

ARTICLE

THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN HIGHER EDUCATION DURING COVID-19 PANDEMIC

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ABSTRACT: The pandemic caused by the new coronavirus has brought several challenges to higher education and education in general. The nationwide lockdown disrupted traditional face-to-face teaching and forced teachers and students to stay home. The closure of all educational institutions led to the need to think about alternatives to continue the teaching-learning process. Thus, the educational field has experienced significant variation in terms of including a range of information and communication technologies (ICTs) tools. This qualitative and exploratory research starts from a universe of 283 online journalistic articles from the first two years of the pandemic that, after selection, resulted in 27 articles for a more detailed analysis. The results converge to three major areas: (1) structural aspects, (2) those concerning the teaching staff, and (3) those on the students. The analysis of the selected materials verified that, as support tools, the ICTs gave the educational system more flexibility, adaptability, and dynamism,

allowing the continuity of the teaching process. Though these technologies have brought new and significant possibilities for educational practices, they have faced, and still face, several challenges related to teacher training, educational teams' resistance to changes, educational institutions' structural characteristics, and the need for students' motivation.

Keywords: Information and communication technologies, Distance Education, Higher Education, Covid-19.

USOS DAS TECNOLOGIAS DA INFORMAÇÃO E COMUNICAÇÃO NO ENSINO SUPERIOR DURANTE A PANDEMIA DA COVID-19

RESUMO: A pandemia provocada pelo novo coronavírus trouxe uma série de desafios ao ensino superior e à educação como um todo. Resultou no fechamento das atividades nacionalmente, interrompendo o formato tradicional de ensino presencial e forçando professores e alunos a ficarem em casa. Com isso, as instituições de ensino foram compelidas a pensar em formas alternativas para a continuidade do processo de ensino-aprendizagem. Assim, o campo educacional experimentou uma variação significativa com a inclusão das Tecnologias de Informação e Comunicação (TICs). Baseando-se no método qualitativo e exploratório, esta pesquisa parte de um universo composto por 283 matérias jornalísticas on-line publicadas nos dois primeiros anos de pandemia que, após seleção, resultou em 27 matérias para análise detalhada. Os resultados da investigação convergem para três conjuntos de domínios principais: (1) aspectos estruturais, (2) aspectos relativos ao corpo docente e (3) ao corpo discente. A análise pormenorizada dos materiais selecionados permitiu a constatação de que as TICs, enquanto ferramentas de suporte deram mais flexibilidade, adaptabilidade e dinamismo ao sistema educativo, permitindo a continuidade do processo de ensino. Embora o uso dessas tecnologias tenha trazido novas e significativas possibilidades para as práticas educativas, sua adoção enfrentou, e ainda enfrenta, diversos desafios relacionados à formação docente, à resistência às mudanças por parte das equipes educativas, às características estruturais das instituições de ensino e à necessidade de motivação dos discentes.

Palavras-chave: Tecnologias da Informação e Comunicação, Ensino a distância, Ensino superior, Covid-19.

USOS DE LAS TECNOLOGÍAS DE INFORMACIÓN Y COMUNICACIÓN EN LA EDUCACIÓN SUPERIOR DURANTE LA PANDEMIA DEL COVID-19

RESUMEN: La pandemia provocada por el nuevo coronavirus ha traído una serie de retos a la educación superior y a la educación en su conjunto. Resultó en el cierre de actividades a nivel nacional, interrumpiendo el formato tradicional de enseñanza presencial y obligando a docentes y alumnos a quedarse en casa. Con eso, las instituciones educativas se vieron obligadas a pensar en formas alternativas para continuar el proceso de enseñanza-aprendizaje. Así, el campo educativo experimentó una variación importante con la inclusión de las Tecnologías de Información y Comunicación (TICs). Basada en el método cualitativo y exploratorio, la investigación parte de un universo compuesto por 283 artículos periodísticos en línea pertenecientes a los dos primeros años de la pandemia que, luego de la selección, resultó en 27 artículos para un análisis detallado. Los resultados de la investigación convergen en tres conjuntos de dominios principales: (1) aspectos estructurales, (2) relacionados con la facultad y (3) cuerpo estudiantil. El análisis detallado de los materiales seleccionados permitió comprobar que las TIC, como herramientas de apoyo, otorgaron mayor flexibilidad, adaptabilidad y dinamismo al sistema educativo, permitiendo la continuidad del proceso de enseñanza. Mismo que el uso de estas tecnologías haya traído nuevas y significativas posibilidades para las prácticas educativas, su adopción enfrentó y enfrenta varios desafíos relacionados a la formación docente, la resistencia a los cambios por parte de los equipos

educativos, las características estructurales de las instituciones educativas y la necesidad de motivación de los estudiantes.

