

The Pandemic Impact on Online Education as an Urban Insurgence: Cognitive Neuroergonomics of Virtual Learning Environments

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Abstract This research sought to present an urban insurgence aggravated by the coronavirus pandemic and that is still overrunning the Brazilian Education: the access to online Education. The research objective was to propose a study of urban management that aimed to promote a negotiated management for online Education. The methodological proposal was subdivided into three sections, using a triangular nature: bibliographic, quantitative and exploratory. This urban phenomenon evidenced the need for rapprochement between the Educational Market and the City to plan access strategies that would guarantee the basic rights of citizens such as Education. The pandemic highlighted the urban weaknesses of Internet access, as well as some precarious consequences in the teaching and learning process students who seek a better qualification when they opt for this modality of Private Network Education. The result shows that there is a lack of decentralization and quality in the Internet access, which compromises the students' affective (feelings and emotions) and cognitive (neuroergonomics) experience in virtual environments.

Keywords: *online education, virtual learning environment, cognitive neuroergonomics*

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1. Introduction

In the last ten years, the Distance Learning market and the models of an increasingly hybrid Education have been growing rapidly in Brazil. It is even understood that this is an educational market trend. However, what is this market? It is possible to call it Education, which is mainly related to Higher Education Institutions (HEIs). After a period in which the market shares were not yet defined and saturated, there were some HEIs that even tried to make the Distance Learning niche their new educational investment, perhaps as an expectation of survival in an increasingly competitive market or seeking to innovate in a modality that has not been potentially explored yet. In recent years, it was possible to observe some numbers that point to the reason why such the need for distance education has become a market trend, as well as some impacts that directly or indirectly affect the network of cities and that should be considered as urban insurgence.

Therefore, it is necessary to guide the discussion between the educational market and the city, for the urban insurgences as a management practice negotiated between the Government and HEIs must be urgently debated. By reading the Entrenched Clauses of the Constitution of the Federative Republic of Brazil of 1988, Title II –

Fundamental Rights and Guarantees, Chapter II – Social Rights, Article 6, it is possible to understand that Education is a social right for all. In addition, Title VIII – The Social Order, Chapter III – Education, Culture and Sports, Section I – Education, states that everyone has the right to education and lifelong learning. No less important, Article 26 of the Universal Declaration of Human Rights states that everyone has the right to education as a fundamental element of the full development of the human personality. Finally, it is worth pointing out that the 2030 Agenda of the United Nations (UN) highlights, in its 17 Sustainable Development Goals, the fourth SDG – Quality Education. SDG 4 predicts that the world's citizens will have quality, equitable and inclusive education by 2030.

At first, it is possible to highlight the numbers related to the growth of the educational market of Distance Learning in Brazil. And in a second moment, the urban insurgences that were calamitous exposed by the coronavirus pandemic in cities where the number of students of different age groups, from basic and higher education, who pleaded difficulties in accessing the Internet was deeply worrying. In the context of Brazilian social vulnerability, the impact on Youth and Adult Education (EJA) during the pandemic period can be considered an educational anathema, since, given these tensions, the right to quality online Education and the virtual environment were compromised, which demonstrated, in

the same way, the involved actors' educational weaknesses in teaching and learning. Therefore, it is important to invoke the following question: how would it be possible to join forces between the actors (the educational market and the city) in order to carry out a negotiated management? The city's daily insurgences compromise the very quality of services provided by HEIs, since they are rooted in the civilizing process and are part of the urban phenomenon: the access to the Internet and the virtual environment.

The justification for this research is based on data from Simesp Institute which, in its tenth edition of 2020, released the Map of Higher Education in Brazil and demonstrated that the Distance Learning reached a variation in enrollments of 91.7% only in private schools in the period from 2014 to 2018. These data were considered and cross-checked with surveys carried out by the National Institute of Educational Studies and Research Anísio Teixeira (Inep) and the Ministry of Education (MEC), through the Higher Education Census, which also released the figures for this growth in 2019: from 16,425,302 vacancies for higher education, 10,395,600 corresponded to the Learning Distance modality.

These figures indicated that, for the first time in the private educational network, the number of entering students in undergraduate courses in the Distance Learning modality surpassed the number joining the face-to-face learning. In other words, 50.7% (1,559,725) of students opted for Distance Learning programs, while 49.3% (1,514,302) prioritized traditional classroom programs. It is also noteworthy that in 2018, the Brazilian Association of Higher Education Supporters (ABMES) indicated that this number would be exceeded in the private network only in 2023. This means that this number had already been reached in 2019. It should be emphasized that this growing phenomenon was made possible since the Decree nº 9,057, of May 25, 2017, issued in the Government of then-president Michel Temer, which established the regulatory framework for Distance Learning in Brazil.

Given this scenario, the central topic of this text is to understand the weakening consequences in the teaching and learning process of students who seek better qualifications when they choose the Distance Learning modality in the private network. This model exists in a considerable number of HEIs that, after a certain period of investment and market strength, start to operate in the massification rules and aim to maintain quality: focus on products and services that dominate the market [1]. In the meantime, it is imperative to consider the political movements involved in the quality online education in Brazilian cities, since the current Distance Learning moment begins to overcome the “digital utopianism”, mainly due to the situation that devastates Brazilian education in times of Covid-19 pandemic.

