the COVID-19 pandemic and the associated newly emerging 'emergency pedagogies' that needed to be devised" (Williamson *et al.*, 2020).

This paper raises questions and brings scenarios. Two hypotheses guide it. The first is that the platformization of education is real, expansive, and here to stay. We do not know to what extent it will strengthen or transform education systems or control student learning with the growing ability of private companies to enter the world of digital education. The second is that platformization opens up a new field of possibilities for public policy. Is it possible to harness digital technology's power to expand the right to education? How can platforms be used to meet Sustainable Development Goal 4 (SDG4)¹² for Education 2030?

The COVID-19 pandemic has been overwhelming. The suspension of face-to-face classes amplified social injustices due to the gap in access to technology. This process revealed an emergency that requires urgent solutions (Bozkurt *et al.*, 2020; Lorente *et al.*, 2020). We do not know when and how this process will end. We know that we must act faster and generate policy responses that provide disadvantaged sectors with more educational possibilities. The exploration of new directions becomes a decisive agenda in times of crisis.

The education technologies (EdTech) market

The evolution of the incorporation of digital technologies in education has had two major stages. The first was based on the incorporation of hardware and a wide range of educational software, from mid-1990 to 2010. In this stage, innovation tried to transform old technologies with new technological devices. One computer per student program was the most visible star (Bender *et al.*, 2012). Interactive whiteboards reinvented blackboards (Betcher & Lee, 2009), whereas the arrival of tablets made textbooks become digital in an attempt to multiply access to educational content.

This first stage generated, in many cases, frustration due to the unfulfilled promises of the technological solutions (Cuban, 2003). The traditional school seemed invincible in all the good and bad of its matrix. The second stage is the one we have been experiencing since the beginning of 2010 – the platformization period of digital education, a stage of combined evolutionary content systems, student management, and learning assessments. It is a fast-paced race to increase virtual learning time to improve the accuracy of educational algorithms. As a recent report indicates:

In recent years, there has been a tremendous shift taking place in the education sector, from conventional exam-oriented learning to a personalized and interactive learning approach. Digitization is increasingly penetrating the education sector with technologies used to deliver education, skills, and knowledge in new and creative techniques (Grand View Research, 2020).

Is it possible to harness digital technology's power to expand the right to education? How can platforms be used to meet SDG4 for Education 2030?

¹² Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Find out more: <https://sdgs.un.org/goals/goal4>

This new educational market is expressed in different segments that seek integration through the platformization process.

EXAMPLES OF PLATFORMIZATION IN THE NEW EDUCATIONAL MARKET

» **DIGITAL TEXTBOOKS.** These have become key publishing platforms. The market for digital textbooks is growing through platforms that integrate data and increase the number of users and of producers in a connected way.

» **LEARNING MANAGEMENT SYSTEMS.** These are evolving to integrate functions. Many systems have become educational content platforms with adaptive learning engines.

» **DIGITAL TUTORING SYSTEMS.** These have been robust in contexts in which Higher Education entrance exams are decisive. Some models are closely associated with the examination systems of countries. These platforms are being adapted to the students' needs in moving towards the Affective Tutoring System (ATS) (Hasan et al., 2020).

» **MASSIVE OPEN ONLINE COURSES – MOOCS.** These are a well-known revolution in Higher Education that is showing the same trend towards platformization. In certain cases, the platform model focuses on partnering with universities and on increasingly powerful artificial intelligence engines to create content based on user consumption.

» **SCHOOL NETWORKS.** These express the same logic as platforms using digital technologies in physical spaces and multiply the number of students in the digital cloud. Examples include schools that are physical places, and a centralized platform for curricular content that teachers deliver daily with tablet support. This “school in a box” model shows both the potential and risks of platforms in low-resource settings with scripted lessons and central control (Tessitore, 2019).

» **OTHER DIGITAL SYSTEMS.** These focus on controlling attention in classrooms and are used to regulate students' behavior.

» **ADAPTIVE EDUCATIONAL CONTENT PLATFORMS WITH ARTIFICIAL INTELLIGENCE (AI) ENGINES.** Some systems make use of the Big Data of millions of students' educational consumption to predict learning and generate personalized digital content routes. Other platforms focus more on growth through gamification as an incentive mechanism for advancing data collection. These platforms integrate “cognitive systems” to learn on a large scale, reason with their intention, and interact with humans naturally (King et al., 2016).

» **DIGITAL TEST PLATFORMS WITH TEST CORRECTION VIA AI.** Automatic essay correction, for instance, speeds up test processing and provides students with immediate feedback.

A map of education platformization

A decade of constant evolution of the second stage in introducing digital technology in education has passed, a process that is altering its forms, contents, and meanings (Decuyper, 2019). In this section, we draw up a map of those transformations that define the transition from traditional educational systems to the era of educational platforms.