Palabras clave: Tecnologías de la información y la comunicación, Educación a distancia, Educación superior, Covid-19.

INTRODUCTION

In modern societies, technological and digital devices have taken a prominent role. We use these tools for various activities, such as meetings, classes, shows, and lectures. Furthermore, we need technology to connect with people (Simonson; Smaldino; Zvacek, 2015). The increasing technological evolution that permeates our social and educational scenario reflects the demand for more modern and accessible devices that can solve simple and complex problems.

In the educational field, technological innovations started to raise discussions and studies about their role in teaching practices and promoting new learning types. Several publications emerged presenting Information and Communication Technologies (ICTs) as an important support for teachers' work and as relevant tools for the main demands of students' teaching and learning (Silva, 2021; Lastória *et al.*, 2020).

Despite this, until the 2020s, using ICTs in educational actions was not frequent in all realities, being restricted to specific contexts. This scenario started to change due to circumstances, when the need for social isolation was declared because of the Covid-19 pandemic in early 2020.

Faced with the virus spreading, the World Health Organization (WHO) declared the pandemic with worldwide repercussions, and measures started to be adopted to contain the dissemination of the disease. On March 16, 2020, in-person classes were suspended, and education institutions closed in Brazil. The following day, on March 17, the Ministry of Education (MEC) established Ordinance n.º 343 authorizing institutions to substitute in-person classes for digital ones, implementing the emergency remote education (ERE) during the pandemic and incentivizing the modality of online education (OEd).

Based on geographical distance, remote teaching shares the same time, i.e., classes occur synchronically, following the principles of in-person classes. Communication is predominantly bi-directionally, the one-to-many type, in which the teacher is the protagonist of video classes or gives an expository class through web conference systems, characterized by frontal and analogical learning architectures (Schlemmer; Felice; Serra, 2020).

However, this way of using ICTs, transposing and reproducing practices, does not represent innovation in education. Innovation takes place when there is a connection and a dialogue between ICTs and individuals, allowing the construction of interactive and connective networks. These networks create a logic of an intelligent ecosystem known as Education *OnLIFE* that transforms the way of thinking and doing education by overcoming the form of learning architecture to reticular and digital dimensions (Schlemmer; Felice; Serra, 2020).

In this new framework that was being established in the country, higher education degrees were forced to adopt teaching methods supported by technology to continue classes and students' learning, keeping social isolation and preventing COVID-19. The new educational situation that the world was experiencing brought new challenges to access and interpret this system at all educational levels, contradicting the perspective aimed by Law n.º 12.965/14 or the Brazilian Civil Rights Framework

for the Internet. In its 4th, 7th, 26th, 27th, and 28th articles, internet inclusion and democracy are presented as objectives, and its access is a right for all and essential for citizenship.

Therefore, the insertion of technological resources, which seemed to be a simple path to continue the educational actions held in in-person environments, faced, from the beginning, endless challenges in practice: students' technological support to follow remote activities; the regularization of actions and procedures; teacher formation and breaking the resistance against changes; students' access to equipment— and the consequent deconstruction of the idea that nowadays all individuals have access to the Internet; and the State's financial support to subsidize and guarantee everyone's access to these tools.

Given the above, knowing the tools applied in the teaching-learning process during the pandemic, focused on the development of current education, helps fill an important gap in educational transition nowadays and for future generations. In this sense, the present article aims to understand, through a qualitative and exploratory methodological design of journalistic articles, the approach of the main tools used in remote education during the pandemic and their challenges for higher education. Aware that journalistic articles are external narratives that seek to answer, in many cases, the interests of certain groups, their information are parameters to the critical analysis of our research object.

COVID-19 PANDEMIC AND THE EDUCATIONAL CONTEXT IN BRAZIL

Several countries have implemented social distance measures to mitigate and suppress the contamination caused by the new coronavirus. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), the closure of education institutions meant the suspension of in-person classes of approximately 1.5 billion students in 165 countries (from childhood education to graduate programs), strongly affecting academic performance and students' academic progress (UNESCO, 2020). Education mediated by technology was considered an alternative to substitute in-person classes during social distancing, decreasing the number of COVID-19 cases (Viner *et al.*, 2020).

Due to the needed sanitary measures, the Brazilian government authorized exceptionally the substitution of in-person classes for remote ones through digital means during the pandemic crisis. Remote classes aimed to guarantee that high school students could access university and that those from technical and higher degrees could finish their professional and academic formations (Arruda, 2020).

The *Conselho Nacional de Educação* (CNE—National Education Council), the body responsible for advising the federal government on education issues, also expressed concerns about school organization during the pandemic. In the higher education scope, MEC's guidelines were reinforced, and it was established that higher education institutions (HEIs) could use ICTs as alternatives for curriculum and pedagogical organization (CNE, 2020). This guideline sought to direct the 2,608 HEIs in the country.