Faced with the digital exclusion and the guarantee of accessing the Internet with quality, in order to promote the right to Education, “the global technological platforms are no longer seen as harmless and invisible companions [...]” [2]. Therefore, the digital technology involved in Distance Learning cannot be seen only as a data science applied to online education at HEIs, but rather as a structure that is also a basic policy that should support the urban management: the informational ethos and the students' cognitive ergonomics through the experience in

cyberspace. The concept of informational ethos refers to the individual who lives in the world based on new technologies, in society, and accesses and produces his/her own information, individually and collectively in cyberspace [3,4].

When private and market-leading HEIs meet a certain educational demand from citizens spread over specific regions of Brazil, such as the South, Southeast, Midwest, North and Northeast, there is a standard model (learning path) to be offered and that favors the choice of some large technology companies' platforms. These are the cases of Blackboard, D2L and Moodle, widely used in the national territory. It is a dynamic offered through models called Massive Open Online Courses (MOOCs). It is a business logic, developed to offer the possibility of global learning. Even when not using one of the aforementioned platforms, as there are HEIs that have exclusively developed their own platforms, the pattern and modular dynamics follow the same logic as MOOCs.

Thus, this work has the general objective of proposing a study of urban management that aims to promote the need to join forces between actors in the educational market and the city for a negotiated management. A management that is capable of offering a common ethos to society, in an explicit, objective and effective way. A business and governmental ethos, in order to rethink society's performance through quality education and technologically democratic — a common and global solution of social, physical and mental well-being, as this solution becomes ecosystemic and transversally inclusive when it involves Online Education. Since it is an isotropic dynamic between individuals and their physical-virtual spaces — that is, it involves the triad world, body and mind — the phenomenon to be considered is the Global Brain.

After considering this dynamic, studies should proceed to neurocognitive issues, as institutional planning in virtual environments directly impacts the students' cognitive performance, either through the products of digital technologies used, or through the methodologies and their pedagogical proposals in cyberspace. Both considerations are related to students' cognitive neuroergonomy. Likewise, they are directly dependent on the quality of Internet access. These are urban aesthetics that must be considered through the user's affectivity in their physical (objective) and virtual (subjective) experiences. Analyzing meaningful learning through Online and Distance Education has become the biggest challenge of the massive educational market of Distance Learning: human beings need to be motivated, feel pleasure and recognize themselves in what they do for a quality learning to take place.

In the next sections, this study will develop the discussion of how these daily insurgences in the city compromise the very quality of services delivered by HEIs, since the demand for needs that have not yet been systematized is rooted in the civilizing process and is part of the urban phenomenon. Furthermore, the archetypes of these same civilizational phenomena present crises and changes and, as they are part of a paradigmatic revolution, they require new instruments [5]. In other words, the physically and virtually built environments start to involve a new scientific-instrumental and inclusive demand, in order to understand the sensations and emotions aroused

in their users. These environments are neuroarchitecture, neurodesign and neuroergonomy in Online Education.

2. Inside Internet: A Philosophical Approach to Cyberspace

It is commonly known that, since the Internet emergence and data evolution, life has never been the same, as the information production and human experience through digital platforms were directly and significantly affected. But what is new in this discussion? For the information philosopher Luciano Floridi, professor at Oxford University and director of the Oxford Internet Institute, Internet architecture needs to promote Human Rights [6]. Therefore, it is worth questioning some factors of these universal rights: what is the access quality to online Education and the Internet offered?

The flow of information available over the Internet and the access quality are part of a mediation that depends exclusively on corporations and organizations that develop and offer the entire technological infrastructure. Therefore, decisions involving the provision of Internet access depend on an ethical responsibility involving political and architectural elements. The guarantee of Human Rights starts to be guided through this perspective [6], and, specifically, when analyzing the online Education agenda in a negotiated management between the educational market and the city.

According to Lemos (2013) [7], the computer technology, preceding the Internet itself, encompasses three historical dimensions: technical, social and ideological. These categories refer to analog technology, socio-political organization and rational administration of life, which became part of the strategic innovations of cities and institutions. In addition, the global appeal that the Internet gained through a cosmopolitan perspective, which would foster human emancipation with the highly acclaimed age of cyberculture, is questionable. However, this emancipation was the result of a negotiation conducted by the citizen/consumer with the market mediation [2].

According to Morozov (2020) [2], the political and ideological power behind the Internet is also part of how high-tech companies manage to awaken qualitative trends in the market, and, therefore, their rhetorical strategy should be analyzed. This occurs since, in online Education, for example, issues involving urban infrastructure may be exclusively in the domain of large Internet corporations that target Education, data management and free advertising, but their marketing is focused on the Education of the future accessible to all. This ends up generating a worrying picture, as this path can lead to austerity urbanism [8].

Keeping away from a technophobic stance and against Silicon Valley, it is common knowledge that it was from these achievements provided by the Internet and, therefore, by Information and Communication Technologies (ICT) that citizens began to consume and produce more information, as well as seeking services with greater accessibility and speed. The access to the Internet gave rise to another network phenomenon: the popularization of the so-called hypertexts, that is, cultural productions in a

global and online cyberspace. The demand for more agile and efficient services has become a current practice in the daily lives of the connected cities [7].

