



## LJMU Research Online

**Leal Filho, W, Price, E, Wall, T, Shiel, C, Azeiteiro, UM, Mifsud, M, Brandli, L, Farinha, CS, Caeiro, S, Salvia, AL, Vasconcelos, CR, de Sousa, LO, Pace, P, Doni, F, Avila, LV, Fritzen, B and LeVasseur, TJ**

**COVID-19: the impact of a global crisis on sustainable development teaching**

<http://researchonline.ljmu.ac.uk/id/eprint/16134/>

### Article

**Citation** (please note it is advisable to refer to the publisher's version if you intend to cite from this work)

**Leal Filho, W, Price, E, Wall, T, Shiel, C, Azeiteiro, UM, Mifsud, M, Brandli, L, Farinha, CS, Caeiro, S, Salvia, AL, Vasconcelos, CR, de Sousa, LO, Pace, P, Doni, F, Avila, LV, Fritzen, B and LeVasseur, TJ (2021) COVID-19: the impact of a global crisis on sustainable development teaching. Environment.**

LJMU has developed [LJMU Research Online](http://researchonline.ljmu.ac.uk/) for users to access the research output of the University more effectively. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Users may download and/or print one copy of any article(s) in LJMU Research Online to facilitate their private study or for non-commercial research. You may not engage in further distribution of the material or use it for any profit-making activities or any commercial gain.

The version presented here may differ from the published version or from the version of the record. Please see the repository URL above for details on accessing the published version and note that access may require a subscription.

For more information please contact [researchonline@ljmu.ac.uk](mailto:researchonline@ljmu.ac.uk)

<http://researchonline.ljmu.ac.uk/>



## LJMU Research Online

**Leal Filho, W, Price, E, Wall, T, Shiel, C, Azeiteiro, UM, Mifsud, M, Brandli, L, Farinha, CS, Caeiro, S, Salvia, AL, Vasconcelos, CR, de Sousa, LO, Pace, P, Doni, F, Avila, LV, Fritzen, B and LeVasseur, TJ**

**COVID-19: the impact of a global crisis on sustainable development teaching**

<http://researchonline.ljmu.ac.uk/id/eprint/16134/>

### Article

**Citation** (please note it is advisable to refer to the publisher's version if you intend to cite from this work)

**Leal Filho, W, Price, E, Wall, T, Shiel, C, Azeiteiro, UM, Mifsud, M, Brandli, L, Farinha, CS, Caeiro, S, Salvia, AL, Vasconcelos, CR, de Sousa, LO, Pace, P, Doni, F, Avila, LV, Fritzen, B and LeVasseur, TJ (2021) COVID-19: the impact of a global crisis on sustainable development teaching. ENVIRONMENT**

LJMU has developed [LJMU Research Online](http://researchonline.ljmu.ac.uk/) for users to access the research output of the University more effectively. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Users may download and/or print one copy of any article(s) in LJMU Research Online to facilitate their private study or for non-commercial research. You may not engage in further distribution of the material or use it for any profit-making activities or any commercial gain.

The version presented here may differ from the published version or from the version of the record. Please see the repository URL above for details on accessing the published version and note that access may require a subscription.

For more information please contact [researchonline@ljmu.ac.uk](mailto:researchonline@ljmu.ac.uk)

<http://researchonline.ljmu.ac.uk/>

## COVID-19: the impact of a global crisis on sustainable development teaching

Walter Leal Filho<sup>a</sup>, Elizabeth Price<sup>b</sup>, Tony Wall<sup>c</sup>, Chris Shiel<sup>d</sup>, Ulisses M Azeiteiro<sup>e</sup>, Mark Mifsud<sup>f</sup>, Luciana Brandli<sup>g</sup>, Carla Sofia Farinha<sup>h</sup>, Sandra Caeiro<sup>i</sup>, Amanda Lange Salvia<sup>j\*</sup>, Claudio Ruy Vasconcelos<sup>k</sup>, Luiza de Sousa<sup>l</sup>, Paul Pace<sup>m</sup>, Federica Doni<sup>n</sup>, Lucas Avila<sup>o</sup>, Bárbara Fritzen Gomes<sup>p</sup>, Todd Jared LeVasseur<sup>q</sup>

<sup>a</sup> European School of Sustainability Science and Research, Hamburg University of Applied Sciences, Ulmenliet 20, D-21033 Hamburg, Germany and Department of Natural Sciences, Manchester Metropolitan University, Chester Street, Manchester, M1 5GD UK E-mail: [w.leal@mmu.ac.uk](mailto:w.leal@mmu.ac.uk)

<sup>b</sup> Department of Natural Sciences, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, UK; [e.price@mmu.ac.uk](mailto:e.price@mmu.ac.uk)

<sup>c</sup> International Centre for Thriving, University of Chester, Chester, CH1 4BJ, United Kingdom. E-mail: [t.wall@chester.ac.uk](mailto:t.wall@chester.ac.uk)

<sup>d</sup> University of Bournemouth, Christchurch House C212, Talbot Campus, Fern Barrow, Poole, BH12 5BB, UK. E-mail: [cshiel@bournemouth.ac.uk](mailto:cshiel@bournemouth.ac.uk)

<sup>e</sup> Department of Biology and Centre for Environmental and Marine Studies, Universidade de Aveiro, Aveiro, Portugal. Email: [ulisses@ua.pt](mailto:ulisses@ua.pt)

<sup>f</sup> Centre for Environmental Education & Research, University of Malta, Msida MSD 2080, Malta. E-mail: [mark.c.mifsud@um.edu.mt](mailto:mark.c.mifsud@um.edu.mt)

<sup>g</sup> Graduate Program in Civil and Environment Engineering, University of Passo Fundo, Campus I - BR 285, São José, 99052-900, Passo Fundo, RS, Brazil. Email: [brandli@upf.br](mailto:brandli@upf.br)

<sup>h</sup> Center for Environmental and Sustainability Research (CENSE), NOVA School of Science and Technology, Universidade NOVA de Lisboa, Lisboa, Portugal. Email: [carlasofia.farinha@gmail.com](mailto:carlasofia.farinha@gmail.com)

<sup>i</sup> Department of Science and Technology, Universidade Aberta, Lisbon, Portugal; Center for Environmental and Sustainability Research (CENSE) Department of Science and Environmental Engineering, Faculty of Science and Technology, Universidade NOVA de Lisboa, Caparica, Portugal. Email: [scaeiro@univ-ab.pt](mailto:scaeiro@univ-ab.pt)

<sup>j</sup> Graduate Program in Civil and Environment Engineering, University of Passo Fundo, Campus I - BR 285, São José, 99052-900, Passo Fundo, RS, Brazil. +55 54 3316-8203. Email: [amandasalvia@gmail.com](mailto:amandasalvia@gmail.com) \*corresponding author

<sup>k</sup> Department of Production Engineering, Federal University of Paraíba, Brazil; Algoritmi Research Centre, School of Engineering, University of Minho, 4800-058, Guimarães, Portugal. Email: [claudioruy@yahoo.com](mailto:claudioruy@yahoo.com)

<sup>l</sup> Department of Geography Education and Environmental Education, North-West University, Potchefstroom, South Africa. Email: [Luiza.DeSousa@nwu.ac.za](mailto:Luiza.DeSousa@nwu.ac.za)

<sup>m</sup> Centre for Environmental Education & Research, University of Malta, Msida MSD 2080, Malta. E-mail: [paul.j.pace@um.edu.mt](mailto:paul.j.pace@um.edu.mt)

<sup>n</sup> Department of Business Administration, Finance, Management and Law, University of Milano-Bicocca, Milan, Italy. Email: [federica.doni@unimib.it](mailto:federica.doni@unimib.it)

<sup>o</sup> Federal University of Santa Maria - UFSM, Department of Postgraduate Studies in Administration, Cachoeira do Sul, RS, Brazil. Email: [admlucasveiga@gmail.com](mailto:admlucasveiga@gmail.com)

<sup>p</sup> Graduate Program in Civil and Environment Engineering, University of Passo Fundo, Campus I - BR 285, São José, 99052-900, Passo Fundo, RS, Brazil. Email: [barbara.m.fritzen@gmail.com](mailto:barbara.m.fritzen@gmail.com)

<sup>q</sup> College of Charleston, School of Humanities and Social Sciences, Sustainability Literacy Institute, Charleston, USA. Email: [levasseurjtj@cofc.edu](mailto:levasseurjtj@cofc.edu)

Conflict of Interest: The authors declare that they have no conflict of interest.

# COVID-19: the impact of a global crisis on sustainable development teaching

## Abstract

The COVID-19 pandemic has caused a global crisis, one which also influences the ways sustainability is being taught at universities. This paper undertakes an analysis of the extent to which COVID-19 as a whole and the lockdown it triggered in particular, which has led to the suspension of presence-based teaching in universities worldwide and influenced teaching on matters related to sustainable development. By means of a worldwide survey involving higher education institutions across all continents, the study has identified a number of patterns, trends and problems. The results from the study show that the epidemic has significantly affected teaching practices. The lockdowns have led to a surge in the use of on-line communication tools as a partial replacement to normal lessons. In addition, many faculty teaching sustainability in higher education have strong competencies in digital literacy. The sampled higher education institutions have -as a whole- adequate infrastructure to continue to teach during the lockdowns. Finally, the majority of the sample revealed that they miss the interactions via direct face-to-face student engagement, which is deemed as necessary for the effective teaching of sustainability content.

The implications of this paper two-fold. Firstly, it describes how sustainability teaching on sustainable development has been affected by the lockdown. Secondly, it describes some of the solutions deployed to overcome the problem. Finally, the paper outlines the fact that the COVID-19 pandemic may serve the purpose of showing how university teaching on sustainability may be improved in the future, taking more advantage of modern information technologies.

## Keywords

COVID-19 shutdown; online teaching; HEIs; sustainability teaching

# COVID-19: the impact of a global crisis on sustainable development teaching

## 1. Introduction: sustainable development and teaching

In December 2019 several novel coronavirus-infected pneumonia (NCIP) cases were recorded in a large metropolitan city in China, Wuhan, caused by infection with a new coronavirus named SARS-CoV-2 (Li et al. 2020). The COVID-19 pandemic (coronavirus disease 2019) is the infectious disease caused by SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) (Elflein 2020; Lupia et al. 2020) and is a coronavirus that affects the lower respiratory tract and manifests as pneumonia in humans (Park et al. 2020; Sohrabi et al. 2020).

Coronaviruses are transmitted from animals to humans. The COVID-19 strain of coronavirus is thought to have originated from a seafood market in the city of Wuhan, Hubei Province, in China in late December of 2019 (Elflein 2020). Since the first reported case in Wuhan COVID-19 has rapidly spread despite global efforts to prevent this (Lai et al. 2020). Symptoms include fever, coughing, and shortness of breath. The infection can lead to pneumonia, multi-organ failure, severe acute respiratory syndrome, and death in severe cases. The elderly and those with pre-existing chronic health conditions have accounted for the majority of deaths (Elflein 2020).