Several formats were experienced throughout the pandemic: synchronous remote education, with online interactions between teachers and students; asynchronous remote education, with recorded classes accessed by students at any moment; and the hybrid model, a mixture of in-person and remote activities.

In-person classes were gradually resumed in the second semester of 2020 and mainly in 2021, establishing the use of a hybrid format for educational actions in different contexts. According to information disseminated by the *Coronavírus* panel from the Ministry of Education, in March 2021, 93% of federal public universities held their pedagogical activities mediated by ICTs (INEP, 2022).

The institutions were advised to implement online work for teachers and administrative staff, attending the university community while following the sanitary protocols established by local and regional authorities; to organize HEIs work according to the guidelines of local and regional authorities; and to inform regulation bodies about higher education in national and local contexts about the activities offered using ICTs resources (CNE, 2020). Following the recommendations of MEC and CNE to substitute the subjects and other activities for remote activities, the HEIs had to promote training actions for the teachers to learn how to use technological resources in the teaching-learning processes, as well as how to use social media to stimulate students' participation in academic practices (CNE, 2020).

INFORMATION AND COMMUNICATION TECHNOLOGIES

Information and Communication Technologies are extremely relevant tools for human interaction during the pandemic period, allowing the continuity of several daily activities that, without their use, would be a great biological risk due to physical contact. In the educational sector, for instance, activities through chat or web platforms, trainings through webinars, forums, and others meant a return to academic processes after a short interruption period to plan the actions, avoiding the physical proximity between students and teachers in the classroom and, thus, protecting public health (Sinche Crispín *et al.*, 2021).

In a study conducted by Galvis (2004), the author described and classified the ICTs into three groups according to their use possibilities in educational practices: active, interactive, and transmission. The active resources seek to allow students to act over the study object and, from experience and reflection, generate and refine their ideas about the knowledge that grounds such object. The interactive resources allow learning to occur through a constructive, synchronous or asynchronous, a dialogue among co-learners using digital means to communicate. Finally, the transmission resources seek to support the effective delivery of contents to the target audience.

Information and Communication Technologies (ICTs) have established themselves as fundamental resources to broaden the possibilities of accessing education in Brazil. The incorporation of ICTs into education systems directly affects the decrease of digital exclusion in the country and provides opportunities to form individuals able to face the increasing demands of technology use in daily situations and work life (UNESCO, 2022).

Thus, the insertion of education actions demands changes in pre-and in-service teacher training, allowing the development of competencies to use the technological resources so teachers might plan and implement educational actions suitable to students' specificities and be able to promote the construction of new knowledge (UNESCO, 2022). In a continental country marked by extreme social inequalities, improving students' access to equipment and the Internet is also fundamental to making the use of technology a reality in teaching and learning practices.

Studies conducted by Souza *et al.* (2020) with students from technical and higher education degrees highlighted that 25.7% of participants affirmed not having a computer or notebook at home, 7.5% had limited or no access to the Internet, and 26.2% stated having access to the Internet but with connection difficulties, be it through the mobile Internet of tablets or smartphones or via cable and household wireless.

METHODOLOGICAL PROCEDURE

This qualitative and exploratory research is anchored on documental search and analysis, using journalistic articles published on open-access websites as data sources. The study period was delineated between the first news about the COVID-19 pandemic, in early January 2020, and the end of June 2022, establishing a two-year cycle on the effects of the sanitary crisis in Brazilian education.

The search associated the terms "pandemic," "information and communication technology," and "higher education," thus establishing a set in which we seek to observe in depth a specific education segment. The phases of research were: insertion of search terms in the initial screen of Google; based on the initial results, the establishment of a first filter through the tab *news*, and, finally, a filter adjustment using the tab *tools* to research only in Portuguese with a personalized time frame, classified by relevance, and hiding duplicates.

As a result, we found 283 online journalistic articles that were classified and selected through a superficial reading. The inclusion criteria were guided by the three search elements and whose articles, of varied nature and objectives – such as public or private initiatives, research/perspectives, experiences/interviews – developed and reflected the themes studied, conceptual approximation/depth, relevance for the general public. Furthermore, they should be from reliable sources – such as specialists on the theme and consolidated studies or from nationwide trustworthy institutions. Texts that only cited the elements with no depth were excluded. Materials about different themes were also not selected.

After the first selection, 27 texts were left. These works were treated and analyzed to construct a table with general information on the articles and their summaries. The findings were analyzed from meaning units based on the content analysis in the thematic modality. To Bardin (2011), the interpretation of the material raised takes place in three phases: pre-analysis using floating reading and the first organization of the material; exploration and treatment of raw data through codes aligned to the research objectives; and the result treatment, in which the vast material is analyzed, dialoguing with the theoretical reference of the knowledge field.