Thus, the human being finds new spaces in a virtual environment for interaction and knowledge construction. Access and traffic in virtual space allowed the fragmentation of a problem that limited and, at times, even discouraged people to develop greater relationships, exchange and creation of information caused by geographic distances [9]. It is now possible for citizens to access public and private services through cyberspace. Meanwhile, to have access to virtual reality available by the market and by the city, it is important to reflect on what actors are actually trying to promote to improve quality access and foster inclusion.

According to Lévy (2007a) [9], there is a synchronization phenomenon that is beyond the need for unity and place. Education has the potential to make use of these two environments, as it is included in both realities: physical and virtual. Students are part of these communities that now have access to virtual environments, breaking with the notion of space and time. Thus, the virtual begins to have a real place nature. Or, a priori, referring to the ontology of the concept discussed by Deleuze, it would be the full reality of the virtual [10]. With the ICT potential, the virtual environment has become a space in which human communication speeds are multiplied without the need for physical mobility. This was fundamental for the expansion of online Education and its modalities: Distance Learning, blended and remote.

The citizens who start to enjoy services through online and offline virtual environments share a multitude of information about various experiences in the infosphere. This massive and networked exchange is able of quickly updating learning between people and the public and private sectors. The city and the citizen effectively become more connected from this sustainable perspective of accessing and sharing information, in which changes in the urban life world can be considered. Therefore, it is possible to have as a premise the Actor-Network Theory (ANT), since actions become more and more collective in networks and still leave dynamic trails for other actants who seek and support a virtual ecological dimension [7,11]. The term “actant”, as used here, can be understood as the hybrid relationship between people on social networks, as well as the exchange of information available and recorded on devices and their circuits. A kind of input trigger (mediation) with output potential (translation), or the one who makes the other do [12].

In addition, it is worth remembering that the market and the city can take advantage of these actants’ registered actions. According to Ashton (2017) [13], author who proposed the concept of Internet of Things (IoT), there are numerous devices connected to the Internet and spread across the cities that feed the urban Big Data, in order to improve public and private services [7]. Once these actant propositions are considered, it is possible to see that they are connective actions promoted by humans and non-humans in digital networks, and that they are consistent with the ANT concept [13,14,15]. Thus, it is important to consider equally the non-human forces ecologically involved in public and private phenomena, in a kind of vital materialism, as they are natural forces [16]. Currently,

part of these connected devices that feed the Big Data hypertextuality comes from online Education, which adds the human/non-human relationship. Learning data are even achieved, which are transformed into collective resources [8].

It is possible to see that there is a demand for more careful observation and an exchange of competences, or as Lévy ([9]: 60) already warned, a [...] knowledge of how to be [...] that has to do with the virtual. With this, the involvement of the actors — who start to worry about ethical issues related to the virtual environment and public responsibility that must return to the State — grows. For example, Online Education becomes a post-Internet emancipation program if, and only if, the educational market and the city start to listen to the demands of citizens connected in a network, giving a partial voice even to those on the margins of the virtual environments. This can be explained by the fact that, due to the pandemic caused by coronavirus, some people were excluded from educational spaces precisely because of the lack of access to quality Internet.

Therefore, the influence that citizens exert start to assume a characteristic of more joint action and in a collaborative network. It is net-activism, that is, the social (human) expansion that connects to the network horizontality in order to seek a more expansive communication through the Big Data complexity. Factors such as these become an issue in the urban management of inclusive cities. In this search, there is a need for the reticular actions to be ecological, as planning for sustainability takes place through hyper-complex relationships.

Net-activism can enhance the communicational sustainability between citizens and the State in the face of this informational hypercomplexity through Big Data. However, for this to happen, apparently the popular participation and the users' engagement to the services offered depend on an Open Data proposal in the background. The innovation comes with the optimization of urban projects that encourage the active Open Data to the users of the public and private system precisely because they receive access to free data in cyberspace [17].

For example, Brazilian MOOCS have directly and effectively contributed to students seeking learning opportunities, many of them free and low-cost. Likewise, they are not just a choice of open and low-cost courses, but of access to digital common goods, as they are goods characterized as instruments that can promote the subject's emancipation [8]. The same potential is found in the HEI's VLE platforms, which offer different courses authorized and recognized by the Ministry of Education (MEC), specifically undergraduate and graduate courses, between 100% Learning Distance (EaD), blended and remote modalities. The challenge for HEIs, which seek to enable access to education through these modalities, is to make the virtual environment more meaningful, horizontal and cognitively neuro-ergonomic [18].

It is also an ethical concern regarding the information available on the web, as there is a whole potential for collective resources. On the one hand, there is the user-student's online Umwelt (own world) and, on the other, the indistinguishable world of the actor-machine. These are ethical consequences that must be considered

when discussing the cyberspace concept, since information in Big Data progressively acquires an active character in earthly life. Social organization must be thought of as an increasingly complex network of rights.

According to Lemos and Lévy (2010) [19], these new forms of society manage to democratically form a collective intelligence in cyberspace. And what would be the benefit of this collective level of intelligence? According to Lévy (2007b) [20], decision-making starts to be analyzed in a transversal and collective way, which generates an active and real-time relationship on the web. A student, who performs his learning journey in a virtual environment of a specific HEI, whether he/she wants to or not, has created an actant trigger and its informational trail, now on the web, and can generate a transposition of experiences.