On 30 January 2020, after careful assessment of the situation the World Health Organisation (WHO) (Rodríguez-Morales et al. 2020) declared the Chinese outbreak of COVID-19 to be a public health emergency of international concern (Lai et al. 2020; Sohrabi et al. 2020). The outbreak subsequently spread to other cities in the Hubei province, across China (Bogoch et al. 2020; Zhao et al. 2020) and then Italy (Porcheddu et al. 2020) and soon thereafter across Europe and the rest of the world.

On March 11, 2020 the WHO declared the outbreak as a global pandemic (Thompson 2020; WHO 2020a). The number of cases reported to date is likely to represent an underestimation due to difficulties with surveillance and diagnosis (Lewnard and Lo 2020). The reported mortality for COVID-19 infections varies (Park et al. 2020) but is thought to be approximately 3.4% (Sohrabi et al. 2020). Although the case fatality rate may be far lower than that of SARS- CoV-2, the concern with COVID-19 are the

1 respiratory infections of varying severity and ease of contagion (Wilder-Smith and  
2 Freedman 2020; UN 2020a).  
3

4  
5 The spread of the severe acute respiratory syndrome coronavirus 2 (COVID-19)  
6 has taken on pandemic proportions (Remuzzi and Remuzzi 2020), affecting over 100  
7 countries in a matter of a few weeks (WHO 2020b). This has caused a global crisis due  
8 to emergency management mechanisms including social distancing (which proved quite  
9 efficient in China [Zhang et al. 2020]), including the lockdown of cities and shutting down  
10 of schools and universities, which led to a suspension of presence-based teaching.  
11  
12  
13  
14  
15

16  
17 As part of this introduction, a **statement of the problem** is herewith made: Higher  
18 Education Institutions (HEIs) are among the organisations facing the COVID-19 impacts  
19 in their operations as a whole, and on sustainable development teaching in particular. But  
20 it rather unclear how sustainability teaching has been influenced by the pandemic.  
21  
22  
23  
24  
25

26  
27 Historically, it is a generally accepted view that universities have played a key  
28 role in transforming societies, by educating decision-makers, leaders and entrepreneurs.  
29 McCowan (2016) also emphasizes that universities have been attributed a central role,  
30 namely in the post-2015 development agenda and the achievement of the sustainable  
31 development goals (SDG). This role in a post-COVID-19 world will only be more urgent.  
32 In fact, Karatzoglou (2013:49) goes further when mentioning that “universities continue  
33 to cope effectively and sustainably with the dynamic nature of sustainability by displacing  
34 barriers, changing teaching paradigms, developing social competencies, communication  
35 skills, and community relations”. Concerning the international debate, Bizerril et al.  
36 (2018) mention the significant contributions to sustainability in HE (Higher Education),  
37 especially in the dimensions of education, research and assessment and reporting. This  
38 article in part attempts to further the understanding of how higher education institutions  
39 can continue to contribute to such contributions, especially in a post-COVID 19 context.  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49

50 The COVID-19 shutdown also presents an opportunity to reflect on challenges  
51 encountered by higher education institutions to date. Universities face various barriers  
52 concerning Sustainable Development (SD) implementation, such as a lack of financial  
53 and human resources, and lack of trained personnel (Farinha et al. 2020). Moreover, there  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 are also other barriers that may be regarded as preconditions for universities to  
2 successfully implement long term sustainability initiatives. These include:  
3

- 4 (i) lack of planning,
- 5 (ii) (ii) non-adoption of a whole-school approach for embedding sustainability  
6 (Farinha et al. 2020; Leal Filho et al. 2018a), and  
7
- 8 (iii) (iii) lack of financial resources to support sustainability initiatives (Leal Filho et  
9 al. 2018a).

10 The new trends in society and technology in the course of the fourth industrial  
11 revolution come with challenges, but also provide opportunities (Brudermann et al. 2019)  
12 and so the barriers that universities face can also be seen as drivers for SD implementation  
13 (Farinha et al. 2020). This article looks at possible advances for technology in helping  
14 teach SD in HE. It also recognizes the need for creative thinking in order to adjust quickly  
15 to a rapidly changing environment. However, it needs to be acknowledged that not all  
16 academic staff are aware of the existing policies regarding the use of technology in HE,  
17 whether these policies are to be found at the national, institutional or faculty level (Habib  
18 and Johannesen 2014). During the COVID-19 outbreak and the shutting down of  
19 universities, the Chinese Ministry of Education launched an emergency policy initiative  
20 called “Suspending Classes Without Stopping Learning” to switch teaching activities into  
21 large-scale online teaching while schools were closed (Zhang et al. 2020). Many countries  
22 were taken by surprise and the implementation of sudden teaching based on on-line means  
23 posed a challenge which some struggled to cope with.

24 Higher education does have a track record of using technology to aid pedagogical  
25 goals. Distance Learning Universities already offer degrees in e-learning and Open  
26 Education Resources (Azeiteiro et al. 2014, 2015) based on their pedagogical models.  
27 And presence-based teaching universities had to respond to the COVID-19 epidemic with  
28 an immediate transition to Online Distance Teaching. The situation configures what  
29 Hodges et al. (2020) refer as a situation of “*Emergency Remote Teaching*”. E-learning is  
30 a challenge for presence-based teaching Universities, however, given the historical  
31 pedagogical model of face-to-face education utilized by presence-based teaching  
32 practices. COVID-19 also created an opportunity for collaboration and sharing  
33 experiences in presence-based university contexts. Successful responses include  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 Sustainability and Climate Change teaching (Azeiteiro et al. 2014, 2018) and *b*-Learning  
2 Teaching for the after COVID-19 global crisis (Dans 2020).  
3  
4  
5

## 6 **2. COVID-19: facts, figures and impacts on sustainability teaching**

7  
8 COVID-19 is a major public health issue, and knowledge about this human-to-  
9 human transmission virus remains limited (Lai et al. 2020). No specific treatment for the  
10 infection is currently available (CDC 2020) and public health and infection control  
11 measures are urgently required to limit the global spread of the virus (Song et al. 2020).  
12 ‘Social distancing’ was introduced in communities in order to separate individuals who  
13 may be infectious but have not yet been identified hence not yet isolated so as to prevent  
14 further transmission (Eurosurveillance 2020; WHO 2020a). Measures such as quarantine,  
15 strictly restricting the movement of people, reducing person-to-person contact overall via  
16 work and school closures, physical distancing, and educating communities about reducing  
17 spread through hand washing (UN, 2020a) are crucial. Once an outbreak has entered the  
18 community transmission phase, it can double in scale every three to five days (UN 2020a).  
19 COVID-19 has the potential to create devastating social, economic and political crises  
20 that will leave deep scars (UN 2020b).  
21  
22

23  
24 The COVID-19 pandemic has resulted in significant health, economic, and social  
25 impacts. The known impacts include closing of schools and universities to facilitate social  
26 distancing and prevent virus spread (Mahase 2020; Omary et al. 2020; Sen-Crowe et al.  
27 2020; Zhang et al. 2020), impacting over 90% of the world’s student population  
28 (UNESCO 2020) and over 1.25 billion learners worldwide (UNESCO 2020). The 60.3  
29 million teachers who are no longer in the classroom in 166 countries (UN 2020a) have  
30 been rapidly transitioning to remote working, distance learning solutions and online  
31 teaching (Gewin 2020; UNESCO 2020). It is within this context that the research  
32 questions guiding this paper were written, to help HEIs better respond to COVID-19 in  
33 teaching sustainable development content.  
34  
35

36  
37 One likely development post-COVID-19 is an increased dependency on online  
38 teaching, even in historic presence-based teaching universities. Online pedagogical  
39 practices can enhance face-to-face learning and online educational spaces can offer new  
40 opportunities for higher education (House-Peters et al. 2019). While online learning and  
41 teaching methods to improve access to education have been adopted worldwide  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65



1 (Panigrahi et al. 2018), the proportion of online courses compared to face to face courses  
2 offered by universities prior to the pandemic remained low (Bao 2020). Globally,  
3 lecturers are reminded to ensure that they reach out to students who do not have stable  
4 internet connections at home for logistical or financial reasons, so as not to run the risk  
5 of deepening inequities in educational opportunities and social inequalities more broadly  
6 as a result of online teaching (Anguelovski et al. 2020). After all only around 60% of the  
7 globe's population is online (Tam and El-Azar 2020).  
8  
9

10 Among the challenges to a rapid shift to online delivery in response to the  
11 pandemic, mention can be made to a lack of online teaching experience, the limited time  
12 to make the transition, technical obstacles and poor learning environments for students  
13 when working remotely (Bao 2020). Furthermore, a rapid transition to remote delivery  
14 may present particular challenges. For example, while the potential for using virtual field  
15 trips, virtual labs or immersive virtual reality for environmental education is promising  
16 (Stainfield et al. 2000; Jones 2018; Markowitz et al. 2018), to date, the use of virtual  
17 reality to simulate learning environments varies globally and by discipline (Salmerón-  
18 Manzano and Manzano-Agugliaro 2018). Evidence also suggests that environmental  
19 field-based projects have been halted or postponed as a result of COVID-19 (Kimbrough  
20 2020). To date, no studies have systematically explored potential impacts of the COVID-  
21 19 shutdown on technology-enabled teaching and learning practices for education for  
22 sustainable development.  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36

37 The World Health Organisation emphasizes that quality education needs to be  
38 supported, even in case of closures and shutdowns. For example, the use of online/e-  
39 learning strategies, assigning reading and exercises for home study, radio, podcast or  
40 television broadcasts with academic content, assigning teachers to conduct remote daily  
41 or weekly follow up sessions with students, and reviewing/developing accelerated  
42 education strategies are all suggestions to improve online education (WHO 2020c).  
43 Furthermore, the COVID-19 pandemic has occurred in the middle of UN efforts to  
44 achieve the Sustainable Development Goals (SDGs) (SDG-Education 2030 2020). It can  
45 disrupt the progress toward SDG 4 targets since quality education can be compromised  
46 (UN 2020a). For example, the achievement of the targets 4.3 and 4.5 highlights the urgent  
47 need for all students to have a computer or tablet to attend online courses and all other  
48 forms of e learning. This fact may represent a barrier for an equal education (World  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 Education Blog 2020). Nevertheless, with the right action, the COVID-19 crisis can mark  
2 the rebirthing of society as we know it today to one where we protect present and future  
3 generations, where part of this protection is providing them with a quality, affordable  
4 education tethered to the SDGs (UN 2020a). Universities play a profound role in a century  
5 in which society will be judge by its capacity for self-transformation in response to  
6 pandemic crises (Baker-Shelley et al. 2017; Disterheft et al. 2013; Leal Filho et al.  
7 2018b). Students, academics, researchers and practitioners co-create knowledge and skills  
8 to promote sustainable development (Baker-Shelley et al. 2017), but one of the main  
9 challenges for lecturers is to design learning activities that will allow students to  
10 effectively acquire sustainability competences (Molderez and Fonseca 2018).