RESULTS AND DISCUSSION

The results of this study converge to three major areas: structural aspects, aspects related to teachers, and those related to students. Half of the articles were from 2020, a moment to reflect about the teaching paths during the sanitary crisis. Generally, the articles present, on the one hand, a panorama of the implementation of educational strategies to maintain educational activities. On the other, the most recent articles from the first semester of 2022 point out future challenges, such as using new tools to engage students, such as gamification and metaverse.

Faced with the learning challenges aggravated by the pandemic – as the increasing demand to use technology in the education process and schools' difficulties in dealing with technologies and different teaching methodologies – the articles analyzed (Box 1) revealed the concern in the political sphere, which raises the debate on guidelines, plans, and programs to improve university formation regarding the use of ICTs and innovative teaching methodologies, aiming to identify the pillars of a national policy of technology in education.

Box 1- List of articles (A) analyzed

N	Title in English	Publication date	Link	Main information
A1	MCTIC will create a committee to supervise telecommunications in the coronavirus crisis	Mar.20, 2020	< https://www.terra.com.br/byte/mctic-criara-comite-para-supervisionar-telecomunicacoes-na-crise-do-coronavirus,47e878f438cf312acd5bfc742c988654e2lr6zp45.html >	The text reports a ministry action with measures to guarantee the work in the communication network, reinforce the connective structure in health bodies, and support public policies from other sectors, such as education.
A2	Only 6 out of the 69 federal universities adopted online education after the interruption caused by Covid-19	May 14, 2020	< https://g1.globo.com/educacao/noticia/2020/05/14/so-6-das-69-universidades-federais-adotaram-ensino-a-distancia-apos-paralisacao-por-causa-da-covid-19.ghtml >	Measure implemented by the Ministry of Education to maintain education in the national territory. A bit less than 100,000 out of the 1.1 million students were having virtual classes, against more than 960,000 students with no classes.
A3	Brazil has 134 million internet users; research states – Most access the Internet via cellphone	May 26, 2020	< https://agenciabrasil.ebc.com.br/geral/noticia/2020-05/brasil-tem-134-milhoes-de-usuarios-de-internet-aponta-pesquisa >	Data from a 2019 research about the inequalities of digital inclusion in Brazil, considering income, race, educational level, sex, and demographic location. The text brings reports from professionals working in the area about the difficulties to overcome remote education challenges.
A4	Consultation with students will map the general study conditions during the pandemic	Jun.03, 2020	< https://www.medicina.ufmg.br/consulta-ao-corpo-discente-vai-mapear-condicoes-gerais-de-estudo-durante-a-pandemia/ >	An initiative from a higher education institution to consult students about their general conditions to gradually plan the return to activities. Improvement of the policy of digital inclusion and connectivity of its academic community.
A5	Professionalization: Finish today the enrollment to the free online courses from Capes	Jun. 26, 2020	< https://www.acidadeon.com/cotidiano/Profissionalizacao-terminam-hoje-as-inscricoes-para-cursos-gratuitos-a-distancia-da-Capes-20200626-0049.html >	Capes, together with the Ministry of Education, offers training courses about ICTs to undergraduate students.
A6	Education after pandemic: greater inclusion and more independent students.	Jun. 26, 2020	< https://tab.uol.com.br/noticias/redacao/2020/06/25/a-educacao-pos-pandemia-maior-inclusao-e-alunos-mais-independentes.htm >	The coronavirus pandemic shed light on social inequalities in various fields. Students' and teachers' difficulties to connect are frequent complaints. Students who have no access to the Internet or computers, and teachers who face challenges to transpose the content to online platforms.
A7	Remote education in USP shows the collective effort to keep quality	Jul. 24, 2020	< https://jornal.usp.br/universidade/ensino-remoto-na-usp-mostra-esforco-coletivo-para-manter-qualidade/#:~:text=Na%20USP%2C%20desde%20que%20as,e%20ferramentas%20de%20educa%C3%A7%C3%A3o%20a >	Besides the institutional effort to offer resources, teachers had to adapt teaching methods and evaluations to attend students in need, in a collective effort to overcome inequalities in online education.
A8	Distance architectures: what the pandemic can reveal about Architecture and Urbanism teaching	Aug. 03, 2020	< https://www.archdaily.com.br/944738/arquiteturas-da-distancia-o-que-a-pandemia-pode-revelar-sobre-o-ensino-de-arquitetura-e-urbanismo#:~:text=Arquitetura%20e%20Urbanismo-,Arquiteturas%20da%20dist%C3%A2ncia%3A%20o%20que%20a%20pandemia%20pode%20revelar%20sobre,ensino%20de%20Arquitetura%20e%20Urbanismo&text=A%20cruel%20pedagogia%20do%20v%C3%ADrus,delinead >	Architecture understood that the best way to combat the proliferation of OEd was to defend the presential and integral dimension of architecture in society, in its practical, field, and outreach activities, in laboratories, models, experimental works, and even components factories. The pandemic can teach architects, teachers, and students that having a much deeper discussion about architecture as a profession is urgent and necessary.

