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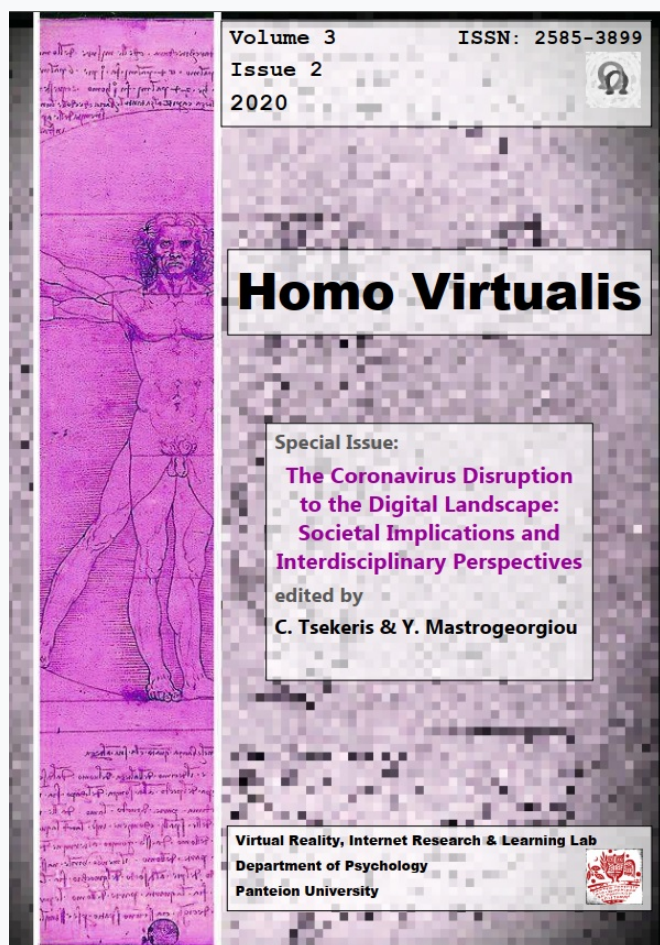
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Socioeconomic changes, digital technologies and neuroeducation during the COVID-19 era

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Abstract: This paper maintains that the management of the pandemic, which relied mainly on digital tools, can become effective when it covers many sectors. Digital technologies enabled us to contain the epidemic on an administrative level and a health care level. Homeschooling is also possible with the help of digital tools and it contributed significantly to the control of COVID-19 spread. Digital technologies can also relieve the mental health problems that are caused or that are aggravated by the lockdown. Psychological support can be provided online even through social media. Neuroeducation had always been an effective approach to teaching. Nowadays, neuropedagogy is even more necessary in order to address the problems that arise because of the excessive use of digital tools in the learning process.

Keywords: Digital technologies, national and subnational governments, telemedicine, remote learning, neuroeducation, mental problems, lockdown

Introduction

The world is facing a global public health crisis as the COVID-19 pandemic has spread to many countries. Many governments suspended mass gatherings and closed schools, museums, offices, universities and libraries. Some cities didn't allow the entry of people who didn't live there. This level of containment on a global scale is unprecedented.

Homeschooling was imposed as an educational solution since school closure was one of the most important measures for controlling the pandemic. It is of utmost

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importance, particularly during this period, to associate teaching strategies with the principles of the brain-based learning and the recent findings of neuroeducation to counteract the effects of the crisis. Brain-compatible learning is a set of principles based on the underlying biology of learning and explains how the brain learns (Caine, Caine, McClinik, & Klimek, 2004). The times we are going through are challenging for the human brain, so brain-based teaching is the key to success (Lampou, 2020).

