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# Responding to the Initial Challenge of the COVID-19 Pandemic: Analysis of International Responses and Impact in School and Higher Education

Christian M. Stracke <sup>1,\*</sup>, Daniel Burgos <sup>2</sup>, Gema Santos-Hermosa <sup>3</sup>, Aras Bozkurt <sup>4</sup>, Ramesh Chander Sharma <sup>5</sup>, Cécile Swiatek Cassafieres <sup>6</sup>, Andreia Inamorato dos Santos <sup>7</sup>, Jon Mason <sup>8</sup>, Ebba Ossiannilsson <sup>9</sup>, Jin Gon Shon <sup>10</sup>, Marian Wan <sup>11</sup>, Jane-Frances Obiageli Agbu <sup>12</sup>, Robert Farrow <sup>13</sup>, Özlem Karakaya <sup>14</sup>, Chrissi Nerantzi <sup>15</sup>, María Soledad Ramírez-Montoya <sup>16</sup>, Grainne Conole <sup>17</sup>, Glenda Cox <sup>18</sup> and Vi Truong <sup>19</sup>

- <sup>1</sup> Center for Higher Education (BZH), University of Bonn, 53115 Bonn, Germany
  - <sup>2</sup> Research Institute for Innovation & Technology in Education (UNIR iTED), Universidad Internacional de La Rioja (UNIR), 26006 Logrono, Spain; daniel.burgos@unir.net
  - <sup>3</sup> Faculty of Information and Audiovisual Media, University of Barcelona, 08014 Barcelona, Spain; gsantos@ub.edu
  - <sup>4</sup> Distance Education Department, Anadolu University, Eskişehir 26470, Turkey; arasbozkurt@gmail.com
  - <sup>5</sup> Instructional Design, Ambedkar University Delhi, New Delhi 110015, India; rcsharma@aud.ac.in
  - <sup>6</sup> Academic Library, Université Paris Nanterre, 92000 Nanterre, France; cswiatek@parisnanterre.fr
  - <sup>7</sup> Joint Research Centre, European Commission, 41092 Seville, Spain; andreia-inamorato-dos.santos@ec.europa.eu
  - <sup>8</sup> College of Indigenous Futures, Education & the Arts, Charles Darwin University, Darwin 0909, Australia; jon.mason@cdu.edu.au
  - <sup>9</sup> Swedish Association for Distance Education (SADE), International Council for Open and Distance Education (ICDE), OER Advocacy Committee, 22235 Lund, Sweden; info@i4quality.se
  - <sup>10</sup> Computer Science, Korea National Open University, Seoul 03087, Korea; jgshon@knou.ac.kr
  - <sup>11</sup> College of Interdisciplinary Studies, Taipei Medical University, Taipei 110, Taiwan; wanhhsu@tmu.edu.tw
  - <sup>12</sup> Wuse 2 Study Centre, National Open University of Nigeria, Abuja 106104, Nigeria; oagbu@noun.edu.ng
  - <sup>13</sup> Institute of Educational Technology, The Open University (UK), Milton Keynes MK6 7AA, UK; rob.farrow@open.ac.uk
  - <sup>14</sup> School of Education, Iowa State University, Ames, IA 50010, USA; ozlem@iastate.edu
  - <sup>15</sup> University Teaching Academy, Manchester Metropolitan University, Manchester M15 6BG, UK; c.nerantzi@mmu.ac.uk
  - <sup>16</sup> Institute for the Future of Education, Tecnológico de Monterrey, Monterrey 64849, Mexico; solramirez@tec.mx
  - <sup>17</sup> Independent Consultant, E4innovation, Leicester LE1 7RH, UK; gconole@gmail.com
  - <sup>18</sup> Centre for Innovation in Learning and Teaching (CILT), University of Cape Town, Cape Town 7701, South Africa; glenda.cox@uct.ac.za
  - <sup>19</sup> Faculty of Information Technology, Monash University, Melbourne 3177, Australia; vi.truong@monash.edu
- \* Correspondence: stracke@opening-up.education



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**Abstract:** This paper presents and analyses solutions where open education and open science were utilised to reduce the impact of the COVID-19 pandemic on education. The COVID-19 outbreak and associated lockdowns created huge challenges in school and higher education, demanding sudden responses which aimed to sustain pedagogical quality. Responses have varied from conservative to radically innovative. Universally, the COVID-19 pandemic disrupted and shocked societies worldwide, and education systems were on the front line. The lockdowns largely stopped face-to-face and formal education in almost all countries, and in most cases, distance learning soon became the 'new normal'. A central challenge concerned sustaining educational visions and ideals in such circumstances. To better understand the state of the art in the educational landscape, we collected case studies from 13 countries during the first year of the pandemic starting on 11 March 2020 (when the World Health Organization declared a pandemic). This paper presents summaries of the full country reports that were collected and describe lessons learned. Our overall aim was to identify good practices and recommendations from the collected case studies that can be taken forward in the future. We categorised the responses on the three generic educational levels (macro, meso and micro) and

identified seven key aspects and trends that are valid for all or most countries: (1) formal education at a distance for first time; (2) similar approaches for formal education; (3) missing infrastructure and sharing open educational resources; (4) diverse teaching and learning methods and practices; (5) open education and access to open educational resources; (6) urgent need for professional development and training for teachers and (7) assessing and monitoring learning environments, teachers and students. Finally, we identified key recommendations on how open education and open science can benefit formal education in schools and universities in the future, namely, improved awareness of open educational practices, provision of ICT infrastructure, embracing and sustaining the practice of open access publications and OERs, capacity building for stakeholders and finally encouraging research and development in the area of open education and open science. We found significant evidence for the proposition that open education and open science can support both traditional face-to-face and distance learning.

**Keywords:** school education; higher education; distance education; online learning; open education; open science; COVID-19 pandemic; impact; educational innovation; international practices and case studies

## 1. Introduction

COVID-19 had a profound and immediate impact on all segments of our societies, and not at least formal education systems typically organised around face-to-face contact. Challenges were presented to governments as well as all teachers, students, parents, strategic leaders and policymakers. Responses varied across regions and countries. Current studies from global organisations provided initial overviews of the national responses on the COVID-19 pandemic and related lockdowns [1–5]. Traditional education in face-to-face mode was disrupted in almost all countries worldwide to avoid COVID-19 spreading through hotspots in schools and universities. Consequently, teachers, strategic leaders and policymakers had to quickly respond in determining how formal education could and should continue in consideration of unprecedented social-emotional health and well-being issues.

The primary focus of this study is the extent to which open education and open science were utilised in facilitating and supporting distance education during, and after the initial lockdowns, at local and national levels. Another aspect was to identify similarities and differences in the countries and their experiences. For this research, we focused on the first year of the pandemic commencing with the official announcement on 11th of March 2020 as declared by the World Health Organization [6]. This paper presents and discusses reports from 13 countries collected as practices and case studies with the intended special focus on open education and open science.

The concept of openness has been connected with education and with science for millennia, even though it is sometimes vague due to the semantic versatility of the core term ‘open’ and refers to several dimensions in both disciplines [7–10]. Open education has its beginnings in ancient times, e.g., expressed in the philosophies of Greek educators such as Socrates and Plato as well as in China by Confucius [11–17]. In the contemporary world it goes beyond simple understandings of open access to education and includes a richness of innovative, collaborative, and empathic learning processes facilitated on all educational levels (micro, meso and macro). This broader conception addresses multiple dimensions and common examples include computer-supported cooperative work (CSCW) or flipped classroom designs [13,18,19]. Cultivating an open ‘mindset’ that values inquiry and questioning is perhaps another contemporary way of thinking about some of the roots of formal education. The idea of mindset is used here in reference to the acclaimed work of [20] on the role of a ‘growth mindset’ in optimising learning outcomes.