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A9	Online education advances in higher education in Brazil	Aug. 23, 2020	< https://abmes.org.br/noticias/detalhe/3979/educacao-a-distancia-avanca-no-ensino-superior-do-brasil >	Increase of the online model in higher education in Brazil boosted by the Covid-19 pandemic.
A10	Gender inequality manifested in technology in Latin America	Oct. 15, 2020	< https://www.correiobraziliense.com.br/tecnologia/2020/10/4882423-desigualdade-de-genero-se-manifesta-na-tecnologia-na-america-latina.html >	Gender inequality regarding access to technology. The study shows that women have less access to the internet than men.
A11	CIEB tool to diagnose the use of educational technology will be used in 38 countries	Oct. 26, 2020	< https://porvir.org/ferramentado-cieb-para-diagnostics-de-adocao-de-tecnologia-educacional-sera-usada-em-38-paises/#:~:text=Para%20ajudar%20nesta%20tarefa%2C%20o,programa%20ProFuturo%2C%20da%20Fundacao%20A7%20Telef%C3%B4nica >	The text reports a diagnosis of digital competencies in schools and the use of ICTs as strategic tools for education.
A12	Students describe pedagogical practices during online education.	Dec. 03, 2020	< https://ufmg.br/comunicacao/noticias/docentes-relatam-experiencias-e-praticas-pedagogicas-em-tempos-de-ensino-remoto >	Report on the pedagogical challenges and strategies implemented during the pandemic, Emphasizing the use of ICTs.
A13	Pandemic, suspended classes, and change of ministers: Education in 2020 and the 2021 challenges	Dec. 25, 2020	< https://www.gazetadopovo.com.br/educacao/pandemia-aulas-suspensas-e-troca-de-ministros-a-educacao-em-2020-e-os-desafios-de-2021/ >	The use of ICTs as a theme of questions from <i>Tribunal de Contas da União</i> (TCU) to the Ministry of Education. In an online forum, the body asked for more technology in schools, while the ministry agreed about this necessity, though listing other priorities.
A14	Hybrid education in higher education should spread to more courses after the pandemic.	Jan. 09, 2021	< https://jovempan.com.br/noticias/brasil/ensino-hibrido-na-educacao-superior-deve-se-alastrar-para-mais-cursos-no-pos-pandemia.html >	Points out that remote education brought alternatives to work the competencies of each student, opening up possibilities for dynamic learning, not only through oral teaching.
A15	"Our greatest mistake was the long time to return the classes," says CNE president Nosso grande erro Maria Helena Guimarães de Castro	Feb. 03, 2021	< https://www.gazetadopovo.com.br/educacao/nosso-grande-erro-foi-a-demora-em-retornar-as-aulas-diz-presidente-do-cne/ >	Evaluation of the education scenario at the beginning of the Covid-19 pandemic. The delay in resuming classes and planning for future actions in the sector.
A16	Nothing will be as before, thankfully. Education changed with OEd.	Marc. 25, 2021	< https://www.correiobraziliense.com.br/euestudante/educacao-basica/2021/03/4914071-nada-como-antes-ainda-bem-a-educacao-mudou-com-a-ead.html >	Digital technologies are a promising factor for teaching-learning efficiency and the OEd model that most benefits from ICTs.
A17	Without a connection to the Internet, how is Education in 2021?	Apr. 28, 2021	< https://novaescola.org.br/conteudo/20301/sem-conexao-a-internet-como-fica-a-educacao-em-2021 >	In the context of remote or hybrid education, the lack of connectivity deepens educational and social inequalities.
A18	The new teaching agora in pandemic times	Apr. 29, 2021	< https://www.cartacapital.com.br/opiniao/a-nova-agrada-docente-em-tempos-de-pandemia/ >	Remote education and the use of several technologies do not substitute the presence allowed by universities as spaces of humanization, exchange, and collective construction. However, amidst the global crisis, there is an opportunity to enjoy shared resources worldwide.
A19	Chamber Study Center promotes a debate on	Aug. 19, 2021	< https://www.camara.leg.br/noticias/794087-centro-de-estudos-	Debate on the political sphere about pre- and in-service university training and the use