Political and socio-economic aspects of digitalization in the pandemic management

Digital technologies create significant opportunities for governments and citizens to improve human lives and to deliver goods and services in a more efficient way. In times of crisis, such as the COVID-19 pandemic, digital technology can play an even more important role. Crisis might be a window for positive reforms and a huge opportunity for technologies (Auener, Kroon, Wackers, Dulmen & Jeurissen, 2020). Digital technologies help policy makers monitor the implementation and effectiveness of the measures taken against the spread of the pandemic. For instance, Google has already been gathering data from maps to monitor people's movement over time in order to determine how well social distancing measures are observed (Daskal, 2020).[2]

Furthermore, the interface between national and subnational governments is important in the effort to slow down the pandemic (De Mello & Ter-Minassian, 2020a). This effort is significantly supported by the use of digital technologies. Cooperation between different levels of national and subnational governments is very important in order for the inequalities among different subnational governments to be bridged. It's well-known that almost in every country, rural and remote areas are underprivileged as far as skills and resources are concerned. Compensating for this lack of effectiveness can be critical in controlling pandemics.[3]

Subnational programs can benefit for example by Geographic Information Systems (GIS) in their effort to identify health risks. The use of sensors can give information about traffic, the state of infrastructures or the quality of environment or the drinking water just to cite a few. The above-mentioned information is very important in controlling a pandemic. Furthermore, digital portals facilitate communication

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[2] This is an example of a population-level analysis using aggregating data to assess trends that can provide important information. In general, aggregate-level analysis does not violate privacy and at the same time it can help determine when it is time to lift restrictions (Daskal, 2020).

[3] One of the keys to implementation of effective communication among different levels of government is peer support which can include demonstration effects, technical assistance and joint training of officials, as well as effective interfaces among subnational digital systems in areas of common interest. It is noteworthy to mention that subnational governments account for 40% of government spending on average in OECD countries (De Mello & Ter-Minassian, 2020a).

between governments and population. This is essential during times of confinement and social distancing.

As significant as digitalization is for national and subnational governments, it imposes many challenges especially on a subnational level. Lack of skills, inadequate funding and poor infrastructure can make the implementation of digital policies against pandemics very difficult. These constraints not only exist on the public sector but also come from the private citizens who in many cases they are mistrusting or resisting the introduction of digital technologies. All the above-mentioned factors make the efforts to control a pandemic very time- and energy- consuming. This is a great disadvantage when the circumstances require immediate and effective action.

Therefore, it is necessary to have a well-planned strategy, a good identification of needs, a clear definition of different tasks, realistic timetables, a good knowledge of the main obstacles, procurement of the necessary resources and ultimately a good system of monitoring the implementation of the strategy (De Mello & Ter-Minassian, 2020a). Tracking systems should be open source, decentralized and orientated towards protecting individual personal data. Data should not be retained any longer than it is needed (Daskal, 2020). Despite the challenges, COVID-19 pandemic can be a great opportunity for governments to create efficient crisis management strategies which can prove to be very useful in the future.

Medical aspects of digitalization in the pandemic management

Since there is no cure for COVID-19 and most cases develop mild symptoms, the World Health Organization (WHO) has recommended that uncomplicated COVID-19 cases should be treated at home with careful clinical monitoring (World Health Organization, 2020a). The use of teleconsultations is being highly recommended to prevent the spread of the pandemic, since COVID-19 can be easily transmitted from one individual to another, even from a doctor to a patient. For example, the Chinese government has reported 1.716 cases among health workers and 6 deaths (Schnirring, 2020). In a system based on a face-to-face contact between doctor and patients with multiple chronic conditions we will face the dilemma between risking iatrogenic COVID-19 exposure during a clinician visit and postponing needed care (Keesara, Jonas & Schulman, 2020).

Therefore, it is important to perform medical tasks from safe environments while gathering and analyzing the data necessary to minimize the effects of the pandemic (Mahmood, Hasan, Carras, & Labrique, 2020). Furthermore, running a telemedicine center can cost much less than running a hospital (López Seguí, Franch Parella, Gironès García, Mendioroz Peña, García Cuyàs, Adroher Mas, García-Altés, & Vidal-Alaball, 2020). An online training for health care professionals can be very effective in preparing them to handle the crisis even in rural and remote areas (World Health Organization, 2020b; Keesara, Jonas & Schulman, 2020).

It is also important to mention that digital tools can relieve the stress and insecurity of COVID-19 patients, since it enables them to receive clear medical instructions that shield them against the confusion and misinformation which can spread from social media and TV. The support from doctors is also important for the mental stability of patients (Mahmood, Hasan, Carras, & Labrique, 2020).