FIRST TRANSFORMATION: THE DIGITIZATION OF EDUCATION

Educational systems have specialized in copying and repeating. They created mirrors of the sacred texts (religious, scientific, or national-based) in the curriculum, in textbooks, and in examinations. They multiplied the model of division by classrooms, a mechanism that guarantees serial curricular progression. Thus, it was possible to universalize the distribution of basic knowledge with schools and teachers that were spread across (almost) the whole territory of (almost) all countries. This process is costly: classrooms, blackboards, desks, books, and teachers have to be multiplied so that all students have physical access to them.

New technologies are altering the roots of this educational distribution model. The digitization process is the first great force for the transformation of educational formats. The new educational market is a fundamental engine of this process. What is digitized eliminates the cost of its reproduction (Kelly, 2017). Once the "product" is digitized (a book, a class, an exercise, a course), it becomes ubiquitous, immediate, and portable.

Digital education speeds up the process of copying and distributing content at a lower cost (despite the high cost of hardware and initial connectivity).

Digitization breaks the boundaries of space and time. School borders are no longer necessary. It is possible to educate yourself anywhere if there is a connection to digital media. Lifelong learning is a disruptive benefit of these new possibilities. Paradoxically, digitization favors mirroring and breaks away from the uniform format of content distribution, as indicated by the second transformation.

SECOND TRANSFORMATION: CURRICULAR EXPANSION AND DIVERSIFICATION

Traditional education systems had strong centralized control over the curriculum from their roots. During the wars of religion in 1599, the Jesuits created the *Ratio Studiorum*, a curricular regulation model that covered all the details of what had to be learned. In the 19th century, nation-states reproduced the centralized and universal curriculum to control education on a massive and simultaneous scale in all of their territories. Although there were more decentralized models, the compulsory curriculum system became a decisive educational policy dimension.

In recent years this has been changing drastically and rapidly; a profound transformation of the formats and sources of curriculum production has begun around the world. Translation into the digital medium allows the "contents" to expand their communication limits. Platforms that use the work of "prosumers" to develop content and distribute it at low production and dis-

New technologies are altering the roots of this educational distribution model. The digitization process is the first great force for the transformation of educational formats. The new educational market is a fundamental engine of this process.

The migration of educational journeys to the digital world allowed learning events and learning paths to be known as never before. Datafication is perhaps the most powerful force in the new digital educational world.

tribution costs multiply. This is the realm of the new sharing economy (Sundararajan, 2017). A new visual and multimedia language begins to emerge that converts the physical universe of print culture to the virtual universe of image culture (Philips *et al.*, 2010).

The multiplication of educational content sources produces a parallel process of denationalization, globalization, and commercialization of education. It is not clear which official process can control or certify the quality of the multiple offers available on platforms and applications in the EdTech market.

THIRD TRANSFORMATION: GAMIFICATION AND THE INTENSIFICATION OF LEARNING EXPERIENCES

The traditional education system was based on obligation. Design of the educational content followed the logic of this power system: it was linear, abstract, excessively structured, and routinized. Most content was only consumed because it was mandatory. The cultural transformations of recent decades are opening the doors to new paradigms. Teachers and content creators are increasingly looking to make sense of what is to be learned. The growing democratization of societies has opened the doors to diverse and plural cultural consumption. This is also penetrating the educational world.

The search for EdTech market customers is accelerating this process. This search is adaptive: it constantly explores, tests, measures, scales, provides feedback, refines, and adjusts. There is no grand master design, no planning by objectives, and no long-term vision. There are constant tests, with constant data that measure impact and enable the redesign of strategies (Lockwood, 2009).

Gamification is one of the recurring mechanisms in this transformation. It seeks to attract students and generate the addiction of not wanting to leave each platform. Systems are designed with micro-incentives: badges, scores, rankings, personalized messages, and constant incentives to stay connected (Deterding *et al.*, 2011). Gamification also designs educational interfaces that focus on play, with creative, immersive, and fantasy-filled narratives (World Government Summit, 2016). Here we are entering the world of the digital designers of virtual learning experiences.

FOURTH TRANSFORMATION: THE DATAFICATION OF EDUCATION TO PERSONALIZE LEARNING

Traditional educational systems depended on teaching authority to advance learning. The state had very little information about the system: it was an intense system in human relations. The simultaneous teaching method was the dominant strategy: every student at the same pace in each classroom and each school, following the curricular program. It was a slow method because it was regulated by the group mean and was exclusive (after all, the most disadvantaged were systematically left behind).