	technologies in higher education.		da-camara-promove-debate-sobre-tecnologias-na-educacao-superior/>	of ICTs and innovative teaching methodologies.
A20	The pandemic sheds light on educational inequalities, challenges teachers, and changes families' routines.	Aug. 22, 2021	< https://www.nsctotal.com.br/noticias/pandemia-desafia-professores-muda-rotina-familias >	The pandemic unveiled the different teaching and learning conditions of young people in the country due to issues such as income, infrastructure, and digital knowledge, making the education process a challenge for teachers, students, and families.
A21	Teachers stumble onto a lack of structure and training to use technology in teaching	Oct. 15, 2021	< https://querobolsa.com.br/revista/professores-esbarram-em-falta-de-estrutura-e-formacao-para-uso-da-tecnologia-no-ensino >	The pandemic and online classes revealed the problem of digital exclusion in Brazil (access to education and digital tools by students and teachers). Preparation of undergraduate courses to use new technologies and methods.
A22	Online university gets even stronger with the pandemic.	Nov. 03, 2021	< https://www.agazeta.com.br/arenaprofissoes/faculdade-a-distancia-ganha-ainda-mais-forca-com-a-pandemia-1121 >	OEd teaching gained steam during the pandemic, with a higher social perception of how this modality works, and it was incremented as the only possible modality of education during the social distancing period.
A23	Latin America leads the use of technology in higher education	Dec. 27, 2021	< https://www.folhavoria.com.br/geral/blogs/educatech/2021/12/27/america-latina-lidera-o-uso-de-tecnologia-no-ensino-superior >	Research about the determinant factors of students' engagement in higher education shows a good perception toward online learning.
A24	From OEd to the Metaverse: the effects of technology to transform higher education	Apr. 08, 2022	< https://cryptoid.com.br/conectividade-tecnologia-criptografia-id/do-ead-ao-metaverso-os-efeitos-da-tecnologia-para-a-transformacao-do-ensino-superior/ >	Classes mediated by technology were accelerated by the COVID-19 pandemic. The technological scenario in the HEIs affects students' paths in the institutions. Emergence of new teaching-learning models, aligning the demands to advantages for students and universities.
A25	Metaverse in the university? Check out the universities that already take part.	Jun. 15, 2022	< https://querobolsa.com.br/revista/metaverso-na-universidade-veja-as-instituicoes-que-ja-aderiram >	Perspectives and challenges of the metaverse in the educational area. Universidade de São Paulo (USP) and Fundação Instituto de Administração (FIA Business School) acquired spaces in the virtual world.
A26	Brazil registers a drop in in-person education and an increase in online education.	Jun. 15, 2022	< https://odiariodemogi.net.br/canais/educacao/brasil-registra-queda-na-educac-o-presencial-e-alta-no-ensino-a-distancia-1.50692 >	COVID-19 pandemic speeds the growth of online education in higher education institutions.
A27	In education, innovation is more methodological than technological.	Jun. 17, 2022	< https://www.gazetadopovo.com.br/gazz-conecta/na-educacao-mais-metodologia-inovacao-tecnologia >	The text discusses the impacts of digital transformation and the implementation of new learning methodologies. Methodological proposal for hybrid education, applying technology to answer the needs of the area and potentialize the learning process.

Source: created by authors.

The subjects discussed refer to the main challenges to be faced in the education area in Brazil and worldwide, such as the update of curriculum guidelines to include or improve topics related to ICTs, innovative teaching methodologies, and digital culture; the difficulties faced by students, teachers, researchers, and managers in the universities and teaching institutions related to the use of ICTs in management; the development of ICTs and innovative teaching methodologies in undergraduate studies, research, and outreach; critical analysis and perspectives on on-going strategies to answer the theme; and examples of good practices and success cases.

STRUCTURAL CHALLENGES

Much is said in the educational area about the importance of teachers' continuing education to promote new learning. However, the observation of the scenario imposed by the COVID-19 pandemic unveiled the existence of other factors that, when directly interfering in the construction process of new knowledge, should be considered. The structural limitations in many schools and the lack of infrastructure in the homes of teachers and students also negatively interfere with the teaching-learning processes. (Monteiro; Silva, 2015; Souza; Dainez, 2020).

According to the Organisation for Economic Co-operation and Development (OECD), 95% of students have a computer with internet access to study in the so-called developed countries, while in Brazil, only 30% of public school students have a computer. This percentage in the private education system rises to 88% (OECD, 2020). The reflections about the structure refer to the need to guarantee financial resources to provide equipment, such as computers, webcams, and internet access. Furthermore, the development of information systems is vital, as well as the diversification of teaching methodologies that operate in this new digital universe: "Institutions need to quickly adapt to this new reality, from the structure of IT areas, the implementation of well-structured information system, up to the adequacy of teaching offer and digital solutions compatible to technological development" (A24).

Teachers' testimonies point out that, in reality, structural adaptation to incorporate technologies into educational activities occurred in a rush, guided by the use of few resources and with no support from all parties. (Oliveira; Pereira Junior, 2021; Nascimento, 2021).