Contact tracing is also important to identify the extent of the outbreak by keeping track of the contacts that a confirmed case had. Traditionally, outbreak investigators would go door-to-door to obtain information of the contacts, which can be a very time- and energy-consuming procedure (Browne, Gulbudak & Webb, 2015). Digital technology provides a faster and less resources-consuming approach. Contacts can be traced over the phone and the information can be saved into a database. The contacts can be monitored over time on the phone, which eradicates the risk of spreading the infection through face-to-face contact with the investigators (Mahmood, Hasan, Carras, & Labrique, 2020).

Not only does technology help us evaluate the extent of a pandemic under way but it also enables us to predict the next pandemic, which has already been done for the seasonal flu (Daskal, 2020; Keesara, Jonas, & Schulman, 2020). Furthermore, universities, companies, non-profit organizations and governments have developed contact tracing apps that can inform someone if he/she has been in contact with other people who had the disease. For example, Stanford University is developing an app that uses Bluetooth technology that can anonymously notify people when they crossed paths with cases of COVID-19 (Daskal, 2020).

Moreover, health care social network sites can provide real data that serve as a warning when an outbreak is still in initial stages. In this case, an outbreak can be contained with minimal resources if the response is immediate. For example, during the recent outbreak in China some doctors reported a strange acute pneumonia already in early January 2020 (Buckley, 2020). If the authorities had paid more attention to their observations the pandemic would have probably evolved in a different and more manageable way. It is also possible that a global pandemic could have been prevented (Mahmood, Hasan, Carras & Labrique, 2020). Furthermore, many national and subnational governments worldwide are leveraging social media because of its increasing uptake in society. Countries such as Ecuador, the United Kingdom and Chile have Twitter followers which are a great percentage of the population. In the United Kingdom, subnational governments can have Twitter, Facebook, Youtube or Flickr accounts (De Mello & Ter-Minassian, 2020b; Thevenon & Adema, 2020).

However, the validity and reliability of social media is sometimes doubtful but it is reassuring that several social media platforms are collaborating to stop the spread of misinformation and fake news. It is important for the authorities to impose some strict regulations on social media so that their positive contribution in fighting the coronavirus pandemic is assured (Sonnemaker, 2020).

There are more challenges involved in digitalization in the outbreak control. Digital systems pose the risk of medical fraud and individual tracking poses risks concerning privacy and human rights, the violation of which can divide communities into groups of "healthy" and "unhealthy" people (Keesara, Jonas & Schulman, 2020). Privacy regulations can also be suspended during the interaction among doctors and patients. Furthermore, applications of digital technology for the treatment, diagnosis, support of self-management and surveillance during public health emergencies does not always ensure the protection of sensitive personal data (Mahmood, Hasan, Carras, & Labrique, 2020). Therefore, a great deal of efforts should be made to balance public security and individual rights. The debate still continues on how this balancing intervention can be done (De Mello & Ter-Minassian, 2020b).

Educational aspects of digitalization in the pandemic management and mental health issues

During the lockdown, education is possible only through digital technologies. Thus, we are living through the world's largest homeschooling experiment, which is at the same time a social experiment that proves the importance of human connection. In many countries, teachers connect with students synchronously and asynchronously.[4] Through the use of technology, the role of a teacher changed and became more like that of a mentor, a coach and an evaluator. Technology supports new ways of teaching that focus on learners rather than on teachers (Schleicher, 2020).

The pandemic gave teachers the opportunity to collaborate on an international level and exchange their opinions and experiences about this unprecedented situation. In particular, we can mention two platforms, the *Global Education Coalition launched by UNESCO*[5] and *Teachers Task Force for Education 2030.*[6] Teachers can encourage technology companies to participate in their efforts to improve education during times of crisis. Companies can provide free devices, free wi-fi and support to teachers and schools. Motivating teachers to acquire more technological knowledge and reshaping curricula can also be very helpful in order to minimize the adverse effects of school closure (Schleicher, 2020).