Finally, considering the urban insurgences that have drastically become essential needs and revealed the vulnerability of the Government's urban management in acting with Education in Brazil, it is urgent to perform a reontologization on the VLE aesthetics and the use of Digital Information and Communication Technologies (DICT). The Distance Learning cultural symbolic and Online Education in Brazil cannot be limited to the educational market and its regional "slices", but encompass the different types of inclusion that a city should prioritize, through the active participation of the actors who generate strategic data for ecosystem urbanity [3,4,18,21]. And, in this case, the pandemic caused by the coronavirus showed that the lack of negotiated management sometimes made the educational market and the city difficult the right to Education.

3. A Voice of Urban Insurgence: Online Education in Times of Pandemic

This section analyzes the data collected through a questionnaire applied between 05/31/2021 and 06/19/2021 to students of a private HEI in the State of Paraná, to which this research author is linked as a Learning Distance professor. Although this HEI has the mentioned region as its physical location, its performance in the Distance Learning educational market begins to cover the national territory. Responding students are spread across different Brazilian regions.

This research author chose to maintain the HEI secrecy and anonymity, since the analysis nature is qualitatively suited to the framework of a generic research. Since the analysis of the respondents' sensations and emotions are in the field of subjectivity, there is no need for nominal specifications at this time and scope of the research.

This is a qualitative, confidential research with data protection for volunteer respondents. The data collected here were used in a descriptive and numerical/generic way, in order to report some students' experience in the modalities 100% Distance Learning, blended and face-to-face/remote and who had contact with the research author, still as learners during the years of 2019, 2020 and 2021. The researcher was morally and ethically responsible for the confidentiality of the data presented here. This triennium selection represents students who are still enrolled in their respective courses, distributed among

the 1st, 2nd, 3rd and 4th years of graduation. The questionnaire had 302 responses, from a total of 2,531 students linked to the classes that correspond to the three-year term, and was applied through the Google Forms platform.

The following subsections are divided into three stages, which represent different moments of analysis of the questionnaire. These stages are: in the first moment, Identification Data; in the second, User/Student Reality; and, in the third, Cognitive Neuroergonomy. None of the questions that made up the questionnaire were mandatory. Therefore, considering the respondents' freedom of choice, there was some fluctuation in the total number of responses between some questions. Finally, it is possible to highlight three student competences that support the data collected from respondents: digital fluency, autonomy and self-motivation [22].

When considering the triennium selection, the author of this research aimed to identify some personal characteristics of the students spread over different regions, mainly the age group and the course type. No less important was to identify whether the access to education was being mediated by a scholarship. In view of this first collection and selection, the survey reached a total of more than 300 respondents.

Regarding the sequences of questions in the item "age group", it was possible to verify that, from the 301 respondents, the variations are in the following order: 50.5% from 30 to 59 years old; 48.2% from 18 to 29 years old; 1% 17 years or younger; and 0.3% from 60 to 69 years old.

Next, the item "what year of the course they were in" presented a result that allowed the following finding among the 301 respondents: 52.2% were attending the first year; 36.5%, the second; 8%, the third; and 1.3%, the fourth. Another pertinent item to be considered by means of a graph in this subsection was the course modality, with 85.3% of the 300 respondents — the vast majority — being linked to the 100% Learning Distance modality; 13%, to the blended modality; and 1.7%, to the face-to-face/remote modality.

Finally, to conclude this first subsection, it is noteworthy that, from the 301 students who responded to the questionnaire, 298 answered the question "scholarship", PROUNI, FIES, among others. Among these, 72.8% indicated that they did not use any subsidy, while the other 27.2% indicated the use of a scholarship. Thus, it is possible to see that, in addition to the majority having opted for the 100% Distance Learning modality, more than half of the responding students of this private HEI, attended by the research author during the academic years of the triennium, are 30 years old or older, regardless of the modality. This is a mature audience that, in the midst of the pandemic, invested in online graduation/education.

3.1. The Student's Reality: the DICT Use and the Internet

Spread over different regions and cities, the students presented some peculiar and common characteristics that synthesize the experience of a public that regularly studies during the week, at night, and uses the notebook as a digital instrument for Internet access.

For example, in the question that asked which DICT they use to study when accessing the IES's Virtual Learning Environment (VLE), 93.7% of respondents reported using a notebook; 3.7%, a smartphone; and 2.7%, a tablet. When considering the period of the day, the accesses through these digital technological instruments were performed in the following order: 72.1% at night, 16.8% in the afternoon and 11.1% in the morning. It is also noteworthy that 66.7% access on weekdays and 33.3% on weekends, and, in relation to the place from where the access to the VLE is performed, in 99.7% of cases it is performed from home and, in 0.3%, from outdoor environments. Thus, it is possible to conclude that most prefer to maintain a daily study routine, after business hours and in their homes.

Then, the research raises the question of the type of connection that students use when accessing the Internet, since it is, in large part, private access. When considering the type of Internet connection, 60.5% of respondents indicated that they used optical fiber; 30.2%, conventional cable; 4.3%, satellite; and 5% were unable to reply. Regarding the particular Internet data package, respondents indicated different variations on the total of megabytes they owned. For example, 25.5% had 100 megabytes or more, 24.8% had 200 megabytes or more, 21.8% had 50 megabytes or more; 13.4% were unable to reply; 12.8% had 300 megabytes or more; and 1.7% had a prepaid package.