11 The COVID-19 pandemic may influence education for sustainable development  
12 in universities, both through impacts on sustainable development and impacts on teaching  
13 methods, but the outcomes are uncertain. This is because “Education for sustainable  
14 development is the process of equipping students with the knowledge and understanding,  
15 skills and attributes needed to work and live in a way that safeguards environmental,  
16 social and economic wellbeing, both in the present and for future generations” (QAA  
17 2014), a target to be met by 2030 (UN 2020). The pandemic, similar to education for  
18 sustainable development offers, the opportunity to remind students of the skills (informed  
19 decision making, creative problem solving) (UNESCO 2019) they need in this  
20 unpredictable world. Now more than ever adaptability and resilience need to be included  
21 into educational systems as well (Tam and El-Azar 2020). The rapid spread of COVID-  
22 19 has shown the importance of building resilience to face threats, from pandemic disease  
23 to climate insecurity to rapid technological change (Tam and El-Azar 2020). Studies  
24 relating to sustainable development predict, for example, that the impacts of COVID-19  
25 may contribute to a short-term decline in greenhouse gas emissions (The Economist 2020)  
26 since air pollution in China has been drastically reduced (Adams 2020), or to a transition  
27 to sustainable consumption (Cohen, 2020), or that COVID-19 impacts may disrupt the  
28 process of sustainable development (Pirouz et al. 2020). The latter impact on sustainable  
29 development may be positive.

30 Conservationists recognize that in order to stop biodiversity loss, trends on global  
31 consumption needs to change (Adams 2020). Education can encourage students to  
32 become advocates for social, environmental and economic issues impacted by COVID-  
33

1 19, by encouraging students to become advocates for disease prevention and control at  
2 home, in school, and in their community, by talking to others about how to prevent the  
3 spread of viruses (WHO 2020c). This may include students advocating on behalf of  
4 protecting biodiversity in part to protect from future virus outbreaks, given that some  
5 viruses may be passed on to humans from species residing in remote and protected  
6 biodiverse areas.  
7  
8  
9

10  
11 In relation to education for sustainable development, online teaching of the  
12 environmental, social and economic pillars of sustainable development requires careful  
13 consideration of appropriate content and pedagogical methods (Li and Zhou 2018). E-  
14 learning in Higher Education can be effective for lifelong learning in ESD (Azeiteiro et  
15 al. 2015). Lecturers who have made the shift to online classes advise colleagues to make  
16 teaching content relevant to the current crisis, and to ask students to reflect on existing  
17 connections between COVID-19 and the studied issue at hand. For example, COVID-19  
18 is an element of microbial diversity and it evolved in the socio-ecological system; making  
19 the link between COVID-19's emergence and international wildlife trade; questioning the  
20 global economic system's immutability; and evaluating the sustainability of global travel  
21 (Adams 2020; Wong 2020).  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31

32 UNESCO (2020) advocates that 'Investment in remote learning should both  
33 mitigate the immediate disruption caused by COVID-19 and establish approaches to  
34 develop more open and flexible education systems for the future.' and while the short-  
35 term challenges may be significant, the COVID-19 pandemic may stimulate advances in  
36 remote delivery in the longer term.  
37  
38  
39  
40

41 By means of a worldwide survey involving higher education institutions, this  
42 study investigates patterns in remote delivery of education for sustainable development  
43 in response to COVID-19 and means by which university teaching on sustainability may  
44 be improved in future, taking greater advantage of existing technologies for remote  
45 learning. To date findings on the impact of coronavirus on higher education (QS 2020)  
46 demonstrated that a large part of respondents have changed their plans to study abroad as  
47 a result of the coronavirus. Students have to face many difficulties such as travel  
48 restrictions; university closures; flight cancellations; difficulties with obtaining  
49 scholarship interviews, visa applications, or language tests; exam cancellations or  
50 postponements; and health concerns. Through this survey other aspects related to  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 institutions' responses are investigated such as ways to embrace online learning, student  
2 recruitment, changes on student mobility and international partnerships, ways for  
3 communicating with international students and the revision of crisis management plans.  
4  
5  
6

### 7 8 **3. Methods** 9

10 Bearing in the mind the current state of affairs and the statement of the problem  
11 earlier made in the introduction, the aim of this work was to analyse the extent to which  
12 COVID-19 as a whole and the lockdown, in particular, has influenced teaching on matters  
13 related to sustainable development. The conceptual scope of this included the delivery of  
14 teaching and learning activity, the assessment of that learning, and communications  
15 related to facilitate such tasks. To attain the aim of this work a cross-sectional and  
16 descriptive study was performed. The descriptive approach is frequently used when little  
17 research has been done in an area to understand new concepts or phenomena (Tarzian and  
18 Cohen 2011).  
19  
20  
21  
22  
23  
24  
25

26 A set of questions was developed to collect qualitative and quantitative data on  
27 the impacts that the COVID-19 pandemic is having on teaching sustainable development  
28 issues. The first list of items was reviewed by the authors to minimize redundancies and  
29 similar items and to ensure that all relevant questions were considered. The instrument  
30 was pre-tested by a panel of academics within sustainability areas at different universities.  
31 The main focus was to do a study that would indicate personal views, opinions and  
32 perceptions of the various respondents on the COVID-19 impacts. Based on the feedback  
33 received, an on-line questionnaire, composed of 29 questions was designed and  
34 disseminated through Google Forms. to collect data from teachers and students. A total  
35 of 29 questions were grouped into three parts. The first part focused on the "background"  
36 of the respondents and their local university context, and was constituted by three open-  
37 ended questions and 2 closed-ended; the second part focused on the implications of "the  
38 shutdown and your work", was more extensive and utilised 19 questions, in which two  
39 were dichotomous, seven closed-ended and nine involved the use of a five point Likert  
40 scale. The last part focused on the "future" implications for teaching pertaining to  
41 sustainable development, and contained two open-ended questions, three dichotomous  
42 and one closed-ended. The questionnaire also collected some sociodemographic  
43 characteristics of the respondents.  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

The invitation to answer the survey was sent to members of the Inter-University Sustainable Development Research Programme and the European School of Sustainability Science Research, composed of over 110 universities, plus other representatives within the network of the researchers who performed the study. The survey was administered in the period from April 13 to May 19, 2020. A total of 238 individuals from 147 different universities in 47 different countries responded to the questionnaire. Table 1 shows the distribution of the respondents.

Table 1: Distribution of the respondents by country and university

Continent	No. of countries	No. of universities	No. of respondents
Asia/Oceania	13	26	27
Africa	5	8	8
North America	4	26	32
South America	5	22	63
Europe	20	65	108
<b>Total</b>	<b>47</b>	<b>147</b>	<b>238</b>

All areas of knowledge (ISCED-UNESCO classification) were represented in this survey, with most respondents (21%) coming from Education (Table 2). 120 (27%) respondents reported working in more than one knowledge area.

Table 2: Distribution of respondents by knowledge area in which they work

Categories	Sum	Percentage (%)
Education	62	21.16%
Engineering, manufacturing and construction	43	14.67%
Social sciences, journalism and information	40	13.65%
Natural sciences, mathematics and statistics	40	13.65%
Business, administration and law	39	13.31%
Health and welfare	28	9.55%
Arts and humanities	16	5.46%

Agriculture, forestry, fisheries and veterinary	16	5.46%
Information and communication technologies	6	2.04%
Services	3	1.05%
<b>Total</b>	<b>293</b>	<b>100%</b>

Regarding gender, 61% of the sample were Female (n=146), 38% Male (n=91) and less than 1% indicated the category Other (n=1). Respondents hailed from a wide range of roles within the university structures, ranging from staff at various levels of administration, lecturing and research.

The 238 responses were analysed through two key methods: simple descriptive analysis and content analysis. The numerical data collected was eventually inputted and converted into SPSS spreadsheets in order to perform both descriptive and inferential statistics.

#### 4. Results and Discussion

The first part of the survey investigated how the shutdown affected the teaching work. At the time the questionnaire was administered, the majority of the respondents (77%, n=184) had already been experiencing the effects of the shutdown on their teaching for more than a month. In their vast majority (92%), university staff were in favour (strongly agree: 55% + agree: 37%) of the measures taken by the university administration to limit the spread of COVID-19. The other responses were equally divided among the options of disagreement or neutral (2.5% each).

Although on shutdown, teaching and learning continued unabated during the crisis, with most university staff (88%) opting to conduct their sessions from their “home office”. Some respondents shuttled regularly between home and their office/laboratory/field location (8%) and just 3% of the sample indicated that they worked normally from their office or laboratory. None reported that they did not work because of a full lockdown.

Shifting teaching and learning from the well-resourced Higher Education Institutions (HEIs) to homes in response to the COVID-19 emergency, required the provision of a greater supportive infrastructure at very short-notice. Nevertheless, for the

1 majority (84%) of the university staff answering the questionnaire, the support provided  
2 by their respective institution to staff and students was either acceptable (36%), good  
3 (33%) or very good (15%). However, Figure 1 shows that when evaluating the available  
4 infrastructure for lecturers and students to perform their activities from home, considering  
5 the challenges of distance learning, although there is a tendency for more positive  
6 responses, students are considered to have less appropriate conditions when compared to  
7 lecturers. This reaffirms the focus of this study is on faculty (and faculty who are also  
8 staff/administrators) perceptions of COVID-19, and not student perceptions. A similar  
9 study on student perceptions would help aid our collective understanding and the authors  
10 invite other researchers to undertake such research.  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20

21 (Figure 1 here)  
22  
23  
24

25 The shutdown forced the academic community to use a variety (as well as a  
26 combination) tools to keep communicating and performing the regular activities. As  
27 indicated by Figure 2, the software of videoconference Zoom was the most used tool  
28 (indicated by 76% of the respondents), followed by Skype (53%) and Microsoft Teams  
29 (33%). With 21% of responses, the option “other” gathered mainly institutional/internal  
30 online tools and Google Hangouts/Meet.  
31  
32  
33  
34  
35  
36

37 (Figure 2 here)  
38  
39  
40

41 Modular Object-Oriented Dynamics Learning Environment (Moodle) was also  
42 mentioned in the option “other” but it was investigated in a secondary question, since it  
43 is a Distance Learning Platform for course management system: 168 respondents (71%)  
44 indicated that their universities use Moodle in their learning operations. The use of these  
45 tools enabled the respondents to adopt a variety (and a combination) of distance learning  
46 methods: lecture capture (indicated by 27% of the sample), discussion forums (27%),  
47 Webinars (22%), and notes online (21%). Other options included the use of tutorials or  
48 doc/screen sharing on communication tools.  
49  
50  
51  
52  
53  
54  
55

56 Although the need to revert to these online communication tools was short notice  
57 and quite rapid, over 91% of the university staff involved in the study rated their skills in  
58  
59  
60  
61  
62  
63  
64  
65

1 dealing with these tools for teaching as acceptable, good or very good. Nevertheless, none  
2 commented whether they already possessed these skills prior to the shutdown or whether  
3 they had received training from the university as part of the COVID-19 contingency plan.  
4 This suggests many faculty teaching sustainability in higher education have strong  
5 competencies in digital literacy. This also suggests a layer of resiliency in faculty in their  
6 ability to adapt their teaching; and that at least for the universities represented in our  
7 sample size, that higher education as a whole has adequate infrastructure to continue to  
8 deliver its services in the middle of a “black swan” emergency, at least in the short term.  
9 This does leave aside the question of increased carbon emissions from universities due to  
10 higher demand on server clouds and grids (although some of this may be offset by less  
11 faculty, staff, and student travel to conferences and athletics), which is outside of our  
12 research purview, but important to further explore.