In addition, students' lives have been seriously affected. While all schools and universities had relied all these years on classroom teaching, the pandemic forced students to give up interacting on one on one basis with their teachers. Talking to a computer can't substitute for connecting with others on a deeper level. Human beings connect through story sharing rather than storytelling, something that a computer can't perform (Betcherman, 2020). It has been proven that technology affects the way people experience crisis. This fact gives teachers an important

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[4] For students without computers, parents and schools collaborated to send them free textbooks at home. (Schleicher, 2020)
[5] See https://en.unesco.org/covid19/educationresponse/globalcoalition
[6] See https://teachertaskforce.org/

responsibility when using digital technologies, because these media influence "bodies and souls, thoughts, conduct, and way of being" and it shapes the lives and future of human beings (Foucault, 1988). As a matter of fact, online learning saves time and resources since it uses less paper and it doesn't involve transportation to a school environment, but learning is not a transactional process. Learning always happens through interaction and a close relationship with teachers is very important (Şen, 2020).

Furthermore, the risks for children from the use of digital technology are increasing due to the confinement and subsequent exposure to the internet. Unsupervised use of digital tools can result in exposure to inappropriate content, cyberbullying and misinformation especially related to health issues (Thevenon & Adema, 2020). Another risk related to on-line learning is privacy risks that can be detrimental to children. Online platforms using video educational services can lead to inappropriate data collection (Thevenon & Adema, 2020; Han, 2020). Furthermore, social networking platforms that facilitate communication among teachers and students do not comply with strict, privacy protection guidelines (World Childhood Foundation et al., 2020).

An important phenomenon that affects the learning process for children is the digital divide. It is well-known that the socioeconomic and educational level of parents is a factor that determines the quality of children's education at home. The socioeconomic differences among parents result in a very deep educational gap that slows down and overloads the educational system. This fact makes school's effort less effective since it has to deal with classes of different speeds (Thevenon & Adema, 2020).

During the lockdown, socioeconomic differences also result in the digital divide phenomenon. Some children have digital infrastructure and bandwidth so that they benefit from e-classes while other children do not have a tablet or a PC at home and they don't have any digital skills. Another factor that contributes to the digital divide is the difference in digital skills among households. Some parents know how to access platforms and as a result they can support children during their homeschooling process while other parents don't even have basic digital skills (Tsekeris, 2019). The digital divide widens the learning gap even more (Livari, Sharma, & Ventä-Olkkonen, 2020).

In addition, there is a correlation between the socioeconomic background and the extent of mental health problems among children. Socioeconomic deprivation is proven to be a threat to mental well-being. Moreover, the lockdown causes financial insecurity mostly among underprivileged families which contributes further to poor child mental health (Thevenon & Adema, 2020).

During the quarantine, many people experience loneliness which is defined as a state of isolation from the community or the society. This state can lead to many mental

disorders like depression, anxiety, insomnia, irritability, poor concentration, adjustment disorder, chronic stress and post-traumatic stress disorder (Wilson et al., 2007; Brooks, Webster, Smith, Woodland, Wessely, Greenberg & Rubin, 2020). A survey in China showed high rates of anxiety among college students during the pandemic (Cao et al., 2020). Furthermore, in the United Kingdom, young people with existing mental health problems reported that their mental conditions have been aggravated since the onset of the pandemic. During previous pandemic outbreaks children experienced similar feelings (Young Minds Report, 2020).

Loneliness can also cause physical disorders like sensory loss, connective tissue and autoimmune disorders, cardio-vascular disorders and obesity. If isolation is prolonged, decreased physical activity will lead to an increased rate of stress and fractures. Physical problems can also be caused by domestic and interpersonal violence which is exacerbated during the lockdown (Mushtaq et al., 2014).