As an umbrella term, open education includes open educational resources (OER) as well as practices (OEP) [8,16,21]. Thus, we employ a broad definition based on common sense addressing all aspects of openness and all educational levels [8,22,23]:

*Open education enables learning for all through facilitating openness on all educational levels (micro, meso and macro) and in all dimensions (visionary, operational and legal openness).*

Open education accommodates innovations in learning processes, roles and pathways and can be seen as an ecosystem that thrives when there exists a general open mindset for such approaches [8,19,24–29]. For that to happen, all relevant stakeholders need to be identified to gain their attention in order to promote the benefits that follow [30]. High learning quality calls for widespread involvement to continuously improve the learning processes in all dimensions and on all levels, where open education can enrich learning environments and support the processes of educational innovation [31]. In our understanding, open education accommodates the philosophies of total quality management and of learning innovations: it is naturally positioned for ongoing modernisation of (formal) education, where traditional teaching is accompanied or replaced by self-regulated and collaborative learning pathways, as well as learning modes. Such an adaptation can also change the delivery mode towards digital or blended learning, which seems to be an effective solution for meeting the challenges of the COVID-19 pandemic.

Similarly to open education, open science has its beginnings deep within the history of science itself. Moreover, like open education, there is no universally accepted definition. Nonetheless, both concepts have steadily gained broad public interest and traction only in recent decades. The main difference is focus—for open science, it is research and knowledge creation, while for open education, it is learning and teaching. Thus, our definition of open science is rather approximate to open education, reflecting the identified need for a broad and commonly accepted definition and merging former proposals [9,32–34] here as

*Open science enables research processes for all through facilitating openness on all scientific levels (micro, meso and macro) and in all dimensions (visionary, operational and legal openness).*

Open science typically focuses on the open inquiry of the scientific method itself and connects this with publicly and freely available research outcomes. This approach combines precise and commonly defined scientific methodologies and procedures to achieve scientific progress through rigorous and evidence-based studies and investigations with an idealistic objective and philosophy for a better world. Reliability, validity, data reuse and trust have been identified as the main objectives of open science for such a global acceptance and understanding [9,34]. Open science research produces and publishes open data with open and free access to allow validation and replication. In doing so, open science can also be seen as a source of open educational resources (OER) for open education and both constitute open educational practices (OEP).

Open education and open science can be characterised as collaborative movements with philosophies and theories that can be facilitated through a personal attitude often referred to as open scholarship [9,28]. Like open education and open science, open scholarship indicates a personal commitment and engagement to apply open and holistic approaches to critically reflect, broaden and improve traditional and outdated patterns.

With the COVID-19 pandemic, the whole world is witnessing how our planet is vulnerable to system disruption, crisis and disruption [5]. The interconnected nature of such challenges remind us of the pivotal role of science and technology to respond to these challenges by finding solutions in the service of humanity. Acknowledging the opportunities enabled by the rapid development of information and communication technologies facilitating interconnectedness, scientific information and sharing of knowledge resources have proliferated. Global health crises affecting the whole world have compelled and heightened the need for enhanced sharing of information and knowledge. These events highlighted the importance of defending the diversity of voices and views and the need to rapidly

adapt educational institutions to a new reality, where collaborative science and shared knowledge constitute a necessary challenge. In line with this need, open science comes into prominence or stands out as a (scholarly) movement in the current digital era, responding to global issues in demonstrating the transformative role of science and technology.

Highlighting that open science is still an evolving concept, [9] defines ‘Open Science, as an umbrella term embracing and referring to all scientific subjects and disciplines, [...] is a combination of objective and subjective goals and means to improve science in the diverse subjects and disciplines and as a whole’ (p. 21). Alternatively, [34] define it as ‘transparent and accessible knowledge that is shared and developed through collaborative networks’ (p. 434). Both definitions indicate an intent to improve the whole society through open, collaborative, transparent processes in which sharing the information and knowledge is the key action.

Open education has its foundation on the principles of sharing knowledge, information and insights freely with others [8,25]. Likewise, open science resides in sharing the scholarship and scientific knowledge through collaboration. Drawing on ‘openness’ and ideals of ‘open education’, open science aims to ‘make scientific knowledge, methods, data, and evidence freely available and accessible for everyone, increase scientific collaborations and sharing of information for the benefits of science and society, and open the process of scientific knowledge creation and circulation to societal actors beyond the institutionalised scientific community’ [3] (p. 4). Current operationalisation of open science tends to rest on the public domain or under open licensing such as Creative Commons licenses. However, the boundaries of intellectual property rights still remain a challenge, influencing the sharing of science outputs without hesitation. Open science is necessarily a broad field interpreted differentially by various stakeholders [9], but it can be viewed as a mechanism to enhance accuracy, trust and transparency through openness. Expanding the reach of science and technology to wider audiences and stakeholders beyond scholarly communication entails adherence to the core principles of openness, transparency and reproducibility, which in turn makes open science practices more reliable and trustworthy [9,34,35].

Open science has gained more prominence with the advent of worldwide internet and communication technologies [9]. However, as an emergent phenomenon, its chief characteristics and boundaries are still being shaped by various disciplines or schools of thought. Research communities composed of researchers, higher education institutions and publishers have recently ‘established proper infrastructure for making research more open, like open access repositories and data archiving centers’, and large initiatives such as Foster and Go Fair have emerged to support open science practices [36] (p. 3). Open science practices offer benefits such as wider sharing and reanalysis of code, data and research materials; increasing replications and more transparent data presentation [35].

There are concerns both in social and life sciences that there is a lack of replication studies of published research as such replication studies often require unfettered access to research data [9]. However, with the evolution of open science practices—notably, open access publication of data—replication studies are becoming more widely appreciated and valued. Despite such benefits, open science practices encounter challenges. Attitudes of researchers toward data sharing are amongst the factors affecting open science practices. Pertaining to this, appearance of the lack of incentives, relative infancy of open data usage and concerns regarding privacy and openness are challenges to the development of open science [35–37].

From this perspective, open science brings opportunities for research enterprises to increasingly share research practices and collaboratively respond to the emerging challenges such as global health issues, e.g., COVID-19. Through such open cooperation and methodologies, open science can also support open education to enable education for all. Higher education is in particular a natural hub for the interaction of approaches to education and science which primarily draw on the concept of openness [28,36].

## 2. Methods

### 2.1. Research Method and Design

This study employed a qualitative case study strategy for describing the different conditions, practices and features of cases of interest [38]. It also implemented a collective case study design for the analysis and comparison across a given set of case studies [39].

There are, however, both strengths and limitations to this approach. Firstly, the research uses triangulation of researchers' perspectives [40] with the objective of increasing the research reliability and validity by defining a guiding research question first [41,42]. Therefore, a specific strength of this research is that it provides insights from multi-dimensional and pluralistic perspectives. Furthermore, the credibility of the study is strengthened through the considerable variety of experiences of the international research team. Concomitantly, the personal interpretations of all researchers are necessarily subjective. However, when documented as such this is routinely acceptable in qualitative studies when individual perspectives and worldviews are foregrounded and reflected upon [43]. In recognition of this, the researchers emphasise that they offer a representative, pluralistic view: Open education and open science are relative terms and can have different meanings and interpretations in different socio-economic, cultural and political contexts.