The migration of educational journeys to the digital world allowed learning events and learning paths to be known as never before. Datafication is perhaps the most powerful force in the new digital educational world (Williamson, 2017). All digital consumption can be tracked through analytics, data becomes the new currency of education. The platform replaces the fixed and repetitive

system. Learning paths on platforms are iterative: the more learning that is consumed, the more refined the offer.

In this regard, the emergence of learning algorithms, Big Data and AI are organic systems of constant growth. The combination of digitization and datafication is opening the floodgates to the arrival of educational algorithms. The master narrative indicates that the use of Big Data will provide personalized feedback in real time to students. Thus, they will learn faster, be more motivated, and constantly active. The algorithms' analytics enable each student's results to be predicted and the learning program rebalanced to enhance personalized rhythm. Schools can be the gateway to a large data platform that will form an ecosystem of constant learning (DiCerbo & Behrens, 2014; MayerSchönberger & Cukier, 2014;).

Does the winner take all?

The paradox of the new EdTech market is that it generates diversification and concentration of power at the same time. The new economy of decentralized digital educational resources multiplies the sources, but the platforms tend to unify them in just a few hands. From reading a text to creating a learning system for schools to buy, all educational experiences are being platformized (Hillman *et al.*, 2020; Van Dijck *et al.*, 2018; Williamson, 2019).

These platforms are based on the "rule of one" (Tiwana, 2013) or "the winner takes all" (Lanier, 2014). The greater the number of participants, the more power they accumulate. The growth of algorithms fertilizes the triumph of the platforms. As Srnicek (2017) points out, platforms are "data-extractive devices" that need many users and much knowledge about each one of them. Thus, they achieve their double effect of massive scale and personalization: more users mean more data, and more data means more predictive power and greater customer loyalty.

The platformization of education opens up numerous ethical questions. Who will be the authors of these new worlds of digital learning? Who will participate in the discussions that will affect education as a public good? Will large EdTech companies define learning? Who controls student privacy and learning data? Who designs the educational algorithms? What will happen to local cultures faced with educational globalization? How will students be trained in citizenship and ethics if content orientation follows the course of the labor market? What will happen to those who do not have access to technology?

Algorithm-based learning poses new justice dilemmas. Power will be in the hands of those who control education data. With enough data, you can anticipate a result, predict a trajectory or modify it. Those who control the platforms will be able to guide the educational destiny of people. As Rifkin (2014) warns: "at no other time in history have so few institutions had so much power over the lives of so many people".

The future remains unclear. Education can become a market good or expand its potential for guaranteeing human rights. The Beijing Consensus on Artificial Intelligence and Education defines a series of ethical principles providing guidance that points in a more humanistic direction (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2019). We are

The platformization of education opens up numerous ethical questions. Who will be the authors of these new worlds of digital learning? Who will participate in the discussions that will affect education as a public good?

The Beijing Consensus on Artificial Intelligence and Education defines a series of ethical principles providing guidance that points in a more humanistic direction.

just beginning to see the possibilities of the new digital educational world. This discussion needs to expand the traditional boundaries of educational policy. Some countries have already moved in that direction and allowed us to advance the clock.

An analytical framework of the platformization of education systems

How will the platformization of education transform educational systems? To address this question, this section proposes an analytical framework that dialogues with previous studies (Trucano, 2016; UNESCO, 2009, 2020, 2021). We propose three dimensions of analysis, and indicate the categories that allow each dimension to be empirically measured for comparing countries and education systems (Table 1).

The first dimension seeks to measure the platformization level of an educational system. This indicates the number of connection points between students and learning that have been converted into operable data on a platform. This dimension is continuous: more points of contact, more students, and more connections between those points of contact imply increasing levels of platformization. This is, however, also paradigmatic: it is necessary to exceed a certain threshold of connections that create an ecosystem in which Big Data can operate, generating changes in learning paths, new personalized content, adaptive learning assessments, and other functions of the platforms.

The second dimension refers to the level of centralization and the sources of control of the platform. Here we find a maximum level of centralization when the State assumes a dominant role in digital education and, on the other hand, maximum decentralization in cases where there is a large private market for EdTech offers and services. This private offer can, in turn, be concentrated in a few or many companies. Diverse assemblages can be found between digital infrastructure, educational content, regulations, evaluations, and public and private data systems. Schools also become axes of a new form of possible autonomy or control in this new scenario¹³.

Finally, the third dimension indicates the direction of this platformization process, which can range from the extreme reinforcement of the traditional educational system matrix to the point of generating profound changes in pedagogies and the curriculum. At the same time, it is possible to analyze in each country which aspects of the system should be strengthened or transformed, as well as the various situations that may arise.

¹³ A recent study on the Netherlands indicated that designing interoperability under public control involved profound private-public negotiations between local actors willing to insist on a form of platformization that facilitates connectivity between different (types of) platforms by pushing open standards: "The concerted effort aimed at creating an open, modular, and decentralised network which promotes schools' control over data flows and the organisation of digital learning" (Kerssens & Van Dijck, 2021).