A study conducted by the company Instructure, creator of the virtual learning tool *Canvas* in Latin American countries (Mexico, Colombia, Peru, Chile, and Brazil), showed that the educational institutions in these countries use communication management systems and online classes. More than 65% of the institutions have technological tools mediating teaching activities and almost 75% of learning tool users accessed them through mobile devices. Virtual learning environments are used well when comparing Latin America with other countries in North America, Europe, and the Middle East (A23).

Furthermore, the study considers that access to the internet and education technologies are key to the success of the virtual learning model. However, in the Brazilian cases, the socioeconomic factors are determinants for non-connectivity: "income levels and the access to learning resources and technological tools continue to harm some students, 80% of respondents point out family income as an impact factor for students' engagement (A23).

Data from the research *TIC Domicílios 2019* from the Comitê Gestor da Internet no Brasil (Valente, 2020) show the impact of access inequality to ICTs by income, pointing out an accessibility difference of up to 33% when considering Brazilian's income, among those earning less than the minimum wage and those earning over ten minimum wages. According to the lawyer and member of the *Coalizão Direitos na Rede e do Comitê Gestor da Internet*, Flávia Lefèvre, overcoming this inequality should pass through more effective governmental actions in the area and greater public funding for digital inclusion (A3).

Considering the challenges for the future, mainly the insertion of the metaverse¹ Some articles (A25, A27) present how this new world will be established in the Brazilian educational context. Higher education institutions, such as *Universidade de São Paulo* (USP) and *Fundação Instituto de Administração* (FIA), opted for this new reality. The classroom from the metaverse, anchored in virtual spaces and using special goggles, needs ultrafast connections and demands equipment to process a large amount of data (A25).

According to Professor Luciana Allan from USP, interviewed in the article, “Before thinking about the metaverse, we need to understand that we still do not have technologies that allow us to enjoy all its possibilities. More sophisticated tools are needed to do so, which is not a reality in Brazil” (A25).

Another relevant issue is the consolidation of OEd in Brazil, which became stronger during the pandemic. An education model with flexible tools has the challenge of transposing socioeconomic barriers mainly in a country with great social and technological access inequality, thus expanding this education modality (A20).

TEACHERS' CHALLENGES

Teachers' effective participation and involvement are fundamental for the success of pedagogical strategies mediated by technologies: “The whole faculty needs to be engaged, working with differentiated teaching and learning proposals” (A21). Most journalistic articles point out that educators' training is a challenge for HEI, encompassing the teachers in the institutions and future professionals during their undergraduate courses. Therefore, investments in teachers' training is needed regarding the use of technological equipment and the new educational methodologies, more flexible and dynamic (A23, A25, A27).

Besides the institutional effort to offer resources, teachers had to adapt their teaching and evaluation methods to attend to students in need in a collective effort to overcome inequalities in the process of online education (A7). Teachers in a public Brazilian university reported the challenges of teaching cartography amidst the pandemic, including the main forms of dialogue with students and the implementation of theoretical-practical activities. Furthermore, they revealed that among the problems resulting from the impossibility of teaching in-person, they constantly sought new ways of enacting practical activities and evaluate them (A12).

A special look can also be guided to the metaverse environment¹, as it is a recent technology, and most teachers are not from the new generation of digital natives. Besides mastering the content, teachers should understand how to control technological resources and the expressions of students' avatars. According to teacher Alessandra Montini from FIA, “Teaching in the metaverse is like a marathon. You have to stop for 15 minutes and rest afterward” (A25).

The COVID-19 pandemic shed light on social inequalities in various fields. Connecting students and teachers is a frequent complaint, ranging from students not having access to the Internet or computers to teachers who are challenged to transpose content to online platforms (A6).

¹ The metaverse is a concept of an online 3D universe combining several virtual environments. We can imagine the metaverse as a future internet interaction. The metaverse will allow users to work, meet, play, and socialize in 3D environments.

Therefore, students' needs should dictate and shape the future of higher education. The digital ecosystems in the field of learning and knowledge emerge and will increasingly be included in this journey towards quality digitalization. Far beyond physical innovation, there is a need to invest strongly in teachers' training.

STUDENTS' CHALLENGES

Another axis in this equation is the higher education students. The articles reveal the need to personalize education, offering attractive pedagogical models to engage this new generation of digital natives (A21, A24). OEd seems quite promising in this aspect as it allows learning individualization, which is hard to reach in in-person education, using current technologies, such as Artificial Intelligence, that allow adaptive learning to be successfully implemented (A16).

In a qualitative study conducted with higher education students from a Spanish university, students raised the benefits and obstacles to using ICTs in pedagogical strategies. Among the positive points, internet access, time-saving, resource diversity, learning improvement, motivation increase, and greater convenience stand out. As obstacles, students highlighted the cost of some devices, technical and access difficulties, the formation level demanded, and the distractions they might create (Ricoy; Couto, 2014).