### 2.2. Data Collection and Analysis Procedures

Our key interest is to identify the diverse responses that governments, educational systems and their policymakers have chosen and followed during the COVID-19 pandemic. Through a convenience sampling approach, we selected 13 countries with different perspectives and described the experiences in reports about practices and case studies. Special attention is on open education and open science as potential enablers and support for the COVID-19 situation with its lockdowns. Thus, our methodology is a qualitative comparative case study [39] based on the collected case studies and country reports. The 13 countries are as follows: Australia, Brazil, France, India, Mexico, the Netherlands, Nigeria, Spain, South Korea, Sweden, Taiwan, Turkey, and the United Kingdom.

The practices and case studies were collected and identified with special focus on open education and open science following this guiding question:

- Which good practices, lessons learned and recommendations exist for the future?

We defined through consensus this guiding question before starting with the collection and descriptions of the country report about practices and case studies. Reports from the 13 countries show several attempts to face COVID-19 with different conditions, perspectives and solutions. As experts and practitioners in the field of open education or open science, we share the common interest to recognise and analyse ongoing developments worldwide and to identify guidelines for their implementation and application in the future.

Each co-author represents by insider research a certain region or country in the world with a full representation of all five continents. Therefore, we as researchers collected and identified data from our own insider and authentic contexts in combination with a deep understanding on the potentials and practices of open science and open education [43]. With this approach, we were able to identify their interpretations to understand how stakeholders in formal education worldwide reacted on COVID-19 [44]. This research design sets the individual observations of the researchers and provides documentary evidence related to the guiding question as the primary data collection tools [38]. The results of the study are reported according to the used analysis framework with its coding schema is discussed and the details of this analysis framework are included in Section 4, the Discussion, in relation to the trends identified in the countries analysed.

## 3. Results

This section summarises the (much longer) case studies that were collected from 13 countries (see Figure 1) following the guiding research question.





Figure 1. Overview of selected 13 countries and how they were impacted.

In general, the countries were all affected by the COVID-19 outbreak and pandemic but there are huge differences in the intensities, as shown in Figure 2.

Impact	1	2	3	4	5
	None	Slight	Moderate	High	Very high
Countries			South Korea Taiwan	France The Netherlands Sweden	Australia Brazil India Mexico Nigeria Spain Turkey UK

Figure 2. Impact by COVID-19 outbreak and pandemic in selected 13 countries.

As a response to COVID-19 and the related mobility restrictions, there are case studies that emerged worldwide and are worth reporting. We present them organised by geographical region.

### 3.1. The Case Studies and Country Reports from Asia

In Asia, in Taiwan, Taipei Medical University (TMU) began its digital initiative in 2018. Students in TMU could engage with a self-directed massive open online courses (MOOCs) and earn credits toward their graduation. The credit limit is eight in total. From January 2018 to January 2020, there were 596 students who completed a course, which is 24 students per month on average. During February 2020 to October 2020, there were 684 students who have completed a course, which is 76 students per month. Many students benefit from the free learning offered by the platforms such as Coursera, FutureLearn and edX.

In India, initially only teaching was suspended but the teachers and staff continued to attend; however, later on, working from home was allowed for online teaching, eContent development and instructional material development, etc. Online synchronous classes witnessed a boom, with use of instant messaging apps such as WhatsApp and Telegram. The Ministry of Education-supported ICT initiatives such as Swayam Prabha (bouquet of 32 DTH free to air channels), national digital library, SWAYAM (Study Webs of Active Learning for Young Aspiring Minds), MOOC platform offering undergraduate and post-graduate courses and e-PG Pathshala (interactive e-content for school curriculum) were

strengthened. The majority of teachers were unprepared to teach online, and, thus, many faculty development programmes were conducted by universities to train teachers for online teaching. Students had difficulty as the state of digital divide was evident in terms of cost of internet data packages and availability of computers or laptops. To support the education system, the government launched the 'Prime Minister eVIDYA' programme with the aim to boost e-learning and technology-driven education with equity as a part of the Aatma Nirbhar Apna Bharat programme. The top-ranking universities were encouraged to create online courses, and a television channel focusing on education of class 1 until 12 was dedicated. Reports indicated that the initial enthusiasm soon paved the way for students' negative reaction as long online hours were taxing to their attention and health. During the same period, the National Educational Policy 2020 was also released, highlighting the adoption of technology and transformations in education.

In South Korea, classes without a teacher, studying alone and taking classes or meetings online have been given little value. The reason has been the fact that it was judged that having a meeting and taking a class in the mode of face-to-face was highly productive. However, people (e.g., teachers, students, school authorities, educational institutions, and related companies) have seen the possibility that the various online tools, which they have to use in situations unavoidable by COVID-19, can increase productivity in education and meetings. In particular, it seems a very good sign that there is a growing awareness that it is desirable for anyone to easily access materials, information, services and contents related to education and learning and to be open to anyone.

### *3.2. The Case Studies and Country Reports from Europe*

In Europe, the Dutch Ministry of Education had already focused open education and open science as key principles and strategies before the COVID-19 outbreak but was still not prepared for the sudden need to transfer and deliver all teaching online and at distance. It transpired that a longer lockdown has strong implications for the pupils, students and their families, strengthening inequity in education. The demand for training through openly and freely available instruments and platforms is huge, and major attempts and investments are required for a quick implementation. There were large numbers of participants in free webinars and of OER downloads from new portals to support online learning and its design such as DDguide. For open science, the Dutch government started a long-term National Plan with huge ambitions: Until 2024, all scientific publications should be direct open access (golden approach), and research data should be re-usable. All these activities are underlining the necessity to offer more support and facilitate more open education and open science to overcome unequal chances for pupils and to extend high quality education to all.

In Sweden, The Open Science Community Sweden is a non-profit network with the aim of learning, discussing and exchanging knowledge about the open science movement in Sweden. The aim is to make science accessible, transparent, reproducible and replicable. The work is organised through promotion activities, such as workshops and lectures as well as by holding active debates. In addition, they lead and discuss open science initiatives, and they have created a platform for stakeholders worldwide to meet in Sweden [45]. The Swedish Research Council is the country's largest governmental research funding body and supports research of the highest quality in all scientific fields. The Swedish Research Council supports a statement calling on researchers, journals and funders to ensure that research findings and data relevant to the management of the coronavirus pandemic are shared rapidly and openly. In June 2020, a national data portal for research into COVID-19 was launched, which was coordinated by SciLifeLab and the Swedish Research Council in collaboration with the European initiative [46,47]. Because Sweden supports open access, the agreement with the science publisher Elsevier has been cancelled. Although it is a large science publisher, Elsevier does not meet the requirements of Swedish universities and research institutes as well as of the Swedish government that set the goal of immediate open access by 2026. To make the necessary transition from a subscription-based to an open

access publishing system, the Bibsam Consortium required the following: (a) Immediate open access to all articles published in Elsevier journals by researchers affiliated with participating organisations; (b) Reading access by participating organisations to all articles in Elsevier's 1900 journals; and (c) A sustainable price model that enables the transition to open access. Elsevier has not been able to present a model that meets the demands of the Bibsam Consortium, and the current agreement was not renewed after 30th of June 2018.