Table 1 - ANALYTICAL FRAMEWORK OF THE PLATFORMIZATION OF EDUCATION

LEVEL OF PLATFORMIZATION OF AN EDUCATIONAL SYSTEM	LEVEL OF CENTRALIZATION / TOWERS OF CONTROL	PEDAGOGICAL AND CURRICULAR ORIENTATION
Percentage of students connected to the Internet (at home and at school)	Public / Private provider and guarantee of access	
Percentage of students and teachers with basic digital skills	Public policies devoted to digital skills	Orientation towards practice and/or critical digital literacy
Percentage of digitized compulsory curricular content	Percentage of free digitized curricular content	Pedagogical orientations
	Percentage of the supply of digitized state curricular content / purchased from the private market / private production	
	Number of dominant private sector companies in the digital content market	
Amount of time that students spend on platforms at home		Percentage of time on platforms that are based on school activities / public exams / individual interests
Amount of time that students spend on platforms in school		
Variety of digital learning routes of the compulsory curriculum	Percentage of public and private compulsory curriculum digital learning routes	Variety of non-compulsory apprenticeships available (third space)
Level of intensity and variety of digital learning experiences that platforms allow	Role of public and private sector	Pedagogical and curricular orientations
Level of gamification of digital learning paths		
Amount of daily digital learning data	Percentage of public and private daily digital learning data	
Proportion of system students reached everyday		
Modification of routes or educational content based on data and algorithms	Role of public and private sector	Pedagogical and curricular orientations

In platform systems, we see the birth of a double educational system, which combines the institutionalized, regular, and massive virtual educational system, running parallel with the bricks and mortar system.

The combination of these three dimensions can generate different scenarios. The first scenario is that of "centralized platformization to reinforce the traditional educational system". This is the case with Asian countries, such as China or South Korea, which have extensive technological infrastructure and a centralized state apparatus control capacity. In partnership with multiple private developments, they can use the power of digital technology and AI to increase, expand and deepen the installed capacity of their educational systems. These educational systems redouble the power of systemic state regulation through digital platforms to improve learning.

A second scenario is that of "decentralized platformization in hybrid models with strong standards". In this scenario, we find a certain curricular conservatism anchored in standards. Systems based on standardized tests have a common foundation that can be more easily platformized, as platforms can reproduce the official curriculum in a personalized and adaptive way.

The difference between these two scenarios is that the latter develops with much more freedom and diversity of providers. The State is not a central actor in the digital offer but controls it through examinations. This type of system favors large private markets for the sale of platform services in schools. This model predominates in the United States and other Anglo-Saxon countries with a strong decentralization of their educational management, centralization through standardized tests, and a large private EdTech market.

These two scenarios seem to reinforce and at the same time transform the traditional educational system through duplication. These are hybrid learning models, in which face-to-face education and digital education can be both convergent and run parallel to each other (Horn & Staker, 2015). Hybrid models appear to be the prominent figures of the future of schools: they build interface bridges; they create digital circuits that interact with the classroom education system; and they do not take away the power of the teachers, since hybrid models maintain the center in each school. They also strive, however, to achieve personalized teaching models thanks to the digital platforms they incorporate.

In platform systems, we see the birth of a double educational system, which combines the institutionalized, regular, and massive virtual educational system, running parallel with the bricks and mortar system. The face-to-face school system, in turn, maintains its homogeneous, national character, with its socialization functions and the strengthening of cultural, citizen or moral ties. These dimensions require teachers with moral authority and high levels of daily interaction to regulate behaviors and learning. Digital platforms also accentuate personalization through AI, and the penetration of a global market, and can be more clearly oriented towards job skills.

The third scenario combines platformization with a more significant dose of pedagogical innovation. This can be seen in part in the cases of Estonia and Uruguay, whose profiles of state public agencies promote profound changes in teaching models. In these cases, we see the emergence of a "third space". This area is studied by specialists in media education that begins to take on a new scale with the expansion of digital networks. Potter and McDougall (2017) state that the third space is "the area in the middle of the formal curriculum and informal learning through skills and dispositions that come from the cultural field".

Digital technologies are opening up new learning spaces. In some of these, students are invited to platforms by their teachers. In others, they become ubiquitous learners and consume education platforms that are not controlled by the education system. There is no curricular domain or standardized tests in the third space: the tutorial videos, the extra-curricular portals, and the platforms are for learning non-school skills. This is a multifaceted market, a new educational dimension that expands the educational boundaries of local proximity. One of the big questions for the future of education is whether the State should expand the third space, or if its role is to strengthen the system so as not to divert attention away from common learning.