The research from Instructure (A23) shows that the managers from education institutions consider students' engagement during remote learning as complex – 60% of managers from North America, 59% from Latin America, and 49% from Europe and the Middle East (A23). Among students, 47% identify themselves and prefer online education (A23). Nonetheless, during the pandemic, there was a lower emotional (feeling of belonging), intellectual (critical sense), and cognitive (wanting to learn) engagement from students (A27). To improve students' participation, the use of adaptative platforms, which value the formative itinerary of each student, and the development of soft skills, i.e., socioemotional competencies, represent a pathway to be taken by the universities.

In this direction, besides the aforementioned metaverse technology, which seems promising in terms of pedagogical praxis (A25, A27), according to Ricoy and Couto (2014), the ICTs also contribute positively to students' motivational aspect, recognized by its validity and applicability in the teaching-learning process. An example is the interactive board that allows the projection of the computer in a board able to recognize writing by the hand touch, making learning more visual, playful, interactive, innovative, and captivating (Ricoy; Couto, 2014).

However, the articles also show that technologies cannot generate educational results alone. The important point is how these education methodologies, whether remote, in-person, or hybrid, are using these technologies. There is no perfect model; it depends on several challenging factors, among them students' training (A16).

The need to train students to use ICTs is highlighted as necessary for the great transformations in teaching in Brazil and worldwide. About this issue, in an article from *Agência Educa Mais Brasil*, the implementation of free training courses on ICTs represent a great opportunity for students (A5). An example was the offering of a free and remote professional improvement course about ICTs, among others, offered by *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (Capes- Brazilian Federal Agency for Support and Evaluation of Graduate Education) together with MEC, which represented a public initiative to incentivize professional improvement by capacitating students with

knowledge that complemented their regular studies. The course lasted 60 hours and approached relevant modules, such as the familiarization of studies in virtual learning environments, media in education and technological evolution, and OEd and network society (A5).

FINAL REMARKS

For a while now, the importance of using technological resources in teaching-learning practices has been the object of discussions in the education area. Despite evidence about the role played by ICTs, the effective insertion of these resources was done differently in different educational settings in the last decades. The social isolation demanded by the COVID-19 pandemic brought to light new demands about the use of technologies, as educational institutions from different levels had to face the challenge of continuing to offer educational actions with no in-person actions.

Using technologies in this context was essential for education institutions to continue the formative processes and impose the adoption of necessary actions. After the period of social isolation, some technological resources became part of the educational practices in certain educational realities. However, their use still presents new demands and challenges in the short, middle, and long term.

One of the greatest challenges is the search for new paths for pre-and in-service teacher training to allow the development of competencies to use technological resources and the means for these resources to be effectively inserted into teachers' planning. Teacher formation demands the creation of public policies that can equip schools with adequate equipment and fast and high-quality Internet. Good learning situations proposed in educational environments that are properly equipped can guarantee students' motivation to use technology and develop use competencies to act in an increasingly technological society.

In the Brazilian context, a large-scale barrier is social inequality, a structural problem. We depend on public policies to improve the education offered in the country and to offer an education that can contribute to constructing a fairer and more equal society.

The only certainty is that the future no longer supports the model from the past. Thus, the findings from this study reveal a conjecture that seeks changes in the teaching-learning process of higher education in Brazil, represented by the incorporation of ICTs in education methodologies.

The conditions of virtual classes and emergency remote education in Brazil offered during the period of social distancing due to the pandemic were experiences that point to a pathway for the future. This path should be grounded in the creation of public policies that guarantee access to quality equipment and internet access to all students.

Besides this, it is important to observe the conditions to access and use ICTs, mainly regarding the abilities with applications, a potency for students – natural to digital natives, contrary to teachers, who are part of a generation that seeks to improve their knowledge during the technological innovations. Being a digital native does not necessarily mean being able to use the equipment and information available critically. Students' engagement in seeking the development of digital literacy demands the insertion of technological resources in different subjects, not as an instrument to reproduce the traditional and mechanical practices but to adopt active learning methodologies that allow the whole formation of subjects.

Regardless of the modality of education practiced – in person, hybrid, or online – the use of tools in higher education faces challenges inherent to its work conjecture, such as teacher's and students'

training, education innovation, and personalization, increasingly demanded by new generations of students, as well as challenges that escape its scope, for instance, the socially unequal reality, which impact the accessibility to mobile technology. This scenario establishes a need to face these challenges, at intrasectoral and intersectoral levels, to effectively build a digital culture in education in Brazil. We need to race against time, and it is quite relative concerning this reinvention.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in the present article.