In France, awareness rose of the urgent need to address the digital gap in the population further. Various programmes were enforced in order to equip, connect and basically upskill the French population. Future national statistics were started to analyse whether this had been achieved and consolidated during and after the COVID-19 pandemic period. Adult competency recognition and employability is also under a strategic reorientation that aims to totally incorporate digital aspects. Beyond digital skills, recognition of skill and competences and adult professional training remain major issues which the COVID-19 pandemic has pushed to the forefront of public authorities' preoccupations. New forms of collaboration emerged with enhancing digital experience in many fields such as health services, public administration, learning and teaching experience. Building communities of mutual assistance and fostering cross-sectoral approaches appeared to be a very fruitful method of which all stakeholders stand to benefit from. Open and shared awareness and monitoring was developed in various communities, for example, by digital learning and teaching stakeholders [48] and by academic libraries [49]. In education, the reflection on new pedagogical methods and models was accelerated and the lockdown worked as a revealer of priorities. Distance and blended learning are clearly connected to the need to reinvent pedagogy, with a clear-cut view on the importance of an on-site teaching and learning experience for students' engagement and retention. Teacher experience and staff experience have been also brought to the main stage, and this is a major step towards renewed teaching and learning methods. In order for these evolutions to be consolidated, there is a real challenge with respect to educational, research, library and support staff training. The need to manage sustainable and interoperable infrastructures and access to documentation, research publications and educational resources has been sharply highlighted. Students' success and retention require a strong articulation of the three dimensions of their learning experience, work environment and access to knowledge.

In Spain, as in most countries, the state of alarm of March 2020 represented a forced step towards the non-presence and the virtualisation of teaching. Universities were challenged to abruptly carry out the transition from face-to-face teaching to an emergency remote teaching [50]. A set of general criteria was developed by the government [51] in order to adapt the higher education system in the light of the COVID-19 pandemic, and a series of methodological, technological and regulatory measures were adopted. Another government report on online university tools and assessment initiatives in the context of COVID-19 [52] completed the previous one by providing guidance for academic assessment and examination supervision. Finally, the open universities and providers with experience in quality online education guided their face-to-face teaching colleagues, by sharing their teaching methodologies and open educational resources.

On the other hand, the transition to distance education provoked by the COVID-19 pandemic has been an opportunity to move towards the paradigm of openness. With regards to open education, most of the movements have been related to the use of ICT innovation and free access to resources (open education as free education). In this sense, some MOOCs have been developed, and OER have been openly published and shared in university institutional repositories [53]. It has also been a chance to expand flexible learning modalities and to provide more educational personalisation, and a new culture of teacher cooperation and coordination has emerged [54], all of them aligned with the open educational practices. Regarding open science, the COVID-19 pandemic has afforded a huge step forward in terms of data sharing and almost immediate dissemination of scientific articles [55]. According to Belli et al. [56], more than 90% of open material has



been recorded, and there is an increase in international collaboration, with the United States and China being the main producers, followed by European countries, including Spain.

To sum up, two main general trends can be observed in Spain. The first one has been to put the online education expertise to good use inside the teaching community. The second, a more global one, is a certain acceleration of the open by default at the current crisis, which is shedding light on what the implications of the open for society can be.

In Turkey, the need for digital transformation, not only in terms of infrastructure but also processes, was highly felt to better deliver education in times of emergencies. The pandemic further revealed the need to improve digital literacies and lessen digital divide. Moreover, the value of openness in education is understood and appreciated considering that there was lack of awareness on open initiatives (e.g., open education and open science) and their derivations (e.g., OEP and OER) before the COVID-19 pandemic. However, in Turkey, it was observed that openness in education is interpreted and practiced differently, which indicates there is no universal definition and there is a need to culturally translate what open(ness) means. However, it was promising to observe that communities of practices were formed using various social media tools not only for information exchange, but also for collaboration and cooperation at high levels.

In the United Kingdom, during the pandemic, creativity came to the rescue. As academics had to make rapid decisions and changes to their practice to adapt to remote, hybrid and fully online provision, they became more experimental and resourceful and harnessed the power of imagination and creativity to problem-solve and stimulate learning in new and exciting ways. The challenging times provided opportunities for collaboration and togetherness. Academic developers and learning technologists started working much closer than ever before with academic colleagues and support curriculum and assessment changes. The creation of an open picture book with foundation year students at Manchester Metropolitan University and two lecturers and an academic developer is such an example [57]. The live project was proposed to two colleagues in the Arts and Humanities Faculty, who had experience with picture books and book design. They embraced the idea and took it forward as a way to enable students to work on such a live project as an extra curricula activity with their peers and be supported by their tutors and the author [57]. In total, nine students participated and co-created the illustrations for the story 'The Invisible King' that was written by the academic developer who initiated the project. The story related to the pandemic, and the ambition was to release it as an openly licensed digital book that could be used by children across the United Kingdom and further afield to express creatively and collaborate as it was encouraging drawing into the book. The picture book team was also hoping through this creative project to raise money for the Manchester Mayor's Charity. Students felt motivated and enjoyed working collaboratively to co-create the illustrations for the book while also developing new skills and competences in children's illustration. The collaboration happened over four months, from April to July 2020, and was supported by a Facebook channel and regular Zoom meetings to discuss, provide feedback on proposed illustrations and agree upon ways forward. Students said characteristically, responding to the question 'What did you learn from this project?': 'I enjoyed the feeling of all working together and helping each other'; 'That very special and diverse art pieces can be accomplished when like-minded people collaborate'; 'People can have very different visual interpretations of the same idea and I think it's interesting to be able to see these'. In the United Kingdom also, the pandemic has encouraged domestic scientific culture. During 2020, daily briefings from leading professors on behalf of The Scientific Advisory Group for Emergencies (SAGE) on BBC1 became commonplace. Attention was paid to explaining the science behind attempts to analyse the mechanisms and effects of COVID-19 and the reasons for measures such as lockdowns, social distancing and the closure of workplaces. This was supported by the systematic unlocking of research data and journal articles, being catalysed by huge media interest. (Arguably the endeavour to explain the COVID-19 outbreak to as wide an audience as possible is one of the most co-ordinated educational actions in history, and could be framed as 'open' apart from

licensing issues.) However, there has been ample opportunity for misinformation or loss of nuance in message. Mainstream media, with an appetite for striking headlines, often raised the profile of pandemic research without qualifying findings, resulting in mixed messages and confusion. The rapid publication of pre-prints may have been unhelpful in some of these cases when taken in conjunction with lower journalistic standards. The study by [58] on misinformation suggested that a significant minority believe conspiracies about COVID-19. Though this is often associated with social media use (and patterns of susceptibility to misinformation vary by country), the most significant factor was that 'reflective and analytical thinking are consistently associated with reduced susceptibility to misinformation'. There is a strong case for improving public understanding of science as misinformation can result in behaviours that can be harmful (vaccine avoidance, refusal to wear a mask, etc.). The United Kingdom presented a good number of open science projects, such as the COVID-19 Protein Portal (<https://covid19proteinportal.org/>) (accessed on 21 January 2022); the Academy of Medical Sciences (<https://acmedsci.ac.uk/policy/uk-policy/coronavirus>) (accessed on 21 January 2022); the UKRI and UKCDR, which provided lists of COVID-19 research projects to help researchers identify and fill funding opportunities (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7590891/>) (accessed on 21 January 2022); and the U.K. Data Service, providing a wide range of data about COVID-19, adjusting licences to allow home-based researchers to continue working with their data (<https://www.ukdataservice.ac.uk/get-data/themes/covid-19/covid-19-data.aspx>) (accessed on 21 January 2022), but it appeared that they were a sort of time-limited emergency response.