This analytical framework allows the construction of scenarios for planning digital educational policies. The objective of this paper was to think about the convergence between educational systems and platforms: how can structural social inequalities be reduced using the greater power that technology offers us for rethinking education? Platformization depends on a high level of technological infrastructure that most developing countries do not have. This is an unavoidable obstacle, but there are also different ways to avoid it, or frugal innovations that use technology to generate transformations for accessing the right to education (Winthrop *et al.*, 2018). Creating alliances between countries and setting up regional networks of digital educational resources will be essential for avoiding a worsening of the inequalities between rich and poor countries.

The greatest challenge is to generate ecosystems for the development of quality educational platforms that integrate face-to-face and digital education, that respect and dialogue with teachers, and seek to guarantee the right to education. The COVID-19 pandemic has changed everything and opened up scenarios for rethinking education when it returns to a certain normality. Hybrid models are an opportunity to redefine the meanings and purposes of education in a changing and unequal society. This conversation has only just begun.

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Interview II

Education technologies and privacy implications

Velislava Hillman is a visiting fellow at the London School of Economics (LSE) and founder of the international consortium Education Data Digital Sovereignty (EDDS). In this interview she discusses the implications of adopting education technologies (EdTech) for learning, associated privacy concerns, and the role of education stakeholders in this process.

Internet Sectoral Overview (I.S.O.)_ How do education technologies (EdTech) contribute to learning in your opinion? How do you perceive the use of such technologies for personalized learning and the role of teachers in this process?

Velislava Hillman (V.H.)_ EdTech is a growing industry with hundreds of applications, platforms, and services that target both basic and higher education, with products ranging from basic connectivity to the provi-



Velislava Hillman

London School of Economics (LSE)

"The commercial imperative behind many EdTech products has meant that they have been driving 'datafication' in education – turning students' every action into data (...)"

sion of content and assessment. It is hard, therefore, to pin down which make contributions and in what way.

During the COVID-19 pandemic, networked technologies were vital for connecting children to their classmates and teachers, and for parents to follow their children's education. There is little substantial evidence, however, about which EdTech products are the best way to provide, assess, or even define education.

The commercial imperative behind many EdTech products has meant that they have been driving "datafication" in education – turning students' every action into data – as the true value to be derived from aggregating data about students and teachers on a large scale, instead of prioritizing teaching and learning outcomes.

EdTech products make two known promises. The first is that the more students and teachers use them, the more data will be generated, which could help to detect learning problems and allow for timely intervention. The second is to actually provide this timely intervention and improve learning for everyone.

The premise that more profiling will help personalize a child's learning, however, can be problematic. Constant surveillance can have a chilling effect and lead to distrust. Assessment is also no longer used in just a formative and summative way, since data-generating technologies enable continuous evaluation; this is a form of loop that has transformed teachers' roles, resulting in them following the 'if-then' model of 'teaching to get to the test'. Little is known with regard to who devised these techniques, or on what criteria they are based. It is also unclear how healthy it is for a child to be constantly monitored and assessed.

Personalized learning is said to be the result of knowing a student at a granular level. Profiling a student based on this information would help tailor their instruction in a precise way. But who decides which student characteristics should be considered? Furthermore, with the personalization of content for all students, one cannot know what the others are reading, which has been happening with social media, thus elevating the risk of creating a form of echo-chamber effect with possible negative consequences.

There are many "unknown unknowns". We do not know how the use of data, profiling, and predicting, and the manipulation of children's behavior by these products can affect them now and in the future. In short, the role of trained and certified teachers and educationalists is being taken over by untested and uncertified EdTech products.

I.S.O._ What are the possible privacy implications of adopting these technologies? What can be done by education stakeholders to safeguard the child's best interest and their fundamental rights?

V.H._ Schools should be safe environments where children can make mistakes, something that is fundamental to learning. Yet children's every move – and even biometrics in some parts of the world – is turned

into data and integrated into private systems that assemble yet more data and continuously profile and make inferences and predictions about them. Data collection, transactions, and computation have permanence, which poses unknown risks. Is it right or useful for a person to have data from their primary school haunt them in adulthood? What do we teach children about privacy in a world where surveillance and data extraction for predicting and manipulating behavior are becoming normalized?

A recent Human Rights Watch (HRW) report¹⁴ identified that many of the EdTech products that were recommended by governments around the world during the COVID-19 lockdown used practices that put children's rights at risk, or undermined or actively violated them. Companies monitored students without their knowledge or consent: they harvested data on who they are, and what they do, and on their parents and friends; and they shared or allowed third parties to access this data, including advertising technology (AdTech) companies and data brokers. The only way for children to protect themselves from this invasion of privacy would be to throw their devices in the bin. How far does this trail go? Is there any stopping it at all? Most importantly, is this relevant to education or conducive to providing it?