Furthermore, fear, which is eminent throughout the pandemic, affects decision-making and the quality of everyday life. In cases like these, emotional management is an important issue that can be a good object of research (Thevenon & Adema, 2020; Betcherman, 2020). As social distancing is important for controlling the pandemic, distancing from social media is necessary to prevent the spread of an "infodemic". An outbreak of an "infodemic" can lead to irrational fear due to misinformation and its results can be long-term and can last longer than the epidemic itself (Hyvärinen & Vos, 2016). The pandemic will eventually be over giving rise to two important lessons: the emotional preparedness for solitude at times of such crises and psycho-social well-being forming the cornerstone of public health (Banerjee & Rai, 2020).[7]

The increased use of digital tools in the learning process caused great changes in the human brain, transformation of already existing cognitive structures or the construction of new ones. The role of neuroscience is very important particularly during this unprecedented period because it can help us understand the inner workings of human brain and it can help us plan our strategy to face problems related to the excessive use of digital tools during social distancing. For instance, neuroeducation can give teachers the framework with the help of which they can develop challenging activities that could increase attention and improve memorization. Human brain learns optimally-makes a maximum number of connections-when it is intrinsically motivated. Intrinsic motivation is also necessary for student creativity (Ansari & Coch, 2006; Goswami, 2006). Brain-based teaching strategies are essential in order to create effective learning. [8]

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[7] Social distancing can be an effective measure against the spread of the epidemic but its effectiveness is limited as far as the homeless or underprivileged people are concerned. Deprivation of human rights and self-dignity surpasses all the results of social distancing that is implemented under normal circumstances. (Banerjee & Rai, 2020).

[8] Brain-compatible learning is a set of principles based on neuroscience. Neuroscience teaches us that is important to connect new knowledge with the existing brain structure on former knowledge patterns. (Howard, 2000; King, 1997; Smilkstein, 1993) Learning is the establishment of new neural networks. It restructures our

On the other hand, fear is an inhibiting factor as far as learning is concerned. In combination with the school closure, the abrupt interruption of routine activities, the lack of the physical presence of friends, the uncertainty about final school exams, and even the financial distress of the family can interfere in the learning process, a process which requires concentration, peace of mind and dedication (Lampou, 2020).

According to neurobiology, fear and threat response are complex phenomena. The brain regions involved in threat response and fear are not organized into a single fear circuit but into several circuits in parallel (LeDoux, 2012). The major regions where fear stimuli take place include: the sensory cortex (stimulus awareness), hippocampus (memory of associated stimuli), amygdala (quick evaluation of danger), prefrontal cortex (integration and conscious decision-making), and hypothalamus (release of stress hormones). The most important role during fear processing is played by amygdala, a component of the limbic system, the centre of emotions (Sah & Westbrook 2008).

Furthermore, a part of the brain that is involved in scanning the environment for danger and in filtering useful information for fear is the Reticular Activating System (RAS) which is nowadays more developed in children than in adults. The reason is the fact that children are more exposed to constant messaging and a fast-pace of every-day life, so they process information more quickly. Therefore, children are more vulnerable to fear (Purves, Augustine, Fitzpatrick, Hall, Lamantia, & White, 2011).

Teachers can do a lot to eliminate the above-mentioned negative factors in order to improve the learning process of their students. Firstly, it is important to establish a new routine. Children need structure in their daily lives and a well-organized schedule in online classes is important so children will keep making progress. Remote learning is aimed at a student who is in the environment of his home, an environment that until now wasn't associated with structured and planned activities such as those that take place in the school. It is important for the teacher to organize the work with his students in a way that reminds them, at least a little, of the structure and organization they experienced in the school space. Therefore, asynchronous training must be combined with the synchronous one within the framework of a regular program. Structured activities can help children feel more secure (Lampou, 2020).

Secondly, teachers should place emphasis on teaching students how to develop empathy, solidarity and altruism. When somebody feels alone, focusing on other

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brain which learns through problem solving and repetition. Structural change also occurs in our brains when we practice critical and creative thinking. (Howard, 2000; Diamond & Hopson, 1999; King, 1997).