13  
14 As expected, the sudden shift from the daily teaching routine to distance learning  
15 teaching activities due to the COVID-19 pandemic affected HEIs and their communities  
16 at various degrees. Figure 3 shows that teaching activities and assessments were similarly  
17 impacted, with more than half of the responses indicating moderate to great influence. On  
18 the other hand, when the impact on disciplines with practices in laboratories, curricular  
19 internships and final course reports is concerned, the scenario is much worse.

20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36 (Figure 3 here)  
37  
38

39 In a different question, the respondents were asked about the problems  
40 experienced in teaching activities during the shutdown. One of the problems that most  
41 respondents (63%) faced during the shutdown was the radical alterations they had to go  
42 through – in a very short time period – to adapt the content and the methods of their  
43 lectures. On top of the challenges related to the new mode of teaching, respondents  
44 reported problems related to timetabling (i.e. delays - 44% and lecture cancellations -  
45 27%) and technological glitches (i.e. disruption of communication - 50%). Respondents  
46 also offered other problems they experienced: difficulties in assessing students’  
47 engagement; cancellation of practical activities (usually preferred by students); different  
48 performances of students with different resources to work from home (e.g. internet  
49 connection); and the time-consuming preparation of online classes. Consequently,  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65



1 respondents claimed that the increased work resulting from the teaching and assessment  
2 activities mentioned above, had a significant effect on their teaching workload. The  
3 majority indicated a moderate (42%) and great (31%) increase. Some respondents (10%)  
4 pointed out that there was no impact on their workload, possibly indicating that these  
5 lecturers might have already been used to online classes. Other respondents indicated that  
6 their workload decreased (17%) - a possible indication of the cancellation of practical  
7 classes or field trips as well as events that could not be shifted to the online version or the  
8 ability to have institutional distance learning platforms that automatically grade student  
9 work.

10 Respondents might have experienced an increased workload because of the  
11 preparations of teaching and learning sessions and materials. Indeed, it is well  
12 documented that preparation of distance learning requests not only a definition of a  
13 pedagogical model but a great effort in materials preparation, since students should be  
14 more autonomous in their study (Azeiteiro et al., 2014, 2015; Pereira et al., 2008). Figure  
15 4 summarises the array of methods used by the respondents to address their information  
16 needs. Consultation of journal articles was the most common method reported by 80% of  
17 the respondents, followed by the use of online media reports (63%) and book consultation  
18 (56%). The other options (10%) included mainly the use of webinars, online conferences  
19 and training sessions provided by the universities. One predicted outcome of COVID-19  
20 on universities suggested by the below is that universities will invest more in developing  
21 faculty expertise in distance learning teaching so as to be better prepared for future  
22 pandemics. A longitudinal study on the impact of COVID-19 on universities would help  
23 tease out this possible response dynamic.

24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45 (Figure 4 here)  
46  
47

48 Figure 5 shows that the primary concerns of the majority of respondents revolved  
49 around the effectiveness of their teaching. In fact, 65% of respondents were concerned  
50 about the lack of communication with students and subsequent reduction in motivation  
51 (41%). Others felt that their teaching suffered because they were not sufficiently prepared  
52 for the sudden change (i.e. a lack of a pedagogical model, indicated by 45% of the  
53 respondents; lack of expertise, indicated by 35% of the respondents; and lack of resources,  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 indicated by 18% of the respondents). While the main challenge of the pandemic induced  
2 lockdown was the lack of communication with students, for a substantial group of  
3 respondents (35%) was the lack of personal interactions/dialogues with students, the lack  
4 of interactions with other lecturers was indicated by 36% of the sample. Although lack of  
5 support from the administration figures among the main challenges cited in studies of  
6 sustainability in HEIs (Ávila et al. 2017), this aspect was the least mentioned by the  
7 respondents (14%). Other challenges (8%) cited include the balance between work and  
8 other tasks at home; the concern about student engagement; and providing a fair  
9 assessment considering that not all students have the same conditions to study (e.g. own  
10 computer at home, proper internet connection). Also these results may suggest that the  
11 majority of faculty in this sample who are engaged in teaching sustainability feel that  
12 direct face-to-face student engagement is necessary for the effective teaching of  
13 sustainability content. Indeed, the majority of the inquired teachers are used to face to  
14 face teaching so miss this synchronous interaction, also they did not have training to teach  
15 in this new regime, as well as students. But e-learning is much flexible in time and space  
16 allowing a students centred study, and when well prepared, a real interaction and  
17 collaborative environment can be created. Nevertheless, e-learning is specially targeted  
18 for an adult population that must of it with already professional experience (Azeiteiro et  
19 al. 2015).

20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38 (Figure 5 here)  
39  
40

41 Irrespective of the challenges and problems caused by the shutdown, university  
42 staff seem to have weathered the storm and a substantial percentage of the respondents  
43 (74%) claimed that the experience enhanced their creativity in teaching.  
44

45  
46 The second part of the survey was related to the future and how teaching will be  
47 deployed after the pandemic. An overwhelming 82% of the respondents claimed that their  
48 experience of the COVID-19 crisis will have a long term effect on their teaching. When  
49 asked to elaborate on the nature of this long term effect, the majority of responses (36%)  
50 signalled a shift towards the adoption of blended learning. A significant amount (34%)  
51 foresee a shift towards a “home office” approach, i.e. a move towards teleworking with  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 all its implications on the university's provision of office space, lecture rooms and in situ  
2 resources (Figure 6).  
3  
4  
5

6 (Figure 6 here)  
7  
8  
9

10 The above responses contain continuity with findings from education researchers  
11 namely Jennie De Gagne and Kelley Walters (2010). Their study of distance learning  
12 educators generated five key themes that are germane to distance learning teaching: that  
13 it “offers flexibility and convenience”; “is time-consuming and labor-intensive”; that  
14 “strong communication skills are essential” for guiding student engagement and success;  
15 that “is learner-centered”; and that “requires continuing education and training” (ibid).  
16 The last finding is consistent with the above data point where 82% of our respondents  
17 claimed that they will most likely continue to train in and engage with some type of  
18 distance learning element as part of their teaching portfolio. This fact can lead to new  
19 challenges with acquired competences for sustainability. Earlier studies demonstrate that  
20 distance learning can be quite effective within education for sustainable development and  
21 problem solving in Higher Education, if well planned and prepared (e.g. Azeiteiro et al.  
22 2014, 2015; Oliveira et al. 2019). Besides distance learning supported by a well-grounded  
23 pedagogical model, allow the use of teaching approaches like problem based learning,  
24 case studies, role playing and gaming that are pedagogical approaches strongly linked  
25 with competences acquisition for sustainability (Lozano et al. 2017).  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38

39 Only 54% (n=129) of the respondents confirmed that they included references to  
40 the COVID-19 crisis when teaching about sustainable development. When asked to  
41 explain what this inclusion involved, university staff cited various examples that were  
42 quite dependent on their specialisation. As expected most of these inclusions involved  
43 using the COVID-19 crisis as an illustration of certain phenomena such infectious  
44 diseases, health procedures, exponential growth, isolation techniques and media  
45 reporting. However, there were a substantial number of responses indicating the creation  
46 of opportunities for reflection, systems analysis, critical analysis of decisions and policies  
47 adopted, and ethical considerations. What is rather worrying is that 46% of the  
48 respondents did not feel the need to mention the COVID-19 crisis in their teaching about  
49 sustainable development, irrespective of the worldwide environmental, social and  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 economic impacts of this pandemic, namely the decrease in CO<sub>2</sub> emissions in main cities  
2 and decrease of consumption.  
3

4 We find this last data point concerning from a pedagogical perspective. Given  
5 there are 17 United Nations Sustainable Development Goals (UN SDG), five key  
6 sustainability competencies (Wiek 2011; UN 2016), and that sustainability is a  
7 supradisciplinary (Foch et al. 2019) concept that can educate and empower students to  
8 understand systemic, wicked problems, the opportunity to better teach any of this was  
9 enhanced by COVID-19 in the spring of 2020. Yet, it seems that many teachers missed  
10 the opportunity to actively frame their sustainability pedagogy through the biggest global  
11 pandemic and economic downturn in memory. It is clear that COVID-19 impacts all  
12 three legs of sustainability, and its impact on higher education presented the opportunity  
13 to use the universities where faculty are employed as a living laboratory to teach  
14 resilience, adaptivity, brittleness, organizational change management, marketing,  
15 accounting, and other sustainability contents. Even the unanticipated move to online  
16 classes and need to shut-down campuses presented a learning opportunity about  
17 sustainability and building adaptive capacity in the face of a natural hazard that has  
18 massive social and economic impacts. If sustainability is in part about a praxis of  
19 flourishing (Ehrenfeld and Hoffman 2013), then it is paramount that all sustainability  
20 educators provide students these tools, so they can use their degrees to help create a  
21 flourishing society. Dealing with pandemics, especially as the permafrost continues to  
22 melt and potential new viruses are released, is part of such a future. This data point  
23 suggests a missed opportunity for sustainability faculty across the curricula to utilize the  
24 tragedy of COVID-19 and its many impacts, including on campus operations, as an  
25 entryway into discussions about sustainability, wicked problems, and sustainable  
26 development.  
27

28 Lastly, the questionnaire also asked respondents' reactions to a set of statements  
29 using a 5-point Likert Scale. Responses were scored (i.e. from 1 – Strongly Disagree to 5  
30 – Strongly Agree) and the average for each statement calculated. A high average score  
31 indicates a high level of agreement. Table 3 summarises these results. An overall analysis  
32 of the responses in Table 3 reveals a general consensus that the COVID-19 crisis has  
33 presented an opportunity to reimagine the future of the global sustainability agenda,  
34 improve the quality of the environment and improve teaching. However, this level of  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

agreement tends to decrease as the statements imply a change in personal and institutional modus operandi in response to the COVID-19 aftermath. In fact, the teaching changes were made in such short notice that teachers add no time yet to reflect or change their speeches and materials to students.