Another question that is worth mentioning was whether the students had already found any problems regarding the Internet type offered by providers in their regions. Based on this question, there were the following findings: 17.1% did not have optical fiber Internet, 9.6% did not have satellite Internet, 2.4% did not have cable Internet, 70.9% were unable to reply. Asked if they knew of any free Internet distribution point in their regions, 85.3% of respondents answered "no", and 14.7% answered "yes", that they knew of some point. These are numbers that show a considerable discrepancy in relation to the Internet in each student's region and the lack of knowledge of the services, plans and the right to the common good, which is the access to information.

Finally, it is important to highlight how this unawareness can represent the lack of a policy between the market and the State, in order to provide citizens with some means of knowledge and common use of the Internet. It is an ethical principle of access to information. It appears that the unawareness of this information affects people's sociability, since it is an urban insurgence that can compromise the cognitive performance of students who, in the learning process, need this basic information.

3.2. Cognitive Neuroergonomics: Affective Impact of VLE Design and Possible Learning Blocks

In this last subsection, it will be possible to observe the impact caused by the Internet quality and the VLE design on students' performance. It is even considered the pandemic context that ended up causing an immeasurable demand for the e-learning platforms used by HEIs.

Asked what most demanded from the Internet data and which ended up affecting the studies on the platform, the

IES students who participated in this survey answered according the following percentage ratio: 54.3% - participation in live web conferences with the tutor; 16% - access to recorded videos; 19.1% - participation in remote classes with the teacher; 10.5% - download PDF files, images, and others.

Based on the question about feelings, the survey asked how students felt when they accessed the VLE for the first time. From the total respondents, 38.7% felt confused; 30%, comfortable; 18.3%, motivated; 7%, scared; and 6%, indifferent. When asked how they felt in relation to the item "freedom of navigation in the VLE", considering the interaction with people and delivery of activities, it was possible to verify that: 43.5% felt total freedom; 31.6%, partially with freedom; 11.6%, with little freedom; 10.6%, indifferent; and 2.7%, without freedom. Regarding activities, the survey concluded that: 66.4% felt that they are sometimes difficult; 17.3%, that they are not difficult; 10.3%, that they are very difficult; 3%, that they are extremely difficult; and 3%, indifferent. It appears that this paragraph results were some of the most significant, as they demonstrate the percentage of the main emotional states that impact the learning outcome: feelings and subjective experiences [23].

The survey also asked how they felt about having the user experience browsing the VLE. From the respondents, 46.2% felt that they were able to navigate the virtual environment right from the start; 41.9%, that had initial difficulties to understand its functioning; 6%, that needed someone to help initially; 3.3%, that, even with the initial help from another person, still had difficulties; 2.3%, indifferent; and 0.3 felt the need for constant help from another person.

Finally, in relation to learning and the learning objects available in the VLE: 44.5% felt that they learn better through a little of each resource (video in lecture format, video in interview format, chat, standardized texts, graphics and images); 36.2%, that learn better through videos in lecture format; 9.3%, that learn better through images and graphics; 5.3%, that learn better through videos in chat and interview format; and 4.7%, that learn better through standardized texts.

It is also noteworthy that the results analyzed here, previously and qualitatively, present the student's experience regarding the quality of the Internet access, as well as the cognitive impacts caused on their learning performance in view of the architecture that involves the entire platform. Worrying about this new demand involves a question of information ethics, which must be considered in a negotiated management between the educational market and the city. With the Covid-19 pandemic, this urban insurgence can be observed, given that there was an overload of the HEI's virtual learning environments, and the urban problem of Internet infrastructure, private or public, compromised the access quality and learning.

In a philosophical and historical analysis, to what extent this selection on the HEI platforms represents the anguish that the materiality process in the traditional classroom causes, now experienced and replicated in the cyberspace of the VLEs, that is, the helplessness feeling and the freedom in spaces of dispute? These sensations of non-place and non-belonging experienced by some students

(and teachers) are an affirmation of helplessness, that is, an aesthetic-ontological insecurity of what online Education is in fact and its common environment: the cyberspace. VLEs should be seen as (cyber)democratic spaces that develop subjectivities. On its own, this is the promotion of citizenship itself. This is a milestone in the political transformation of cyberspace in online Education, which must be embodied between public and private actors [24].

4. Ethical Responsibility and Post-Pandemic Negotiated Management Challenges

Aware of the pandemic scenario around the world and the need to reinforce the challenge of guaranteeing SDG 4 – Quality Education, the UN has been releasing a series of reports to the Heads of State on the alarming situation regarding the access to education and the commitment of quality, as it is the authorities' responsibility to offer alternatives for learning. Therefore, it is urgent to redesign Education in the midst of the coronavirus pandemic, especially when it comes to considering an increasingly hybrid and online design according to new needs and trends.

In Brazil, studies estimated that, at the end of 2020, more than 47 million students in a vulnerable situation faced difficulties in accessing the Internet and this fact compromised the learning quality. In order to guarantee the right of access to Education, the following aspects are fundamental: the Internet becomes a tool for citizenship and meaningful learning begins to demand a socio-emotional relationship in a virtual environment.