Teachers and school leaders should insist that a minimum standard of benchmarking and control of these businesses is mandated. Data privacy impact assessments and EdTech procurement carried out in the United Kingdom, the European Union, the United States, Australia, and New Zealand are a starting point for watching over this growing sector. Data protection officers assess products, ensure that their terms and conditions meet data privacy regulations, and guarantee that school leaders understand how to choose a product. As shown by the HRW, however, these practices do not always prove effective, because none of these audits and checks are mandatory and when algorithms are involved more is needed than reading privacy policies. EdTechs should be licensed to operate as teachers are.

Governments should develop independent entities that overlook, enforce, assess, and monitor the sector continuously to ensure good practice. EdTechs must show a duty of care, remove ad-trackers and dangerous permissions, and simply not collect or use data that does not benefit children and their education.

I.S.O. Which mechanisms of oversight, governance, and accountability are necessary to ensure the transparency of EdTechs?

V.H. Examples can be found in the teaching profession, in healthcare, agriculture, and the pharmaceutical industry. While maybe not perfect, there is much we can learn from existing mechanisms for auditing,

"Governments should develop independent entities that overlook, enforce, assess, and monitor the [EdTech] sector continuously to ensure good practice."

¹⁴ Find out more: <https://www.hrw.org/news/2022/05/25/governments-harm-childrens-rights-online-learning>

"They [stakeholders] should have an alternative to EdTech products so that they are not entirely dependent on such technologies for providing their children's education and assessing what they learn."

assessing, licensing, and enforcing standards, rules, and conditions. Forthcoming EU legislation, in particular the Digital Services Act¹⁵, stipulates that to prevent abuse of their systems, large online platforms should take risk-based action, including having their risk management measures independently audited. It is not clear why only large platforms are considered; small digital companies have limited resources and thus find it difficult to adhere to security standards, which is problematic. Nonetheless, setting up such dedicated entities that can supervise, monitor, and control EdTechs is very necessary. EDDS is leading the way by engaging with government, educators, and ethical EdTechs to build a workable framework that delivers proper sector evaluation and certification systems.

Perhaps one of the hardest tasks, which will require many resources, is to continually develop scholarship on the impact of these products on education. Which products make sense in terms of teaching? According to what criteria do they make sense? How do they work? There is little substantial evidence to show, especially when compared to the scholarship there is on interventions, enduring learning theories, and tried and tested teaching methods. Why, for instance, does one Ed-Tech's math app have more of an impact on a learner's attainment than another? How can we know that one math app has more of an impact than a close student-teacher relationship, which evidence has shown is a powerful predictor variable?

The marketing narratives of EdTech businesses should be toned down, in the way that advertising to children is strictly controlled in Europe. The hype about what these products can do for education should be more subdued and this should be part of the collective responsibility of all education stakeholders.

I.S.O._ How can children, parents, and teachers be involved by schools in the discussion regarding the adoption of technology in education?

V.H._ These stakeholders should be informed and never denied the right and/or the opportunity to know which data is being collected, by whom, and for what objective. They should have an alternative to EdTech products so that they are not entirely dependent on such technologies for providing their children's education and assessing what they learn.

Some scholars suggest that data and algorithmic literacy courses should be introduced for teachers, students, parents, and society in general, because algorithmic data-driven technologies are advancing in every aspect of life. This sometimes seems, however, to be more of

¹⁵ Find out more: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/digital-services-act-ensuring-safe-and-accountable-online-environment_en

a reactive position and an admission of techno-determinism, which I do not fully agree with. We do not need all children to learn how to code. You do not need to know how to cook to be given a nutritious and hygienically-cooked meal – farmers, butchers, chefs, and restaurant owners have a license to operate, and rules to adhere to, and they are subject to audits, which are reflected on the dish you are served.

Teachers and students are the primary users of EdTech products. It is important to know more about their experiences with regard to what works and what does not. Some EdTechs, however, have started to approach teachers through badging programs, offering them the role of product ambassador. This sort of stealth marketing turns teachers into sales agents and disables their ability to provide an honest critique or object to the use of these untested and unlicensed products.