Finally, an outstanding case in Europe is how the library community had provided other information resources to the wider public so they can also learn from home. They adapted to students' personal situations by offering specific learning resources to help them continue their studies. Furthermore, libraries have supported learning, teaching and research activities of students, teachers and researchers through three actions: First, Open access to resources as libraries have joined other cultural institutions in the exchange of knowledge by opening up its content to the public. Second, sharing resources and services about COVID-19, as library associations have created special initiatives and websites to share OER about COVID-19, such as IFLA COVID-19, the Global Library Field (<https://www.ifla.org/covid-19-and-libraries>) (accessed on 21 January 2022) and the SPARC resources related to COVID-19 [59]. Third, training webinars were organised by the library or its resource suppliers to focus on academic databases to help make searching for information easier. They have also performed some actions to implement the UNESCO OER Recommendation [60] and they have joined into social media campaigns, such as #StayAtHomeAndLearn, by highlighting several useful resources. A report [61] from the Association of European Research Libraries as to how academic libraries responded to the COVID-19 crisis indicates the need for co-creation through collaboration and states that 'Working together is essential in the success of future projects, and we need to work hard to make collaboration efficient, pleasant, and meaningful in the (post) COVID world' (p. 21).

### 3.3. *The Case Study and Country Report from Africa*

In Nigeria, current realities have stimulated further awareness on the beauty, versatility and sustainability nature of open education as well as of open science. Thus, misconceptions in both fields are gradually eroding. Research and practice on novel ways of providing open education and facilitating open science have greatly improved with supportive policy statements. This has also stimulated improved ICT infrastructure and capacity building mechanisms in Nigeria. Drawing insights from a workshop on open education with 22 participants (all new entrants to open education), they reported that open education stimulates access to education, that it is interactive, affordable, flexible, accommodating and sustainable and prevents disruption in learning. In further explanations, respondents noted that in events of industrial strike actions or pandemic, teaching and learning could

continue online, thereby preventing disruption in this regard. To them, this is of utmost importance and perhaps a very important role of open education.

#### 3.4. *The Case Studies and Country Reports from the Americas*

In Latin America, in Mexico, the starting point is the important role that the government must play. It is a desire that the federal, state and municipal governments have understood the importance of establishing economic and social development goals that make it possible for all sectors of society to have the support that helps increase the percentage of the population with access to a decent education. It is important to emphasise that socio-economic conditions, health and services are fundamental to establish an integral dynamic that approaches the possibility of democratic access. At the same time, the construction of a robust technological infrastructure throughout the country is required that allows all the country's inhabitants to have connectivity. COVID-19 accelerated a process of implementation of education based on new technologies, which might have taken at least a generation to be carried out, from 'analogue to digital classes', without time or possibilities to analyse it. Teachers who may have been resistant to the use of new technologies had to adopt them as the only way to fulfil the act of teaching. Although it is not possible to speak of widespread training, nor of an increase in teachers' digital competences, the 'forced' approach reduced the time it would have taken the national authorities to raise awareness for change and transformation. This may mean that the next steps will be for teachers to acquire technological competences that will allow them to add to their expertise new tools that will help them to improve communication with their students.

An important aspect has been the deeper contact between parents and teachers. The pandemic encouraged families to have more contact with educational institutions, building new bridges of communication that will favour the construction of a more holistic educational community. Good practises included the opening and innovation of open platforms for training. Universities, companies, consortia and non-governmental organisations promoted spaces for different sectors of society to interact and share knowledge. Virtual and remote open laboratories, repositories, massive open courses, programmes for teacher training in distance learning environments and open science were made available to citizens [62].

During the pandemic, the First International Congress on open science and Institutional Repositories was held in Mexico. The objective was to promote teamwork between the different educational institutions that have institutional repositories in order to influence the improvement, not only of the Institutional Repositories, but also of the way of making public the results of scientific research in the country and, with that, promote collaborative networks, research in line with social problems, recognition of the researcher as a central actor in the social life of the country and the promotion of accountability on the part of both public and private institutions [63]. Thirty-five papers were presented in seven round tables, five of them focused on Institutional Repositories, one on Open Educational Resources and one on open science. There were three keynote lectures, five specialist lectures and three specialised workshops with separate registration. There were 963 registered participants, and two groups emerged from the congress that will promote open science in Mexico: (a) improving web visibility and accessibility for effective, inclusive and equitable access to quality open educational resources and (b) institutional repositories and their contribution to the digital transformation of education. Educational institutions, in an effort to find solutions, joined forces and carried out scientific research to analyse and understand the specific characteristics of the process of the impact of COVID-19 on education. Among the contributions is a guide for academic continuity. The Model for the Continuity of Educational Services in an Emergency Context and its Crisis Stages (Modelo de Continuidad de Servicios Educativos ante un Contexto de Emergencia y sus Etapas de Crisis) converts the main lessons learned and cases worthy of example found into tools and products that—in addition to supporting memory—make it possible to systematise the experience and raise everyone's capacities to better face the challenges of educational

continuity in the face of possible new emergencies and their associated crises [64]. Another positive impact was the link between governmental, academic, social and business sectors, seeking solutions to reduce the impact of the pandemic. One case in point is a private higher education institution that opened up access to its hospitals to the public, significantly reducing the mortality rate for the patients it treated; the deployment also included plans to link up with society, parents and wellbeing for students and teachers. A further case occurred in companies that established partnerships to support teacher training projects in vulnerable schools, through links with the government and universities. These gestures of solidarity showed a possible change of attitude, which allows for understanding the importance of working together for the feasibility of efficient results, from differentiated perspectives that contribute to the common good.

In Brazil, the major question was not the use or reach of open educational resources, but the three major obstacles perceived to use them, which seems to be (1) lack of equality to access the Internet by all students and teachers, due to the increasing poverty level of the population, magnified by the COVID-19 crisis; (2) lack of digital competence of teachers to facilitate the education process online; and (3) a consequential lack of information about open educational resources and open educational practices in the country. A few localised actions that have been taken by Brazilian OER activists over the past years are not enough to cater for the huge number of teachers both in the basic and higher education systems that require information and training on open education and OER. Brazil has many challenges to overcome that seem to be urgent, such as the lack of teachers in the system holding a university degree. The country has been investing in strategies to accelerate the number of teachers with a university degree, particularly in mathematics, languages and sciences. Continuous professional development on OER and open education does not seem to be a priority at the moment, although there is the recognition of the benefit of such open resources and practices, by the textbook initiative and the portal for OER—MEC-RED. However, it is important to reflect on the fact that, by definition, open educational resources are educational materials that must be openly licensed. If one were to expand on the notion of OER to encompass free of charge resources although not necessarily openly licensed, then the initiative of the São Paulo State, of offering classes via television and via an application, could be considered a massive way of promoting the circulation of high-quality educational materials for free via digital means in the Brazilian society.

### *3.5. The Case Study and Country Report from Oceania*

Australia and its close neighbour, New Zealand, both managed to minimise the initial impact of the pandemic through swift and effective interventions by respective governments in forcing lockdowns to control community transmission of the virus. At the same time, however, other close neighbours of Australia struggled to contain the situation, with Papua New Guinea being a standout example.