As UN members warn, local authorities must take responsibility for the impact on students learning (and lives). However, this challenge cannot be exclusively in the hands of the city's public agents or strategically in the powers and influences of private actors. A negotiated management movement between the educational market and the city is necessary, with an equal nature between the parties, since online education, an economic phenomenon of globalization, involves new technological processes of interest to both [25].

It is necessary to join forces to concurrently face this post-pandemic urban insurgence, given that it can compromise the subjects' notion of citizenship, and the quality and performance of the technological services that the HEIs deliver. However, for this to be possible, the negotiated management can be guided by the responsibility ethics [26].

4.1. The City of Curitiba

In 2000, at the turn of the millennium, the Municipality of Curitiba, in partnership with the Instituto de Cidades Inteligentes (ICI – Institute of Smart Cities), launched the *Digitando o Futuro* project, which was committed to distributing strategic points of up to 10 megabytes for free internet access to the Curitiba citizens. In August 2012, the city of Curitiba already had seven points, considering the inauguration of the new free access point in the central

region of Largo da Ordem. In order for the citizen to be able to access the Internet, it was necessary to register in Passaporte Curitiba, an individual registration made directly through its website [27].

Also in November 2012, the Municipality of Curitiba maintained its partnership with ICI and launched the Digital Curitiba project. At that time, this project provided free wireless Internet to eighty Municipal Schools of up to 20 megabytes. This system was offered to schools and local residents, who were able to access the Wi-Fi network “WIFI_CURITIBA” from their electronic devices, within a radius of up to 200 meters around the antenna that replicated the signal. After this access, the citizen was sent virtually to the same Passaporte Curitiba website [28]. In 2014, the project started a second step, which included over fifty Municipal Schools [29].

In March 2015, the city's 322th anniversary, the mayor of that time launched the free Wi-Fi at Curitiba bus station. That year, free Internet reached ninety Municipal Schools and aimed to reach another fifty Schools in the same year. When considering the transparency principle in the management processes, the information exposed from 2015 onwards indicates that the telephone company Oi was responsible for implementing the free service at the bus station. At that time, in order to consider the equipment, technologies and quality of access involved, the Municipal Government was studying the strengthening of partnerships with the private sector [30].

In 2020, the Municipality of Curitiba launches Wi-Fi Curitiba project. In January 2021, it announced that the citizens would have free quality access to the Internet through more than 254 new points, distributed throughout the city, in order to generate digital inclusion. This commitment was signed by means of an agreement of intent together with ICI — a partnership that has been signed since 2019. The responsibility for installing these points was assigned to ICI, and part of this installation should be carried out within 180 days and free of charge to the Municipality of Curitiba. In May 2021, the Municipality inaugurates the Wi-Fi Curitiba project, delivering Internet points spread over 81 addresses. The total number of wireless points currently adds up to 126, installed in places with large flow of people, from the agreed total of 254. For example: bus terminals, streets of citizenship, lyceums of craft, Faróis do Saber (network of small libraries spread across several districts of Curitiba), parks, squares and others. The citizen access and registration are concentrated upon registering and authentication via e-Cidadão Wi-Fi Curitiba [28,29].

It is possible to observe that the public points of antennas, distributed throughout the city, are concentrated in strategic places of great flow of people, as well as the places are restricted to emitting the Wi-Fi signal within a radius of up to 200 meters. Likewise, it is well known that a good part of private HEIs in Curitiba offer restricted access to the private Internet in their academic environments. Thus, it is important to highlight that, in both situations, the students are limited to centralized access, public or private, to the Wi-Fi point and its short distance radius, and that this can directly and affectively impact their learning performance. It can even impact the very principle of digital inclusion and access to Education

and the Internet, as it affects legal frameworks and macro-documents such as the 2030 Agenda and the Universal Declaration of Human Rights [31,32,33,34].

The Federal Government's proposal, implemented through Portal Governo Digital (Government Digital Portal), is to guarantee citizens their effective participation in the sphere of e-Government, especially those who are on the margins, in remote communities and excluded segments. Law N° 12965, of April 23, 2014, establishes principles, guarantees, rights and duties for the use of the Internet in Brazil, such as the one that states that having access to the Internet is essential to the exercise of one's citizenship. In 2016, the Government of the State of Paraná, through partnerships between the Secretariat for Strategic Affairs (Secretaria para Assuntos Estratégicos - SEAE) and the Information and Communication Technology Company of Paraná (Companhia de Tecnologia da Informação e Comunicação do Paraná - CELEPAR), concluded an agreement by signing a resolution that unifies the actions aimed at digital inclusion. In June 3, 2009, Law n° 13.204 was launched in the city of Curitiba, which authorized the Executive Power to create the municipal council for digital inclusion.

With the Covid-19 pandemic, the insurgence that devastated Curitiba and that was the subject — and still is — of lively discussions is the right to Education in a virtual environment. Through this maxim, as it is a universal human right, online Education entered the list of UN requirements as a warning to large cities that are fighting the coronavirus pandemic. There are, in fact, two urban insurgences in one, which lack situational and assertive planning: the right to online Education and the Internet access for all. According to the Universal Declaration of Human Rights, access to the Internet becomes a universal right.