Table 3. Levels of agreements about statements about the COVID-19 crisis

DESCRIPTION	AVERAGE	STANDARD DEVIATION	VARIANCE
The incidence of COVID-19 has offered new opportunities to reimagine the future world and this may benefit the global sustainability agenda	<b>4.18</b>	.896	.804
Despite all challenges, COVID-19 provided some positive impacts (reducing carbon emissions, saving time, etc.)	<b>4.06</b>	1.01	1.02
COVID-19 may change the way universities teach (for adding more online classes instead of fully in-class curricula)	<b>3.96</b>	.997	.995
I can see a frame of COVID-19 and responses through the lens of justice and ethics.	3.71	1.14	1.31
To me, COVID-19 presents a preview of how we will have to respond to global warming.	3.56	1.20	1.44
The impact of the COVID-19 crisis allowed to see a higher level of collaboration between universities to help each other in solving distance learning teaching.	3.48	1.13	1.29
The impact of the COVID-19 crisis on life as we knew it made me change the way I prepare students for change	3.44	1.04	1.10
I expect that global cooperation on tackling COVID-19 will likely divert attention and resources away from global action on climate change	3.38	1.10	1.22
I have revised my teaching methods to highlight the impact of the COVID-19 crisis on life as we knew it.	3.32	1.18	1.39
I have revised the content of my classes to add more issues connected to sustainability during and post-crisis	3.13	1.20	1.45
I used COVID-19 as an opportunity to better teach sustainability competencies to my students.	3.02	1.30	1.70
I used COVID-19 as an opportunity to help my students learn about how linear, industrial systems are brittle and unsustainable.	2.99	1.32	1.75
I used COVID-19 as an entryway into teaching the UN Sustainable Development Goals.	2.68	1.33	1.79

1           Despite the above data point and analysis about 46% not mentioning the COVID-  
2  
3 19 crisis in their classes, this final set of Likert-based questions does point to stimulating  
4 future possibilities for teaching sustainability in a post-COVID world. A vast majority  
5 of respondents agreed that COVID-19 presents a chance to redesign a better future world.  
6  
7 However, part of this reimagining and redesign must include moving away from linear,  
8  
9 brittle industrial systems, and responses suggest that this connection between redesign  
10 and unsustainable linear systems in future teaching plans is currently not strong. And  
11 while there is agreement that COVID-19 is in part a justice issue (for example,  
12 economically poor African Americans in the US have been disproportionately killed by  
13 COVID-19 what happened also in another countries), and that the global response to  
14 COVID-19 is a fraction of what is most likely required to adapt to climate change, that  
15 the responses were not higher in agreement on seeing these two as potentially linked  
16 teaching pathways is noteworthy. This implies that there is still not consensus about what  
17 should be taught as key parts of sustainability/sustainable development--it would seem  
18 that issues of redesigning a linear, industrial, fossil fuel based economy to adapt to climate  
19 change and do so in a way that is just, would be central to sustainability teaching. This  
20 should translate into above four averages for these final questions, yet this is clearly not  
21 the case. While we do not expect faculty to redesign entire courses in the middle of a  
22 highly stressful and traumatic global pandemic, this research suggests that there is room  
23 to better frame and teach sustainability via the lens of what is clearly a  
24 sustainability/sustainable development issue (i.e. COVID-19 and its impact on social,  
25 environmental, and economic systems). Future research would be served by asking more  
26 precise follow up questions on this set of Likert questions, to gauge why these teaching  
27 opportunities and the connections between teaching the UN SDGs, justice, sustainability  
28 competencies, the need to redesign society, the opportunity to reduce consumption, the  
29 need to address circular industrial consumption (see for example suggestion in Kaufmann  
30 et al. 2019, Kopnina 2018), and others were not better capitalized upon by the esteemed  
31 sustainability educators that responded to this survey.  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51

52           The challenges of e-learning stressed earlier (including the potential for natural  
53 resources saving compared to face-to-face education, as stressed for example by Roy et  
54 al. 2008) and of the new ways and paradigms of thinking and living due to COVID-19,  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 can be important drivers and opportunities to enhance education for sustainable  
2 development.  
3  
4  
5

## 6 **5. Conclusions**

7  
8  
9

10 This study has sought to understand the impact of COVID-19 on university  
11 teaching but in particular on the teaching of sustainability through the use of a large-scale  
12 survey. The survey captured the experiences of 238 academics across a range of  
13 disciplines, from 147 institutions across the world. The results show that the impacts of  
14 COVID-19 across the sector have been broadly similar: higher education institutions were  
15 forced to fully abandon face-to-face teaching and campus-based activities for a period of  
16 time, as various forms of lockdown have meant the closure of institutions in order to  
17 reduce physical contact and limit the spread of the virus.  
18  
19  
20  
21  
22  
23  
24

25 Even though the speed with which actions had to be taken has not resulted in a  
26 full stop of teaching, it has required a rapid switch from teaching in the classroom, to  
27 trying to deliver content and student experience through distance learning technologies.  
28 Most respondents have found this adaption a big challenge because it had to be achieved  
29 in a very short space of time, resulting in an increased workload. Laboratory based  
30 courses, field work and student placements have been particularly impacted, and  
31 assessments in general have required re-thinking. However, many courses have been able  
32 to continue in a virtual mode and respondents also suggest that they felt that they had the  
33 necessary skills to adapt to different modes of delivery, with a range of technological  
34 approaches deployed to support the continuation of learning.  
35  
36  
37  
38  
39  
40  
41  
42

43 In the context of learning from home, many responses suggest that students and  
44 staff have been heavily reliant on accessing journal articles, online media reports and  
45 resorting to the use of books. However, concern was shared about the effectiveness of  
46 their teaching, the lack of personal communication with students, along with worries  
47 about students' motivation. A lack of an overall pedagogical model for distance learning  
48 has hindered progresses. But respondents also suggested that the experience has been  
49 positive on occasions, to the extent that creativity has been enhanced. In the future,  
50 respondents foresee the increased use of distance/blended learning approaches and the  
51 greater use of technology in the home office.  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1           With specific regard to the impact on sustainability teaching, this research  
2 suggests that the experience of the COVID-19 pandemic has provided an opportunity to  
3 critically reflect and to consider possible opportunities to redesign the ways sustainability  
4 is being taught at higher education institutions. The impacts of COVID-19 on social,  
5 environmental and economic systems may also serve as a lens to focus on what is clearly  
6 a sustainability/sustainable development issue, and to consider what knowledge,  
7 understanding, skills and attributes are required to deal with the challenges imposed.  
8 There is still lack of consensus about the breadth of issues critical to education for  
9 sustainability/sustainable development, while it is imperative that we need to redesign a  
10 linear, industrial, fossil fuel based economy to adapt to climate change, we also need to  
11 address how unsustainability may lead to global pandemics and the need for global  
12 sustainable solutions. Such issues need to be central to sustainability teaching.  
13  
14

15           This pandemic brought to the fore the difficulties and challenges related to  
16 upgrading the higher education system to take better advantage of digital technologies,  
17 driving change never imagined, in such a short time. These changes need to be  
18 internalized and absorbed by universities, at least in part, in the post-pandemic world.  
19 This research has shown that the pandemic will continue to influence HEIs in the long-  
20 term, where using a blended learning increases, and more staff use technological  
21 resources in their home office. It will be incumbent on universities to facilitate and  
22 support home working with appropriate software and systems access. Governments and  
23 institutions will need to make greater effort and pursue further investments to ensure the  
24 ideal conditions for learning and teaching for students and professors (internet access,  
25 technological resources).  
26  
27

28           There are two main limitations to this study. The first relates to the number of  
29 responses. From the total of 238 individuals from 147 different universities in 47 different  
30 countries, Africa was under represented with only a few universities. Therefore, more  
31 research is needed to identify trends in that part of the world. Also, the second limitation  
32 relates to the timing of the study; the study was undertaken during the lockdown, rather  
33 than at the end of the lockdown. Therefore, whilst it is strongly situated to report a unique  
34 snapshot of the implications of COVID-19, it does not report on the full extent of the  
35 impact of the pandemic (which is currently unknown).  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65



1 The data and evidence gathered from the study are nonetheless robust, in the sense  
2 that it offers unprecedented insights into how higher education institutions have been coping  
3 with the COVID-19 epidemic, and how the teaching on sustainable development has been  
4 influenced by it.  
5  
6

7  
8 The implications of this paper are threefold. Firstly, it clearly shows how the  
9 COVID-19 pandemic impaired sustainability teaching, and the various ways it did so.  
10 Secondly, it outlined some of the means deployed by many universities, with a view to  
11 mitigate the impacts of the pandemic. Finally, it shows that investments in IT are needed,  
12 so as to place universities in a better position to cope with situations when the normal  
13 teaching, based on face-to-face interactions, is impaired.  
14  
15

16 As the world progressively recovers from the pandemic, its economic impacts are  
17 becoming clearer. The increases in unemployment rates, the losses seen in financial  
18 markets, and the fact that social inequalities are becoming deeper, makes it clear that the  
19 principles of sustainability are as important as seldom before. By tackling the need for  
20 maintaining equitable conditions across sectors, countries and time, the pandemic itself  
21 may be used as a teaching resource, to illustrate the need for maintaining a balance  
22 between people, the environment and human health.  
23  
24

25 In moving forward, understanding and overcoming the barriers here described is  
26 crucial so that HEIs can continue with the needed work of embedding sustainable  
27 development teaching throughout the curricula. The need for HEIs to provide sustainable  
28 development education and competencies is only going to grow in the coming years and  
29 decades, regardless of the current COVID-19 shutdown.  
30  
31