For the Australian education sector, the initial impact in early 2020 was severe, although in different ways for schools, vocational training and higher education. A mix of home-schooling and online access to classes was broadly implemented across the schooling sector, and despite the many challenges and public debate, it has been regarded by most stakeholders as largely successful for the majority; however, the situation has exacerbated problems associated with the digital divide, and for many remote communities, the pandemic has brought a major interruption to school education. The phrase ‘emergency remote teaching’ has been somewhat meaningless for many remote Indigenous communities where there is little or unreliable infrastructure. On the positive side, the success could be viewed as partly due to Australia’s long history in implementing distance education while also being an early adopter of digital technologies in education.

In Australian higher education and vocational training, the most noticeable impact of the pandemic was the loss of the international student market. Official figures indicate that in early 2021, there had been a 99% decrease in international student enrolments. Such disruption has caused most universities to shed staff and introduce structural changes such

as the closure of courses and mergers of organisational units to accommodate this impact to revenues. This has been in addition to a decade of diminishing public sector financial support. Despite this, all universities remained open throughout the pandemic, and most institutions have been focused on recalibrating their priorities and business models. There is no doubt that a significant transformation of the sector is now underway, and there is now renewed appetite to supplement traditional academic courses with short-course offerings and micro-credentials geared for the immediate needs of the workplace.

In early 2020, the Australian Government moved quickly to put in place extensive resources and advice online to support all stakeholders in school education [65]. This was also supported by several other leading consulting sources within the education sector that also indicated strong buy-in from teachers. Late in 2020, the Tertiary Education Quality and Standards Agency (TEQSA) published 'Foundations for good practice: The student experience of online learning in Australian higher education during the COVID-19 pandemic'. This comprehensive document was well-received; however, in the context of this study, information concerning OER was a glaring omission. Nonetheless, the value of open educational resources (OER) has received considerable attention and in some contexts discussed as a 'new paradigm' [65]. As all co-authors of this article already know well, OER has been advocated for nearly two decades, and therefore it is hardly a new paradigm. However, to witness commentaries pitching it as such indicates a new and broader appreciation of its value.

Despite the omission in the TEQSA guidelines, the Australian Government has provided useful information for several years on OER to the Australian Schools and Vocational Training sectors through its Smartcopying website, and most libraries in Australia have also supported this agenda [65]. There is now ample evidence that the pandemic has been a catalyst for both teachers and learners seeking out and making use of OER, and this is true of the schooling sector as well as higher education. In relative terms, open science has been less visible, as this is seen more as the domain of higher education research. Nonetheless, as [66] note:

"In the few months since the first case of COVID-19 was identified, the underlying cause has been isolated, its symptoms agreed on, its genome sequenced, diagnostic tests developed, and potential treatments and vaccines are on the horizon. The astonishingly short time frame of these discoveries has only happened through a global open science effort."

Open science has been developing for nearly two decades in Australia, and since 2018, higher education research has been supported by a mature, open, national digital infrastructure known as the Australian Research Data Commons (ARDC), a platform for open data and resource sharing. Open science in Australia is understood primarily in terms of the how of science, which signifies the broad context of open access scholarship and publishing. It is also understood as part of a rich ecosystem of initiatives that cluster together around the pivotal role of openness in the development of the web—open standards, open source, open data, open architecture, open learning, open scholarship, open access, open educational resources and open educational practices. This broad agenda has been developed for nearly two decades in Australia, and since 2018, higher education research has been supported by a mature, open, national digital infrastructure known as the Australian Research Data Commons (ARDC). The ARDC is a platform for open data and resource sharing and is representative of the depth of open science and adoption of open educational practices in Australia.

The specific story of the widespread adoption of open access in Australian higher education is interesting in this context. Arguably, this policy footing became compelling once the authorities overseeing public funding of research saw there also needed to be a commitment from the sector to ensure that research findings from publicly funded research should be made freely available to the public. In Australia, this has been in place now for over a decade.



There now exists a rich diversity of examples of both open science and OER within the Australian education sector. A pertinent example is an open access textbook authored by [67], ‘Trauma Informed Behaviour Support: A Practical Guide to Developing Resilient Learners’. A creative example of open science is the work by a Sydney-based molecular biologist on broadening the genomic displays of the COVID-19 virus with music [68].

There are several key organisations in Australia that prosecute the open agenda, among them being the Australian Open Access Strategy Group (AOASG) which monitors and disseminates relevant policies. Most universities are also now supportive of the open movements, and it was timely that just prior to the COVID-19 outbreak, the universities of Melbourne, Deakin and Swinburne launched AIMOS (the Association for Interdisciplinary Meta-Research and Open Science).

#### 4. Discussions

The case studies and country reports above cover the period from January 2020 to 11 March 2021, the first anniversary of the official COVID-19 outbreak as approved by the WHO. Many national, regional and local solutions were implemented, taking into account the various laws and regulations that emerged in the different countries and regions facing COVID-19.

We structured our analysis according to the generic educational and impact levels, i.e., macro, meso and micro levels [19]. Our selected research design allowed us to set the individual observations of the researchers providing documentary evidence related to the guiding question as the primary data collection tools. For our study, we used an analysis framework with a developed coding schema: The answers collected in the complete country reports were analysed through the coding system, consisting of identifying good practices, needs, strategies, initiatives and solutions where open education and open science were used. This has allowed the differentiation and validation of a coding scheme: Our analysis and comparisons led to 25 variable factors (see Figure 3 with the coding scheme) that could be clustered and related to three levels and seven key aspects (see Table 1).

LEVELS	KEY ASPECTS	VARIABLES	ASIA			EUROPE				AFRICA	AMERICA		AUSTRALIA		
			Taiwan	India	South Korea	The Netherlands	Sweden	France	Spain	Turkey	UK	Nigeria	Mexico	Brasil	Australia
MACRO	Formal education at a distance for	Digital / online learning													
		Measure: Long term opening													
	Similar approaches for formal education	Measure: Immediate closing													
		Mesure (schools): Local lockdown													
		Mesure (schools): Complete lockdown													
	Missing infrastructure and sharing Open Educational Resources	Need: more infrastructures													
		Need: distance learning design													
Need: resources sharing															
Instructional Access: Television & internet															
MESO	Diverse teaching and learning methods and practices	Instructional Access: networks													
		Instructional Access: OER platforms & repositories													
	Strategy: identify equipment & connections needs														
	Institutions' own pedagogical methods and tools														
	Open education and access to Open Educational Resources	Traditional resources vs OER/OE													
OER supporters: Open universities															
Traditional educational resources															
MICRO	Urgent need for professional development and training for teachers	Digital /open textbooks / OA book													
		Policies													
		Challenge: training & professional development													
		Good practice: webinars training													
	Assessing and monitoring learning environments, teachers and students	Good practice: Local skilling events													
		Strategy: identify equipment & connections needs													
		Monitoring learning													
	Assessing learning														
	Quality assurance														

Figure 3. Impact by COVID-19 outbreak and pandemic in selected 13 countries. Coding schema of variables, aligned with key aspects and levels.