Domain Report

Domain registration dynamics in Brazil and around the world

The Regional Center for Studies on the Development of the Information Society (Cetic.br), department of the Brazilian Network Information Center (NIC.br), carries out monthly monitoring of the number of country code top-level domains (ccTLD) registered in countries that are part of the Organisation for Economic Co-operation and Development (OECD) and the G20.¹⁶ Considering members from both blocs, the 20 nations with highest activity sum more than 89.80 million registrations. In June 2022, domains registered under .de (Germany) reached 17.30 million, followed by the United Kingdom (.uk), China (.cn) and the Netherlands (.nl), with 9.77 million, 8.71 million and 6.25 million registrations, respectively. Brazil had 4.97 million registrations under .br, occupying 6th place on the list, as shown in Table 1.¹⁷

¹⁶ Group composed by the 19 largest economies in the world and the European Union. More information available at: <https://g20.org/>

¹⁷ The table presents the number of ccTLD domains according to the indicated sources. The figures correspond to the record published by each country, considering members from the OECD and G20. For countries that do not provide official statistics supplied by the domain name registration authority, the figures were obtained from: <https://research.domaintools.com/statistics/tld-counts>. It is important to note that there are variations among the date of reference, although the most up-to-date data for each country is compiled. The comparative analysis for domain name performance should also consider the different management models for ccTLD registration. In addition, when observing rankings, it is important to consider the diversity of existing business models.

/Internet Sectoral Overview

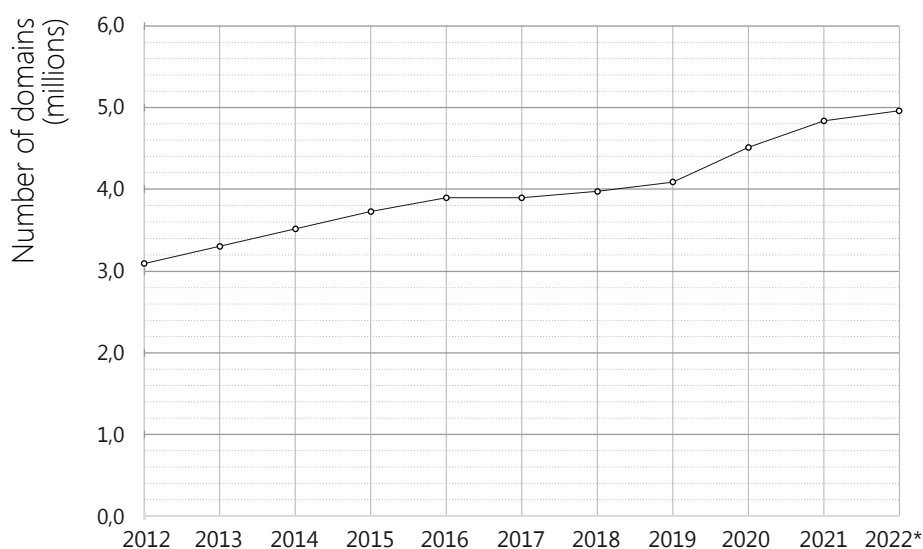
Table 1 – TOTAL REGISTRATION OF DOMAIN NAMES AMONG OECD AND G20 COUNTRIES

Position	Country	Number of domains	Date of reference	Source (website)
1	Germany (.de)	17,303,500	01/07/2022	https://www.denic.de
2	United Kingdom (.uk)	9,775,393	01/06/2022	https://www.nominet.uk/news/reports-statistics/uk-register-statistics-2022/
3	China (.cn)	8,713,778	01/07/2022	https://research.domaintools.com/statistics/tld-counts/
4	Netherlands (.nl)	6,252,182	01/07/2022	https://api.sidn.nl/rest/counters/domains
5	Russia (.ru)	4,993,369	01/07/2022	https://cctld.ru
6	Brazil (.br)	4,968,127	01/07/2022	https://registro.br/dominio/estatisticas/
7	France (.fr)	3,948,186	01/07/2022	https://www.afnic.fr/en/resources/statistics/detailed-data-on-domain-names/
8	European Union (.eu)	3,685,061	01/07/2022	https://research.domaintools.com/statistics/tld-counts/
9	Australia (.au)	3,606,787	01/07/2022	https://www.auda.org.au/
10	Italy (.it)	3,457,175	01/07/2022	http://nic.it
11	Colombia (.co)	3,372,022	01/07/2022	https://research.domaintools.com/statistics/tld-counts/
12	Canada (.ca)	3,287,784	01/07/2022	https://www.cira.ca
13	India (.in)	2,686,238	01/07/2022	https://research.domaintools.com/statistics/tld-counts/
14	Poland (.pl)	2,525,624	01/07/2022	https://www.dns.pl/en/
15	Switzerland (.ch)	2,494,378	15/06/2022	https://www.nic.ch/statistics-data/domains_ch_monthly.csv
16	Spain (.es)	1,986,105	30/06/2022	https://www.dominios.es/dominios/en
17	United States (.us)	1,844,753	01/07/2022	https://research.domaintools.com/statistics/tld-counts/
18	Belgium (.be)	1,742,666	01/07/2022	https://www.dnsbelgium.be/en
19	Japan (.jp)	1,704,363	01/07/2022	https://jprs.co.jp/en/stat/
20	Sweden (.se)	1,452,473	01/07/2022	https://internetstiftelsen.se/en/domain-statistics/growth-se/?chart=active

Collection date: July 1, 2022.