This process is also influenced by emotions because the chemicals of emotion are released almost simultaneously with the chemicals of learning. Therefore, positive emotions lead to better learning. (Damasio, 1994; Hobson, 1994; Ledoux, 1996). Neuroeducation can help us with timing in education, tells us about the mechanism of learning and, in this way, it explains why some subjects are difficult to learn at an early age. The most important contribution of neuroeducation is suggesting ways of learning and teaching that solves the problems associated with traditional teaching (Jensen 2000; Goswami, 2006).

people's needs is the first line of their defense. Our brain is social, that is to say it evolves and learns through interaction and experiences with others (Dunbar, 1998; Dunbar & Shultz, 2007). Learning cannot progress well when students feel isolated and lonely. The brain seems to like learning from others. Natural development alone is not enough. Social distancing is only physical and it shouldn't lead to isolation. Communication and collaboration with their peers are very important for children's development. Communication tools, like bulletin boards, chat channels, discussion groups, etc. foster interaction and peer-to-peer support (Eisenberg & Escobar, 2020).

During the phase of lesson planning, teachers should keep attention spans in mind. According to research, students lose interest in taking notes after 10-15 minutes (Bradbury, 2016). The challenge is to find a way to maintain and develop people's attention during a given time. In order to ensure students' engagement, teachers could include virtual break-up rooms, the use of polls and the creation of narratives for each class. They should set clear rules of interaction from the beginning and promote peer interaction through debates and exchange of ideas.

Furthermore, great emphasis should be placed on choosing the appropriate methodology because what works well in the classroom may not be suitable for remote learning. Appropriate methodology is what fits best to the needs, rhythm and interests of both teachers and students. The coordination of synchronous and asynchronous teaching is very important because with the help of teleconferencing the teacher can discuss the tasks assigned to the children. Assignments and activities given to students should not need special intervention from parents, should respect the material already taught and should not require skills much above average so that the parents are not forced to intervene as teachers because in this case we will have students at different speeds (Lampou, 2020).

Reopening of schools in the post COVID-19 era

After the peak of the crisis, schools have reopened in many countries. There is a new challenge now, how to make the return of students as smooth as possible. Children lived in uncertainty and fear for a few months. Nobody knew if schools would reopen this year or next year. For many children going back to school is a big challenge. They have been disconnected from school routine and it may be difficult for them to be back on track. Other children may come back to school after having lost contact with the learning process because of the digital divide. The fact that classes are divided into groups in order to avoid crowding in the classroom can cause distress to many students because they may miss their friends and they may feel vulnerable due to the establishment of new relationship dynamics. We should not forget to mention the children who won't come back to school either because they belong to high-risk groups or because their family members belong to vulnerable groups.

During this difficult time of transition, our priority should be social and emotional adaptability, mental resilience and well-being. Other important skills and values that should be given priority to are: self-management, respect of self and others, collaboration and self-regulation. Before teachers start using their familiar methods to teach the knowledge that their students need, it is important to start with techniques that can ease the difficult process of transition and reconnection. Story sharing, artistic activities and brain-storming may prove to be very helpful. Other techniques are letter writing, interviewing and peer-counseling which can motivate children to process the traumatic experiences of the quarantine. It goes without saying that the recent heath crisis reminds us that health education is very important for the prevention of epidemics and above all we can't emphasize enough the importance of collaboration among all the parties involved in the educational process, students, parents and teachers.

Furthermore, the crisis showcased the special role of teachers in society. Before the crisis, teachers were unsung heroes. After the crisis, many teachers became celebrated heroes (Lampou, 2020). The public had the opportunity to appreciate the energy a teacher spends and the effort he/she makes to restructure students' brains because "leaders are forged in crisis. Leaders become real when they practice a few key behaviors that gird and inspire people through difficult times" (Koehn, 2020).

Conclusion

COVID-19 has arguably changed lives in unimaginable ways. We still do not know if we will go back to our usual routine, or if our life will be radically transformed. It's very probable that we are going to see rising unemployment and recession that will certainly place demands on the school system. School is a part of society and by necessity it follows all the changes that take place.

We should also bear in mind that teachers are brain changers and great teachers can restructure human brains under any circumstances, even health crises. They can achieve this by having in mind a set of guidelines based on neuroscience. Last but not least, the preponderance of digitalization should not lead to a completely artificial and virtual world because humans, teachers and students, should be the focus of interest in every learning and educational effort.

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