**Table 1.** Impact by COVID-19 outbreak and pandemic in selected 13 countries. Levels and key aspects.

Level	Key Aspect
Macro level	Formal education at a distance for first time
Macro level	Similar approaches for formal education
Macro level	Missing infrastructure and sharing open educational resources
Meso level	Diverse teaching and learning methods and practices
Meso level	Open education and access to open educational resources
Micro level	Urgent need for professional development and training for teachers
Micro level	Assessing and monitoring learning environments, teachers and students

The seven key aspects are the result of a series of variables identified during the analysis of the full country reports, which allow us to see cross-cutting trends in all or most of the countries or to identify particular examples of needs, strategies, initiatives or other aspects. Both variables and key aspects are related with good practices, lessons learned and solutions where open education and open science were utilised, according to our research aim, and they are detailed below.

Thus, we could identify and highlight seven key aspects as presented in Table 1. They are common for all or most case studies and countries.

At the macro level, we can report three key aspects identified in the case studies:

#### 4.1. Macro Level: Formal Education at Distance for First Time

The general shifting to distance learning strategies implied making formal education and its resources available to households for the first time. All countries were surprised by the sudden need including the most developed ones and independent from their advances in digital learning. Many pupils, students and their parents, as well as lifelong and life-wide learners experienced digital and online learning for the first time. As formal education in schools is generally more centralised than in higher education, and school pupils require the help of their families to continue learning, governments developed national strategies. This was fundamental during periods of strategic containment. After the initial local and national lockdown periods in countries where it was put into place, primary schools re-opened for face-to-face provision much earlier than higher education and adult learning institutions.

#### 4.2. Macro Level: Similar Approaches for Formal Education

Almost all countries decided quickly to take measures and means for reducing societal life and activities including formal education. Sweden was a long-term exception, keeping schools still open while all other countries closed school and higher education more or less immediately with or after the first lockdown. The further restrictions were different, and those countries with strong measures and a complete lockdown were earlier in opening schools again. All countries experienced a second wave of COVID-19, with the Asian countries reducing the closure of schools to local cases, while all countries outside Asia had a second complete lockdown (and some even a third). Unfortunately, as we write, this is still happening and unfolding, and some countries are only really being hit now (e.g., Taiwan). Here, we do not judge or evaluate COVID-19 mitigation strategies; our intention is simply to categorise the impact over the time period.

#### 4.3. Macro Level: Missing Infrastructure and Sharing Open Educational Resources

Missing infrastructure and experiences of distance education challenged formal education in most countries. In order to provide easy and free access to online and broadcast educational material, many national solutions relied on television and the Internet (Australia, Turkey, France, Mexico and Brazil), and sometimes on networks (Mexico). In all countries, designing distance learning paths and sharing virtual educational resources became a first necessity. Private companies and EdTechs were partners for designing educational

workspaces and providing access to educational resources and software licenses in many cases for free. Many teachers shared their resources (e.g., short lessons, exercises, etc.) created during the period of confinement, very often through direct and personal channels of dissemination on the internet and social messaging platforms. The modes and strategies for instructional delivery have diversified: the resources produced in various countries have been used by teachers, students and their families, as well as informal learners including adults in training and lifelong learning. Sharing educational resources sometimes led to or accelerated developing open educational solutions, such as repositories (Mexico, Spain, the United Kingdom), MOOCs (Taiwan) and other platforms (India, the Netherlands and Nigeria). Some examples are BELUGA in Africa [69] or the Indian national platform DIKSHA (Digital Infrastructure for Knowledge Sharing), created by the National Council for Education Research and Training (NCERT) and the Ministry of Education. This platform is based on Sunbird (MIT-licensed open-source technology) and provides open digital content for school education [70], which is adopted by 35 states/union territories of India. Moreover, in Spain, the Ministry of Universities, with the lead of the Universidad a Distancia (UNED) and the Universitat Oberta de Catalunya (UOC) and contributions of the rest of Spanish universities, created the national OER platform Conectad@s: La universidad en casa. Another strategy considered how to identify and remedy the needs for equipment and connections per household, as well as how to reach disadvantaged geographical areas or vulnerable populations (South Korea, Nigeria, Sweden, France). Higher education students are one of the populations particularly considered by national, local or institution-related initiatives. However, some regions in the world still did not have adequate internet access.

At the meso level, we can report two key aspects identified in the case studies:

#### *4.4. Meso Level: Diverse Teaching and Learning Methods and Practices*

Teaching staff and support staff equipment and connectivity was also considered. In higher education, which has the particularity of accommodating academic freedom in principle, teaching and learning methods and practices are very diverse. In school education, which normally has a stricter (in most cases national) curriculum, teachers had to switch towards distance education from one day to another: schools and single teachers had to find or develop their own solutions. Thus, actions were less centrally coordinated (or not coordinated at all), as institutions were and still are in charge of determining their own pedagogical methods and of implementing infrastructure, tools and solutions. By consequence, the strategies and solutions were less equally structured and could vary within the institutions by curriculum, sometimes by teachers, and could be guided by students' dominant use or preferences for some solutions. Open universities, where they exist, were strong OER and OE supporters (e.g., Spain, Nigeria, the Netherlands, India). Some institutions have found it extremely difficult to implement a homogeneous dynamic. Some disciplines had cultures that were extremely distant from remote or dematerialised practices; others required manipulation and, furthermore, others could not be conducted off-site.

#### *4.5. Meso Level: Open Education and Access to Open Educational Resources*

Access to documentation and library resources is closely linked to educational practices, whether it is documentation to be read by students, useful resources for the pedagogue or teacher to enrich and develop his or her practices, or for the researcher to conduct their studies. In higher education, a strong persistence of traditional models such as books and manuals was noted: institutions mainly focused on tools and workspaces for distance education but did not explore much the possibilities offered by OERs and open education. However, there are some cases of using digital books (Turkey) and open access or free textbooks through libraries (Europe) and other initiatives (Mexico and India). Negotiation for granting access to e-published journals and books was also a current action, supported by ministries, education councils, academic library consortia and national and international

calls to publishers, with a particular focus on health-related disciplines. Some cases of use of digital books (e.g., Turkey and India) and open access or free textbooks (e.g., France, the United Kingdom, Spain, Mexico and Australia) have been identified. In addition, both academia and publishing communities have entered a new phase of awareness of the benefits of open access. Furthermore, we can also note that some institutions and countries have developed (or have begun to do so) open policies and strategies to help the openness to be introduced in education systems such as the Netherlands and Sweden.

At the micro level, we can report two key aspects identified in the case studies:

#### *4.6. Micro Level: Urgent Need for Professional Development and Training for Teachers*

The biggest challenge arguably lies in training and upskilling professionals, either collectively or individually. Distance teaching revealed strong disparities with technology abilities that presented a training challenge. The different (and often missing) abilities and competencies of teachers, trainers and support staff to use existing tools or to appropriate new environments, sometimes inadequate or insufficient, led to diverse and complicated solutions. Enthusiastic responses coexisted with strong resistance. Some countries have been able to provide training (Brazil and Mexico) and support, sometimes thanks to their experience in distant learning systems (e.g., South Korea, the Netherlands and Spain), but very large inequalities have appeared since this massive change towards online activity was very often made without preparation. Upskilling teachers also led to local or regional events, such as the UNESCO workshop on ICT Competency Framework for Teachers (CFT) in Nigeria or train-the-trainer activities [71]. The DIKSHA platform of the Government of India has a mandate of upskilling of teachers and provides access to curriculum-linked e-content, quizzes and QR-coded energised textbooks (phygital textbooks). In addition, the National Repository of Open Educational Resources (NROER) is an open storehouse of e-content in various languages and formats.