Chart 1 shows the performance of .br since 2012.

Chart 1 – TOTAL NUMBER OF DOMAIN REGISTRATIONS FOR .BR – 2012 to 2022*



* Collection date: July 1, 2022.

Source: Registro.br

Retrieved from: <https://registro.br/dominio/estatisticas/>

In June 2022, the five generic Top-Level Domains (gTLD) totaled more than 191.18 million registrations. With 159.62 million registrations, .com ranked first, as shown in Table 2.

Table 2 – TOTAL NUMBER OF DOMAINS AMONG MAIN gTLD

Position	gTLD	Number of domains
1	.com	159,618,619
2	.net	13,069,840
3	.org	10,600,730
4	.xyz	4,249,920
5	.info	3,646,368

Collection date: July 1, 2022.

Source: DomainTools.com

Retrieved from: research.domaintools.com/statistics/tld-counts

/Answers to your questions

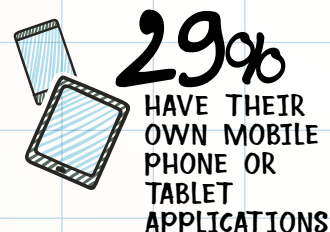
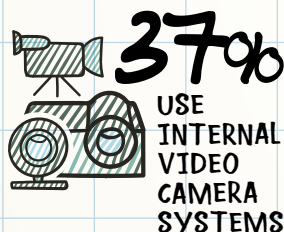
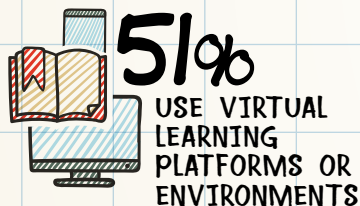
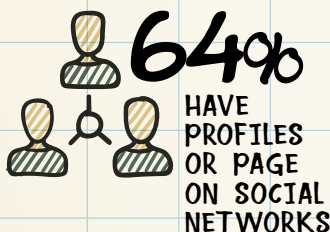
DIGITAL TECHNOLOGIES IN SCHOOLS

Digital technologies are increasingly common in educational environments, whether in school management, learning, or for other purposes. The growing use of these technologies implies an increase in the volume of data being generated about the school community, fueling debate about privacy and data protection.

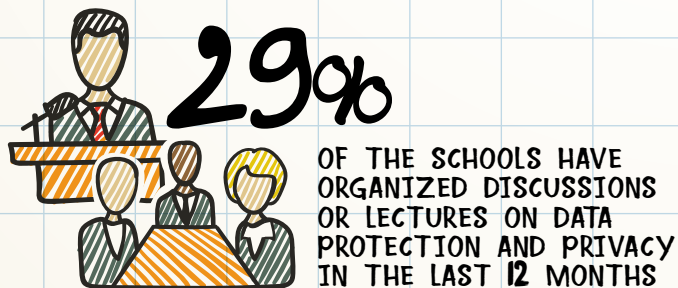
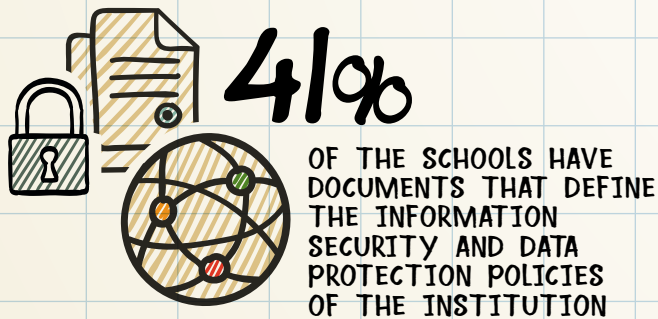
The following indicators¹⁸ are examples of the presence of digital technology in Brazilian schools¹⁹, and of the actions being adopted in relation to data privacy.

PRESENCE OF TECHNOLOGY

Among Brazilian schools:



PRIVACY & DATA PROTECTION



¹⁸ Data taken from Cetic.br | NIC.br's ICT in Education 2020 survey (COVID-19 Edition - Adapted methodology). Available at: <https://www.cetic.br/en/publicacao/pesquisa-sobre-o-uso-das-tecnologias-de-informacao-e-comunicacao-nas-escolas-brasileiras-tic-educacao-2020/>

¹⁹ Data relating to the total of Brazilian public and private schools that offer Elementary and Secondary Education. The data collection for the ICT in Education 2020 survey was carried out between September 2020 and June 2021.

/Credits

TEXT

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