### 32 **Funding**

33 Not applicable.  
34

### 35 **Conflict of Interest**

36 The authors declare that they have no conflict of interest.  
37

### 38 **Availability of data and material**

39 Not applicable.  
40

### 41 **Code availability**

42 Not applicable.  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

## References

- Adams, B. (2020). COVID-19 and Conservation, <https://thinkinglikeahuman.com/2020/03/16/covid-19-and-conservation/>
- Anguelovski, I., Honey-Rosés, J., & Ruiz-Mallén, I. (2020). Academia in the time of Covid-19: Our chance to develop an ethics of care, <http://estevacorbera.com/academia-in-the-time-of-covid-19-our-chance-to-develop-an-ethics-of-care/>
- Ávila, L.V., Leal Filho, W., Brandli, L., Macgregor, C.J., Molthan-Hill, P., Özuyar, P.G., & Moreira, R.M. (2017). Barriers to innovation and sustainability at universities around the world. *Journal of Cleaner Production*, 164, 1268-1278. <https://doi.org/10.1016/j.jclepro.2017.07.025>
- Azeiteiro, U.M., Bacelar-Nicolau, P., Caetano, F., & Caeiro, S. (2015). Education for Sustainable Development through e-learning in Higher Education: experiences from Portugal. *Journal of Cleaner Production*, 106, 308-319. <https://doi.org/10.1016/j.jclepro.2014.11.056>
- Azeiteiro, U.M., Leal Filho, W., & Aires, L. (2018). *Climate Literacy and Innovations in Climate Change Education - Distance Learning for Sustainable Development*. Springer, Cham. <https://doi.org/10.1007/978-3-319-70199-8>
- Azeiteiro, U.M., Leal Filho, W., & Caeiro, S. (2014). *E-learning and Education for Sustainability*. Peter Lang, Frankfurt. <https://doi.org/10.3726/978-3-653-02460-9>
- Azeiteiro, U.M., Leal Filho, W., & Davim, J.P. (2017). *Higher Education Institutions in a Global Warming World The transition of Higher Education Institutions to a Low Carbon Economy*. River Publishers, [https://www.riverpublishers.com/book\\_details.php?book\\_id=464](https://www.riverpublishers.com/book_details.php?book_id=464)
- Baker-Shelley, A., van Zeijl-Rozema, A., & Martens, P. (2017). A conceptual synthesis of organizational transformation: How to diagnose, and navigate, pathways for sustainability at universities? *Journal of Cleaner Production*, 145, 262-276. <https://doi.org/10.1016/j.jclepro.2017.01.026>
- Bao, W. (2020). COVID-19 and online teaching in higher education: A case study of Peking University. *Human Behaviour & Emerging Technologies*, <https://doi.org/10.1002/hbe2.191>
- Bizerril, M., Rosa, M.J., Carvalho, T., & Pedrosa, J. (2018). Sustainability in higher education: A review of contributions from Portuguese Speaking Countries. *Journal of Cleaner Production*, 171, 600-612. <https://doi.org/10.1016/j.jclepro.2017.10.048>
- Bogoch, I.I., Watts, A., Thomas-Bachli, A., Huber, C., Kraemer, M.U.G., & Khan, K. (2020). Pneumonia of unknown aetiology in Wuhan, China: Potential for international spread via commercial air travel. *Journal of Travel Medicine* 27(2). <https://doi.org/10.1093/jtm/taaa008>
- Brudermann, T., Aschemann, R., Füllsack, M., & Posch, A. (2019). Education for Sustainable Development 4.0: Lessons Learned from the University of Graz, Austria. *Sustainability*, 11(8), 2347. <https://doi.org/10.3390/su11082347>
- CDC (2020). Novel coronavirus - information for healthcare professionals, <https://www.cdc.gov/coronavirus/2019-nCoV/hcp/index.html>
- Cohen, M. J. (2020). Does the COVID-19 outbreak mark the onset of a sustainable consumption transition? *Sustainability: Science, Practice and Policy*, 16, 1-3. <https://doi.org/10.3390/su11082347>

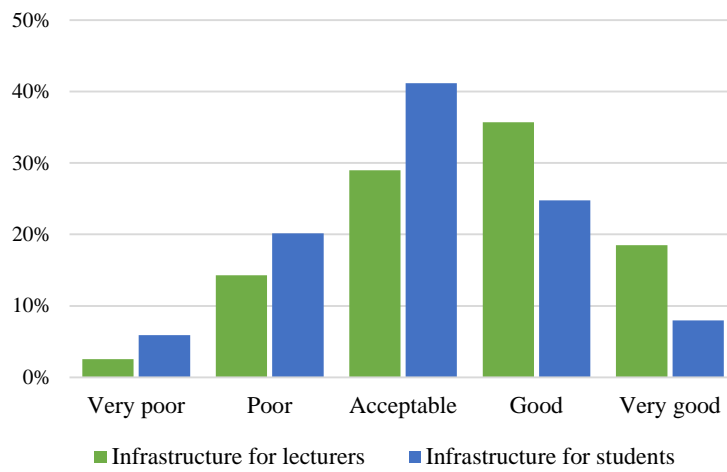
- 1 Dans, E. (2020) The Coronavirus Pandemic Has Unleashed A Revolution In Education: From  
2 Now On, Blended Learning Will Be The Benchmark,  
3 [https://www.forbes.com/sites/enriquedans/2020/04/13/the-coronavirus-pandemic-has-](https://www.forbes.com/sites/enriquedans/2020/04/13/the-coronavirus-pandemic-has-unleashed-a-revolution-in-education-from-now-on-blended-learning-will-be-the-benchmark/#62a81fc0536f)  
4 [unleashed-a-revolution-in-education-from-now-on-blended-learning-will-be-the-](https://www.forbes.com/sites/enriquedans/2020/04/13/the-coronavirus-pandemic-has-unleashed-a-revolution-in-education-from-now-on-blended-learning-will-be-the-benchmark/#62a81fc0536f)  
5 [benchmark/#62a81fc0536f](https://www.forbes.com/sites/enriquedans/2020/04/13/the-coronavirus-pandemic-has-unleashed-a-revolution-in-education-from-now-on-blended-learning-will-be-the-benchmark/#62a81fc0536f)  
6
- 7 De Gagne, J., & Walters, K. (2010). The Lived Experience of Online Educators: Hermeneutic  
8 Phenomenology. *Journal of Online Learning and Teaching*, 6(2), 357-366.  
9
- 10 Disterheft, A., Caeiro, S., Azeiteiro, U.M., & Leal Filho, W. (2013). Sustainability Science and  
11 education for sustainable development in universities: a way for transition. In: Caeiro S, Leal  
12 Filho W, Jabbour C, Azeiteiro U (eds) *Sustainability Assessment Tools in Higher Education*  
13 *Institutions*. Springer, Cham, pp 3-27.  
14
- 15 Ehrenfeld, J., & Hoffman, A. (2013). *Flourishing: A frank conversation about sustainability*.  
16 Stanford: Stanford Business Books.  
17
- 18 Elflein, J. (2020). Coronavirus (COVID-19) disease pandemic- Statistics & Facts. Statista  
19 <https://www.statista.com/topics/5994/the-coronavirus-disease-covid-19-outbreak/>  
20
- 21 Eurosurveillance. (2020). Note from the editors: World Health Organization declares novel  
22 coronavirus (2019-nCoV) sixth public health emergency of international concern.  
23 Eurosurveillance. <https://doi.org/10.2807/1560-7917.ES.2020.25.5.200131e>  
24
- 25 Farinha, C., Caeiro, S., & Azeiteiro, U. (2020). Universities speak up regarding the  
26 implementation of sustainable development challenges: The case of Portugal. *International*  
27 *Journal of Sustainability in Higher Education*, 21(3), 465-506.  
28 <https://doi.org/10.1108/IJSHE-08-2019-0250>  
29
- 30 Foch, W., Reiter, M.A., Barresi, P.A., & Smardon, R.C. (2019). *Education for sustainable*  
31 *human and environmental systems: from theory to practice*. New York: Routledge.  
32
- 33 Gewin, V. (2020). Into the digital classroom. Five tips for moving teaching online as COVID-  
34 19 takes hold. *Nature*, 580, 295-296. <https://doi.org/10.1038/d41586-020-00896-7>  
35
- 36 Goering, L. (2020). Online classes, video meetings: Can coronavirus spur low-carbon habits?  
37 [https://nationalpost.com/pmnenvironment-pmn/online-classes-video-meetings-can-](https://nationalpost.com/pmnenvironment-pmn/online-classes-video-meetings-can-coronavirus-spur-low-carbon-habits)  
38 [coronavirus-spur-low-carbon-habits](https://nationalpost.com/pmnenvironment-pmn/online-classes-video-meetings-can-coronavirus-spur-low-carbon-habits)  
39
- 40 Habib, L., & Johannesen, M. (2014). Perspectives on academic staff involvement in the  
41 acquisition and implementation of educational technologies. *Teaching in Higher Education*,  
42 19(5), 484–496. <https://doi.org/10.1080/13562517.2014.880679>  
43
- 44 Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The Difference Between  
45 Emergency Remote Teaching and Online Learning. EDUCAUSE,  
46 [https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-](https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning#fnr14)  
47 [and-online-learning#fnr14](https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning#fnr14)  
48
- 49 House-Peters, L.A., Del Casino Jr, V.J., & Brooks, C.F. (2019). Dialogue, inquiry, and  
50 encounter: Critical geographies of online higher education. *Progress in Human Geography*,  
51 43(1), 81–103. <https://doi.org/10.1177/0309132517735705>  
52
- 53 Jones, N. (2018). The virtual lab. Can a simulated laboratory experience provide the same  
54 benefits for students as access to a real-world lab? *Nature*, 562, 5-S7.  
55 <https://doi.org/10.1038/d41586-018-06831-1>  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