#### *4.7. Micro Level: Assessing and Monitoring Learning Environments, Teachers and Students*

Assessing, monitoring and sometimes labelling quality and quality assurance in virtual teaching was one of the main concerns that emerged during the pandemic period (Sweden, Spain, Taiwan and Nigeria). Virtual education environments, distance social relations and trusting institutions have been monitored in some countries and/or institutions in order to collect teachers' and students' feedback, gain a deeper understanding of the campus as a learning environment and discover how users (teachers, students) consider future changes in behaviour.

### **5. Lessons Learned and Recommendations**

While 2020 will be recorded in history as one of the most challenging periods of contemporary history, it will also be seen as a critical moment in a broader acceptance and advocacy for openness in science and adoption of open educational resources [72]. In the world of academic publishing, [73] argues that the pandemic has helped 'lock in' the 'shift to open access publishing'. Similarly, [66] put the case that 'after the COVID-19 pandemic there can be no return to closed working'.

Many lessons have been learned at all educational levels and among a variety of stakeholders. All responsible authorities have assigned follow-up studies, not only on the curriculum, content and exams but also on social, emotional and economic concerns. In France, the Education Ministry proposed an action plan during the General Assembly on Digital Technology for Education, with 40 proposals to structure the future work of the educational communities in France [74]. In Sweden, [75] works extensively with the follow up assignment on a broad scale, within several sectors and in eight thematic areas (basic projects, study and work environment, quality of education, research, legal certainty, labour market, finance and financing and mobility and internationalisation).

Most important among the main lessons learned is that there is a 'new normal' or the 'next normal', which departs significantly from the 'normal' in 2019, to which we

cannot return [76–80]. The next normal is about change, recalibration, resilience, agility, sustainability and scaling up the digital transformation to ensure personal, inclusive and accessible learning for all where no one is left behind.

Another lesson learned is that limitations, as well as gaps in scope and support levels have become highly visible, particularly in the most vulnerable groups, which must be taken care of urgently. In addition, the sudden introduction of distance and digital learning has led to new experiences demonstrating their potential benefits for the first time for many teachers, students, parents and policymakers. Regarding the digital transformation, lessons learned include the urgent need to move from the margins to the mainstream. Further recommendations for a near future include:

- Provision of enabling policies to support open educational practices.
- Improved awareness of open educational practices.
- Provision of ICT infrastructure.
- Embracing and sustaining the practice of open access publications and OERs. For example, the government can issue directive for all public-funded teaching and learning material to be openly licensed.
- Capacity building for all stakeholders.
- Encourage research and development in the area of open education and open science.

In addition to these listed needs to design a successful model for open education and open science, ethics and sustainability are two fields that will need to be enhanced in the future. For instance, France is currently developing national policies, frameworks and guidelines related to the European and international level that can provide inspiration and guidance when building the next institutional and organisational strategies. Moreover, data and analytics will also be addressed in a near future in the educational field. At the end of August 2020, the ethics committee published a report entitled ‘Ethical issues in the use of digital educational data in the context of the pandemic’ [81]. This report is the first result of a reflection launched in April 2020 to identify the ethical issues related to the management of educational data raised by the increased use of digital technology in the period. A total of 23 recommendations are listed in this document, including three on respect for the fundamental freedoms of those involved in education, the guarantee of digital sovereignty in education and equal access to digital technology.

Another important aspect of the pandemic is the way it has encouraged agile and creative forms of collaboration at scale. This is undoubtedly supported by the growth in open access publication and sharing of data openly as well as in open professional networks and communities. The COVID-19 pandemic has clearly demonstrated the interconnected and interdependent nature of the world. Open approaches fundamentally recognise this and also draw on the idea of collective interest to motivate sharing and coordination. It can be asserted with certainty that without open approaches the pandemic would have had a greater impact for longer. The challenge faced is how to leverage the ongoing situation for example, through pressuring funders and publishers to retain their temporary commitment to open access; encouraging educational institutions to maintain, develop and share their own repositories of OER and continuing to advocate for open approaches. The COVID-19 pandemic provides an effective framing narrative around the positive impacts of being open but has also been used as an effective framing by commercial providers.

Overall, the lessons learned also concern leadership. From the collected reports, it seems that strong, brave, innovative and inclusive leadership continues to be crucial in going beyond the pandemic crises and in meeting future challenges with recalibration, agility, courage, grit and resilience to ensure sustainability in providing for learners’ needs and wants, the latter of which may be more crucial.

## 6. Limitations of This Global Review

The purpose of this paper is not reporting findings to generalise but to identify and to reflect on the impacts of the COVID-19 pandemic for deeper understanding from the perspective of open education and open science. There are several limitations of this global



inquiry that we want to mention. First, the small number of selected countries (13) is not representative of the whole world and is based on the given availability of experts—their voices, experiences and interpretations. Second, the subjective nature of the case studies and country reports as well as the diverse way to collect them are subjective in relation to personal knowledge and overviews. Third, it is always a challenge to draw global conclusions from a limited data set to allow generalisations. Fourth, the general key aspects identified from the diverse case studies are comparing diverse circumstances and contexts without particular consideration of broad differences in traditions, conditions and cultures. Fifth, we could not include and analyse general impact factors such as the high and alarming numbers of out-of-school children due to the COVID-19 lockdowns. Finally, it is out of our ability to judge, value or validate the different strategies and practices that were taken in the selected countries, and we can only provide their categorisation for a first overview.

## 7. Conclusions

The COVID-19 pandemic disrupted the normal as we know, and there were many earlier efforts to understand the changes and take positions accordingly [27,77,79,80,82,83]. It was seen that the whole globe was unprepared against the challenges that occurred due to the COVID-19 pandemic, and the responses across the world varied. The strategies included low and high technologies, adaptation of best practices and creating innovative strategies. Consequently, we have seen novel ideas, pedagogical practices, strategies, tools and techniques adopted by individual educators and students and also by institutions. In this regard, we contend that the relationship between two pivotal concepts is worth further exploring: technology and openness in education.

In terms of a technology-centric view, we can argue that while solutions emerging with digital transformation are effective in many cases, we also need to develop processes that equip stakeholders with digital competencies to fully benefit from the transition. On the other hand, while we see that digital solutions empower us to survive during the pandemic, we see that they exacerbate problems such as the digital divide and other forms of inequality and inequity. This panoramic view urges us to adopt technology-driven solutions within an ecosystem by relating with each entity that exists, embedding it to social contexts with caution.

In terms of openness in education, it was observed that advocating openness and its derivations in education (open education, open science, open scholarship, open educational practices, open educational resources, etc.) may not be sufficient, yet we need to create spaces (online, offline, and onsite) to facilitate practical application. That is, the pandemic itself can be turned into an opportunity to globally campaign for forms of praxis that present openness as a mantra for both theory and practice.

As a final remark, it can be argued that formal education can be effectively supported by modalities other than face-to-face such as online distance education. Our experiences demonstrate that online distance education can be beyond the second-best option for teaching and learning and can be used even in the situations where the need is not an emergency. Perhaps the debate should not be comparing and contrasting educational modalities (e.g., face-to-face and online distance education) but in adopting the best working option that meet our needs as a society, and most importantly the needs of the learners. Thus, openness in education and science can be understood as a form of pragmatism in a world characterised by crisis.

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