Faced with the harm of these insurgencies to urban management, caused by the pandemic in all Latin American cities, in August 2020, ECLAC (Economic Commission for Latin America and the Caribbean) — a UN member — proposed the Internet universalization as a social measure, a guarantee of access to online Education. This thematic commotion daily involves all actors in public and private Education, given that educational institutions, from basic to higher education, are discussing the best way to plan a return to school without losing basic rights. What intervention measures is the government actually planning to ensure access to the virtual environment? Whether through remote, hybrid or Distance Learning classes, the heart of the matter is whether this urban insurgence further provokes digital exclusion and/or aggravates the users' cognitive impact in a virtual environment compromised by the Internet quality.

Thus, as far as possible and in agreement with the SDGs of the UN 2030 Agenda, especially with SDG 4 “Quality Education”, target 4.5, and SDG 17 “Partnerships for the Goals”, target 17.17, it is necessary to promote public-private partnerships in order to present to the competent bodies the study of a distribution project of Internet signal, not limited to places with a large flow of people. On the contrary, it must ethically enable access to the Internet in overlooked regions, which are peripheral and vulnerable.

When considering a post-pandemic scenario, the spaces for accessing and distributing the Internet signal should be planned through partnerships between the public and private sectors that have informational ethics as a principle. It is a demand that is inaugurated in the face of this new urban insurgency that the pandemic has shown. The connectivity of citizens and the access to the Internet and online Education cannot be restricted to strategic spaces due to the flow of people. This will require that institutions and technology companies are involved in these post-pandemic insurgences, and that citizens can understand that these are joint management responsibilities between the market and the State [2].

5. Neuroarchitecture, Neurodesign and Neuroergonomy: The Affective-Cognitive Triad

Discussing affectivity, emotion and cognition as phenomena of human subjectivity is increasingly a work that requires interdisciplinary investigation. Neuroscience stands out as a science capable of contributing to different areas of knowledge that try to understand phenomena of common interest. This research's outline is limited to highlighting the neuroscientific knowledge related to studies on the impact of the physical and virtual-digital built environment on human behavior, as well as the subjective qualities that influence the learning of online Education students. Reportedly, Kurt Lewin's environmental psychology (1965) [35] inaugurated part of this scope.

With the passing of the last decades and the development of neurosciences, it is possible to verify the emergence of neuroarchitecture which, as well as environmental psychology, studies human-environment relationships, but with greater depth in neuroscientific understanding. Neuroarchitecture seeks to understand in detail the environmental stimuli and how they affect the human brain, such as what would be the sensations and emotions involved in built environments [36].

Likewise, when considering some research related to the virtual-digital environment built for education beyond the physical classroom, the following term is disseminated: pedagogical architecture [37]. This proposal deals with the planning and construction of a learning object capable of offering the provision of digital materials for teachers and students' use, in the modality of classroom-based and distance education, in a more interactionist way and called ARQUEAD — the platform was developed by the professor and researcher Patricia Alejandra Behar and team, and is available on the page of the Federal University of Rio Grande do Sul (UFRS). One of the points of the pedagogical architecture investigation, in addition to new pedagogical learning models, is to analyze the planning of the constructed virtual technological object.

The neuroscientific approach, applied here to architecture and pedagogy, is also related to design, as both areas of knowledge are part of the development of new technologies for online education. However, prior to the pedagogical principles involved in learning, the

product, the graphical interface and the user's subjective experience are initially analyzed, based on his/her intrinsic neural processes. The so-called neurodesign is then achieved, which aims to offer, through product quality (digital platforms), an affective-cognitive sensation of well-being [38,39].

These computer tools or digital platforms made available for online Education, widely known by HEIs as VLE and largely used until then in Distance Learning, have an instructional arrangement for teaching and learning predesigned for their use. For Behar and Silva (2012) [22], the pedagogical architecture tries to propose that the construction of the pedagogical model to be used in the platform cannot be limited to massive models, but rather built in a situational way, that is, planned according to the needs of each course and other agents directly and indirectly involved.

Therefore, it is a question of considering an educational design arrangement capable of generating competences that directly affect the students' involvement in the use of digital-virtual built environments. As highlighted above, three of these skills were presented in this research, based on the questionnaire in Subsection 3 and applied to students: digital fluency, autonomy and self-motivation.

These modular content standards used in online platforms can compromise the creative communication of everyday reality between students and teachers. In order to consider these situational requirements and the fact that the development of digital platforms used as a product in online Education should foster dialogue and social-emotional relationships, it is necessary to seek proposals based on the neuroarchitecture, neurodesign and neuroergonomy principles [40].

The current challenge of online Education is to design a project that guides the way in which the HEI's VLEs can be developed through neurocognitive knowledge, in order to stimulate good emotions aimed at the students' meaningful learning, since, as some of the neuroimaging findings indicate, this can help in retrieving mnemonic information. According to Tyng et al. ([23]: 16), a project based on neurocognitive research considers: environmental factors, ethical issues, memory paradigms, cognitive task difficulty, and emotional induction task intensity must be considered for this.