- 1 Karatzoglou, B. (2013). An in-depth literature review of the evolving roles and contributions of  
2 universities to Education for Sustainable Development. *Journal of Cleaner Production*, 49,  
3 44-53. <https://doi.org/10.1016/j.jclepro.2012.07.043>  
4
- 5 Kaufmann, N., Sanders, C., & Wortmann, J. (2019). Building new foundations: the future of  
6 education from a degrowth perspective. *Sustainability Science*, 14, 931–941.  
7 <https://doi.org/10.1007/s11625-019-00699-4>  
8
- 9 Kimbrough, L. (2020). Field research, interrupted: How the COVID-19 crisis is stalling science.  
10 [https://news.mongabay.com/2020/04/field-research-interrupted-how-the-covid-19-crisis-is-](https://news.mongabay.com/2020/04/field-research-interrupted-how-the-covid-19-crisis-is-stalling-science/)  
11 [stalling-science/](https://news.mongabay.com/2020/04/field-research-interrupted-how-the-covid-19-crisis-is-stalling-science/)  
12
- 13 Kopnina, H. (2018). Teaching Sustainable Development Goals in The Netherlands: a critical  
14 approach. *Environmental Education Research*, 24(9), 1268-1283.  
15 <https://doi.org/10.1080/13504622.2017.1303819>  
16
- 17 Lai, C.C., Wang, C.Y., Wang, Y.H., Hsueh, S.C., Ko, W.C., & Hsueh, P.R. (2020). Global  
18 epidemiology of coronavirus disease 2019 (COVID-19): disease incidence, daily cumulative  
19 index, mortality, and their association with country healthcare resources and economic  
20 status. *International Journal of Antimicrobial Agents*.  
21 <https://doi.org/10.1016/j.ijantimicag.2020.105946>  
22
- 23 Leal Filho, W., Pallant, E., Richter, B., & Brandli, L.L. (2018a). Planning and implementing  
24 sustainability in higher education institutions: an overview of the difficulties and  
25 potentials. *International Journal of Sustainable Development & World Ecology* 25(8):713-  
26 721. <https://doi.org/10.1080/13504509.2018.1461707>  
27
- 28 Leal Filho, W., Raath, S., Lazzarini, B., Vargas, V.R., de Souza, L., Anholon, R.A., ... Orlovic,  
29 V.L. (2018b). The role of transformation in learning and education for sustainable  
30 development. *Journal of Cleaner Production*, 199, 286-295.  
31 <https://doi.org/10.1016/j.jclepro.2018.07.017>  
32
- 33 Lewnard, J.A., & Lo, N.C. (2020). Scientific and ethical basis for social-distancing  
34 interventions against COVID-19. *Lancet Infectious Diseases*. [https://doi.org/10.1016/S1473-](https://doi.org/10.1016/S1473-3099(20)30190-0)  
35 [3099\(20\)30190-0](https://doi.org/10.1016/S1473-3099(20)30190-0)  
36
- 37 Li, C., & Zhou, H. (2018). Enhancing the Efficiency of Massive Online Learning by Integrating  
38 Intelligent Analysis into MOOCs with an Application to Education of Sustainability.  
39 *Sustainability*, 10, 468. <https://doi.org/10.3390/su10020468>  
40
- 41 Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., ... Xing, X. (2020). Early transmission  
42 dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. *New England Journal*  
43 *of Medicine*, 382(13), 1199–1207. <https://doi.org/10.1056/NEJMoa2001316>  
44
- 45 Lozano, R., Merrill, M.Y., Sammalisto, K., Ceulemans, K., & Lozano, F.J. (2017). Connecting  
46 Competences and Pedagogical Approaches for Sustainable Development in Higher  
47 Education: A Literature Review and Framework Proposal. *Sustainability*, 9, 1889.  
48 <https://doi.org/10.3390/su9101889>  
49
- 50 Lupia, T., Scabini, S., Pinna, S.M., Di Perri, G., De Rosa, F.G., & Corcione, S. (2020). 2019  
51 novel coronavirus (2019-nCoV) outbreak: A new challenge. *Journal of Global Antimicrobial*  
52 *Resistance*, 21, 22-27. <https://doi.org/10.1016/j.jgar.2020.02.021>  
53
- 54 Mahase, E. (2020). Covid-19: UK starts social distancing after new model points to 260 000  
55 potential deaths. *The British Medical Journal*, <https://doi.org/10.1136/bmj.m1089>  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

- 1 Markowitz, D.M., Laha, R., Perone, B.P., Pea, R., & Bailenson, J.N. (2018). Immersive Virtual  
2 Reality Field Trips Facilitate Learning About Climate Change. *Frontiers in Psychology*.  
3 <https://doi.org/10.3389/fpsyg.2018.02364>  
4
- 5 Mccowan, T. (2016). Universities and the post-2015 development agenda: an analytical  
6 framework. *Higher Education*, 72(4), 505-523. <https://doi.org/10.1007/s10734-016-0035-7>  
7
- 8 Molderez, I., & Fonseca, E. (2018). The efficacy of real-world experiences and services learning  
9 for fostering competences for sustainable development in higher education. *Journal of*  
10 *Cleaner Production*, 172, 4397-4410. <https://doi.org/10.1016/j.jclepro.2017.04.062>  
11
- 12 Omary, M.B., Eswaraka, J., Kimball, D., Moghe, P.V., Panettieri Jr., R.A., & Scotto, K.W.  
13 (2020). The COVID-19 pandemic and research shutdown: staying safe and productive.  
14 *Journal of Clinical Investigation*, <https://doi.org/10.1172/JCI138646>  
15
- 16 Oliveira, C., Trindade, J., & Caeiro, S. (2019). Contribution of advanced training for real  
17 problem solutions within Sustainable Development Goals: the case of an e-learning PhD. In:  
18 Davim P, Azeiteiro U (eds.) *Higher Education and Sustainability: Opportunities and*  
19 *Challenges for Achieving Sustainable Development Goals*. Taylors & Francis Group. pp  
20 261-271.  
21
- 22 Panigrahi, R., Srivastava, P.R., & Sharma, D. (2018). Online learning: Adoption, continuance,  
23 and learning outcome—A review of literature. *International Journal of Information*  
24 *Management*, 43, 1-14.  
25
- 26 Park, M., Thwaites, R.S., & Openshaw, P.J.M. (2020). COVID-19: Lessons from SARS and  
27 MERS. *European Journal of Immunology*, 50, 308–316.  
28
- 29 Pereira, A., Mendes, A.Q., Morgado, L., Amante, L., & Bidarra, J. (2008). Universidade  
30 Aberta's Pedagogical Model for Distance Education. Universidade Aberta, Lisbon, pp 109.  
31
- 32 Pirouz, B., Haghshenas, S.S., Haghshenas, S.S., & Piro, P. (2020). Investigating a Serious  
33 Challenge in the Sustainable Development Process: Analysis of Confirmed cases of COVID-  
34 19 (New Type of Coronavirus) Through a Binary Classification Using Artificial Intelligence  
35 and Regression Analysis. *Sustainability*, 12, 2427. <https://doi.org/10.3390/su12062427>  
36
- 37 Porcheddu, R., Serra, C., Kelvin, D., Kelvin, N., & Rubino, S. (2020). Coronavirus Outbreak  
38 Similarity in Case Fatality Rates (CFR) of COVID-19/SARS-COV-2 in Italy and China. *The*  
39 *Journal of Infection in Developing Countries*, 14(2), 125-128.  
40 <https://doi.org/10.3855/jidc.12600>  
41
- 42 QAA (2014). Education for sustainable development: Guidance for UK higher education  
43 providers, [https://www.qaa.ac.uk/docs/qaa/quality-code/education-sustainable-development-](https://www.qaa.ac.uk/docs/qaa/quality-code/education-sustainable-development-guidance-june-14.pdf?sfvrsn=1c46f981_8)  
44 [guidance-june-14.pdf?sfvrsn=1c46f981\\_8](https://www.qaa.ac.uk/docs/qaa/quality-code/education-sustainable-development-guidance-june-14.pdf?sfvrsn=1c46f981_8)  
45
- 46 QS Quacquarelli Symonds (2020). The impact of the coronavirus on global higher education,  
47 [http://info.qs.com/rs/335-VIN-535/images/The-Impact-of-the-Coronavirus-on-Global-](http://info.qs.com/rs/335-VIN-535/images/The-Impact-of-the-Coronavirus-on-Global-Higher-Education.pdf)  
48 [Higher-Education.pdf](http://info.qs.com/rs/335-VIN-535/images/The-Impact-of-the-Coronavirus-on-Global-Higher-Education.pdf)  
49
- 50 Remuzzi, A., & Remuzzi, G. (2020). COVID-19 and Italy: what next? *Health Policy*,  
51 395(0231), 1225-1228. [https://doi.org/10.1016/S0140-6736\(20\)30627-9](https://doi.org/10.1016/S0140-6736(20)30627-9)  
52
- 53 Rodríguez-Morales, A.J., MacGregor, K., Kanagarajah, S., Patel, D., & Schlagenhauf, P.  
54 (2020). Going global – Travel and the 2019 novel coronavirus. *Travel Medicine and*  
55 *Infectious Disease*, 33. <https://doi.org/10.1016/j.tmaid.2020.101578>  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

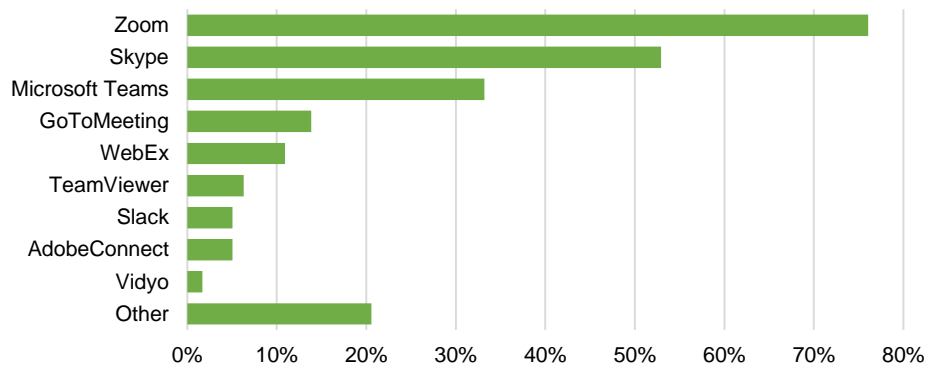
- 1 Salmerón-Manzano, E., & Manzano-Agugliaro, F. (2018). The Higher Education Sustainability  
2 through Virtual Laboratories: The Spanish University as Case of Study. *Sustainability*, 10,  
3 4040. <https://doi.org/10.3390/su10114040>  
4
- 5 SDG-Education 2030 (2020). The SDG- Education 2030 Steering Committee  
6 Recommendations for COVID- 19 Education Response,  
7 [https://www.sdg4education2030.org/sites/default/files/2020-04/SDG-  
8 Education%202030%20SC%20recommendations%20-%20COVID-  
9 19%20education%20response.pdf](https://www.sdg4education2030.org/sites/default/files/2020-04/SDG-Education%202030%20SC%20recommendations%20-%20COVID-19%20education%20response.pdf)  
10
- 11 Sen-Crowe, B., McKenney, M., & Elkbuli, A. (2020). Social distancing during the COVID-19  
12 pandemic: staying home saves lives. *American Journal of Emergency Medicine*,  
13 <https://doi.org/10.1016/j.ajem.2020.03.063>  
14
- 15 Sohrabi, C., Alsafib, Z., O'Neill, N., Khanb, M., Kerwanc, A., Al-Jabirc, A., ... Agha, R.  
16 (2020). World Health Organization declares global emergency: A review of the 2019 novel  
17 coronavirus (COVID-19). *International Journal of Surgery*, 76, 71–76.  
18
- 19 Song, F., Shi, N., Shan, F., Zhang, Z., Shen, J., Lu, H.,... Shi, Y. (2020). Emerging coronavirus  
20 2019- nCoV pneumonia. *Radiology*. <https://doi.org/10.1148/radiol.2020200274>  
21
- 22 Stainfield, J., Fisher, P., Ford, B., & Solem, M. (2000). International Virtual Field Trips: A new  
23 direction? *Journal of Geography in Higher Education*, 2, 255-262.  
24 <https://doi.org/10.1080/713677387>  
25
- 26 Tam, G., & El-Azar, D. (2020). 3 ways the coronavirus pandemic could reshape education,  
27 [https://www.weforum.org/agenda/2020/03/3-ways-coronavirus-is-reshaping-education-and-  
28 what-changes-might-be-here-to-stay/](https://www.weforum.org/agenda/2020/03/3-ways-coronavirus-is-reshaping-education-and-what-changes-might-be-here-to-stay/)  
29
- 30 Tarzian, A.J., & Cohen, M.Z. (2011). Descriptive Research. In: Fitzpatrick JJ, Kazer M (Eds.)  
31 *Encyclopedia of Nursing Research*. Springer Publishing Company.  
32
- 33 The Economist. (2020). Clear thinking required; Covid-19 and climate change. *The Economist*  
34 434(9187), 70.  
35
- 36 Thompson, R. (2020). Pandemic potential of 2019-nCoV. *The Lancet*, 20.  
37 [https://doi.org/10.1016/S1473-3099\(20\)30068-2](https://doi.org/10.1016/S1473-3099(20)30068-2)  
38
- 39 UN (2016). Transforming our world: The 2030 Agenda for Sustainable Development.  
40 A/RES/70/1. United Nations,  
41 <https://sustainabledevelopment.un.org/post2015/transformingourworld>  
42
- 43 UN (2020a). Shared Responsibility, Global Solidarity: Responding to the socio-economics  
44 impacts of Covid-19, [https://www.un.org/sites/un2.un.org/files/sg\\_report\\_socio-  
45 economic\\_impact\\_of\\_covid19.pdf?fbclid=IwAR3m46tjDdV47-  
46 Jy6\\_hWT7nCBrts5p03gM5qsZ78-FtslukJsTWR7DyH\\_UE](https://www.un.org/sites/un2.un.org/files/sg_report_socio-economic_impact_of_covid19.pdf?fbclid=IwAR3m46tjDdV47-Jy6_hWT7nCBrts5p03gM5qsZ78-FtslukJsTWR7DyH_UE)  
47
- 48 UN (2020b). COVID-19 pandemic. Humanity needs leadership and solidarity to defeat the  
49 coronavirus, <https://www.undp.org/content/undp/en/home/coronavirus.html>  
50
- 51 UNESCO (2019). SDG 4 – Education 2030 Part II Education for Sustainable Development  
52 Beyond 2019, 206 EX/6.II. Paris. 15p.  
53
- 54 UNESCO (2020). COVID-19 Educational Disruption and Response,  
55 <https://en.unesco.org/covid19/educationresponse>  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