Emotions influence the students' cognitive aspects. Therefore, the design of any pedagogical proposal involving exercises, deadlines, tests, among other learning objects, can be rethought based on neuroscientific knowledge oriented towards education, since these traditional proposals are associated with the emotional states of anxiety, frustration, fear, and so on. This affects the ability to learn, memorize, maintain attention and achieve good academic performance. Through affective computing, it is not different in online Education.

Therefore, affective experiences in these constructed digital-virtual environments must facilitate the effects of good emotions. Virtual environments can offer better potential for self-organized, autonomous, self-taught learning with a constructivist-interactionist [41,42,43] or dialectical-interactionist bias. Thus, there is a distance from the idea that, in online Education, the use of digital

platforms would be a new Skinner box [44], since the methodologies used seem to favor only the behaviorist learning theory.

Currently, it is also noteworthy that affective computing, as an interdisciplinary field, is showing an important role in areas that benefit from the human-machine relationship: several studies have focused on identifying the cognitive-emotional state of subjects by using machine-learning algorithms and by achieving high levels of accuracy [45].

According to Marco, Arbeloa and Bagdasari (2017) [46], the virtual environments should enjoy an architecture that encourages cognitive and emotional factors, in a unified, real and simple way, in order to make the user's experience easier. It is an affective-cognitive architecture capable of influencing the user's behavior through enhanced emotions.

When discussing the cognitive-emotional aspects — qualitative and subjective — of the student's experience in digital-virtual platforms, that is, in the involved neuroarchitecture and neurodesign, the neuroergonomy foundations are equally considered. This is because VLEs, in addition to serving as learning objects, are at first products that serve the online Education market. It is a product that has the ease of use as an educational purpose (functionality), in addition to the affective impact, as demonstrated by the questionnaire in Subsection 3. The design of new VLE products (in addition to their Pedagogical Architecture potential) could consider, more pertinently, the relationship “product and consumer” through an ontological approach planning of the cognitive and affective experience [47,48].

The virtual environment (as a product) could have as a means the representation of the socio-emotional relationship established by students and teachers, an appropriate factor for meaningful learning [49]. According to Damásio ([59]: 162), the social emotions embody moral principles and form a natural foundation for ethical systems. In other words, they could be fundamental and ethical characteristics to be considered neuroergonomically, in a more pertinent way, given that tasks and activities performed in a virtual environment should promote well-being.

It is a challenge for HEIs and cities to promote this meeting between actors, since the virtual environment broke the walls of a materiality that was limited to the physical built environment and the exclusive responsibility of one of the parties. This challenge is also dialectical, as it is part of our historical process to understand that such social transformations are intertwined.

The coronavirus pandemic turned this simulacrum called online Education into an insurgence that demands urgent ethical responsibility. Therefore, it is necessary to reassess the spaces that promote learning, whether physical or virtual, products or services, as an affective-cognitive experience that can encompass the classroom structure, elements and devices, as well as a digital platform. Regardless of the environments, the Internet and TDICs become instruments of inclusive citizenship in which the right to Education prevails.

6. Final Considerations

As presented during this research, the coronavirus pandemic in Brazilian territory highlighted the need for public and private actors to deal with an imminent urban insurgence: the quality of online Education. This joint work provides the opportunity for a negotiated management between the educational market and the city, based on an ethical principle of responsibility, for this is a dilemma of our time, as is the case of digital inclusion in cyberspace, the right to Education and Internet.

Meanwhile, through a questionnaire and a sample applied in the city of Curitiba, it was possible to obtain, as a preliminary result, the assumption that the educational market and the city face difficulties in human interactions, precisely because the quality of experiences is linked to vertical management models. This is the insufficient decentralization and quality of Internet access, which compromises the users/students' relationships of freedom and the affective (feelings and emotions) and cognitive (neuroergonomics) experiences in physical and virtual environments. Therefore, as a main direction, this research asked: how would it be possible to join forces between the actors, the educational market and the city, in order to carry out a negotiated management?

Based on this insurgence-insufficiency, the research considered that the future perspectives for public and private actors are the legal and ethical bases. The negotiated management could be better guided by a common principle involving the following fronts, which were aggravated by the coronavirus pandemic: free Internet access points, digital inclusion and online education. Furthermore, these principles would consider the planning of services and products in physically and virtually built environments, that is, from urban to pedagogical characteristics.

For this, it is necessary that the architecture of a situational educational space, such as, for example, the physical or virtual learning environment as well as its transients — students and teachers — are inserted in a concept that involves neuroarchitecture (phenomena of the mind-brain interface), neurodesign (phenomena of the man-machine-product relationship) and neuroergonomy (phenomena of the affective experience). It is about understanding more about these areas of knowledge and the affective-cognitive phenomena enhanced by physical and virtual teaching methodologies and spaces that promote inclusive environments that maximize learning.

Finally, this research's next steps will include a search for more details about free internet points in Curitiba and other regions, through a partnership established with ICI — contact that was made previously when concluding this article and perhaps an implementation of a joint social enterprise called, for the time being, “Antena Solidária” (“Supportive Antenna”). The survey will also promote the search for more details about the involvement of the private sector with the Municipality and ICI, since data were not very clear to the researcher. Lastly, it will be necessary to seek information from some technology companies and HEIs focused on the development of e-

learning tools and that may be involved in the discussion of new digital platforms.

The heading of the Acknowledgment section and the References section must not be numbered.

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