- 1 WHO (2020a). WHO Director-General's opening remarks at the media briefing on COVID-19,  
2 [https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-](https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020)  
3 [media-briefing-on-covid-19---11-march-2020](https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020)  
4
- 5 WHO (2020b). Coronavirus disease (COVID-19): Situation dashboard,  
6 <https://who.sprinklr.com/>  
7
- 8 WHO (2020c). Key messages and actions for COVID-19 prevention and control in schools,  
9 [https://www.who.int/docs/default-source/coronaviruse/key-messages-and-actions-for-covid-](https://www.who.int/docs/default-source/coronaviruse/key-messages-and-actions-for-covid-19-prevention-and-control-in-schools-march-2020.pdf?sfvrsn=baf81d52_4)  
10 [19-prevention-and-control-in-schools-march-2020.pdf?sfvrsn=baf81d52\\_4](https://www.who.int/docs/default-source/coronaviruse/key-messages-and-actions-for-covid-19-prevention-and-control-in-schools-march-2020.pdf?sfvrsn=baf81d52_4)  
11
- 12 Wiek, A., Withycombe, L., & Redman, C. (2011). Key competencies in sustainability: a  
13 reference framework for academic program development. *Sustainability Science*, 6, 203-218.  
14
- 15 Wilder-Smith, A., Freedman, D.O. (2020). Isolation, quarantine, social distancing and  
16 community containment: pivotal role for old-style public health measures in the novel  
17 coronavirus (2019-nCoV) outbreak. *Journal of Travel Medicine*, 1-4.  
18 <https://doi.org/10.1093/jtm/taaa020>  
19
- 20 Wong, E. (2020). TB, HIV and COVID-19: urgent questions as three epidemics collide,  
21 [https://theconversation.com/tb-hiv-and-covid-19-urgent-questions-as-three-epidemics-](https://theconversation.com/tb-hiv-and-covid-19-urgent-questions-as-three-epidemics-collide-134554)  
22 [collide-134554](https://theconversation.com/tb-hiv-and-covid-19-urgent-questions-as-three-epidemics-collide-134554)  
23
- 24 World Education Blog (2020). [https://gemreportunesco.wordpress.com/2020/03/24/how-are-](https://gemreportunesco.wordpress.com/2020/03/24/how-are-countries-addressing-the-covid-19-challenges-in-education-a-snapshot-of-policy-measures/)  
25 [countries-addressing-the-covid-19-challenges-in-education-a-snapshot-of-policy-measures/](https://gemreportunesco.wordpress.com/2020/03/24/how-are-countries-addressing-the-covid-19-challenges-in-education-a-snapshot-of-policy-measures/)  
26
- 27 Zhang, W., Wang, Y., Yang, L., & Wang, C. (2020). Suspending Classes Without Stopping  
28 Learning: China's Education Emergency Management Policy in the COVID-19 Outbreak.  
29 *Journal of Risk and Financial Management*, 13(3), 55, <https://doi.org/10.3390/jrfm13030055>  
30
- 31 Zhao, S., Lin, Q., Ran, J., Musa, S.S., Yang, G., Wang, W., ... Wang, M.H. (2020). Preliminary  
32 estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China,  
33 from 2019 to 2020: A data-driven analysis in the early phase of the outbreak. *International*  
34 *Journal of Infectious Diseases*, 1(92),214-217. <https://doi.org/10.1016/j.ijid.2020.01.050>  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

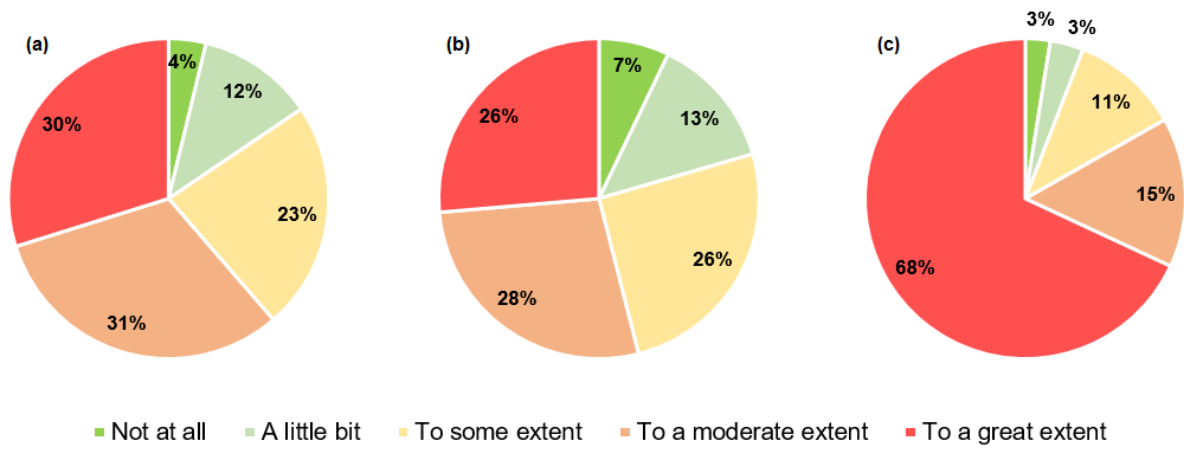
**Fig 1** Evaluation of available infrastructure for lecturers and students

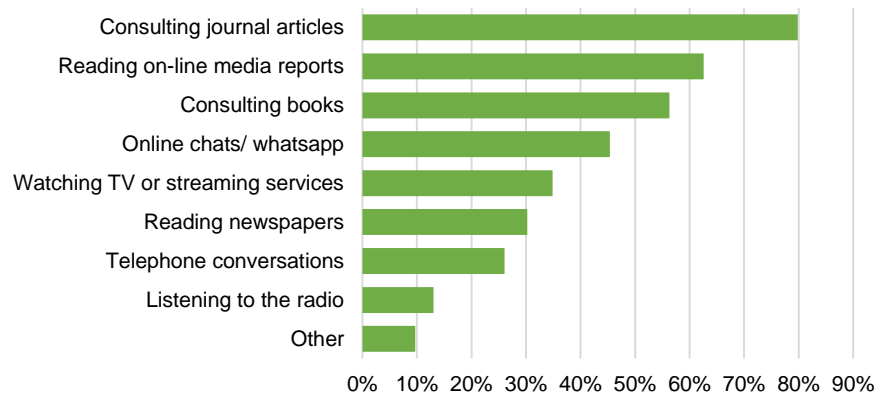


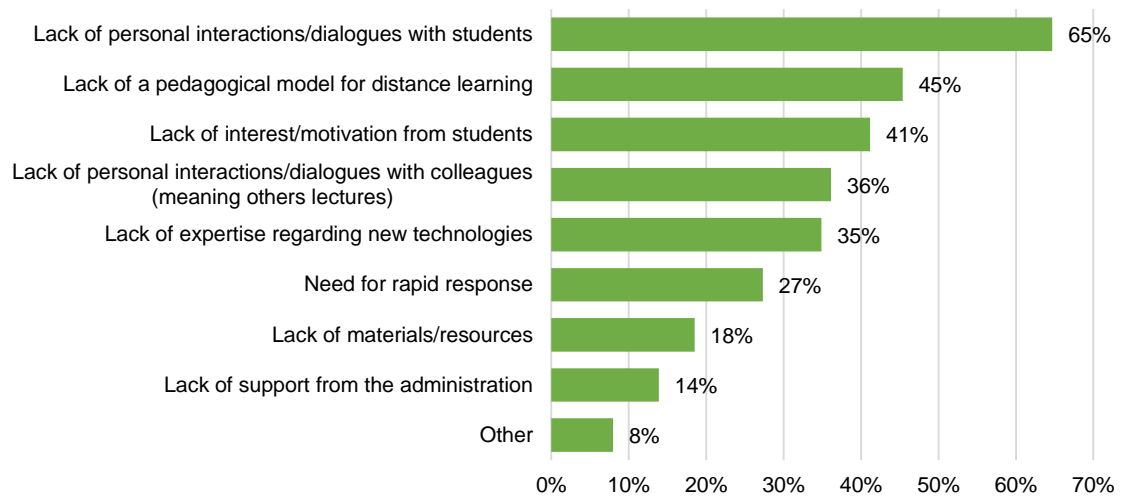
**Fig 2** Main tools used for synchronous communication during the shutdown



**Fig 3** Extent to which the shutdown has influenced teaching activities (a), assessment activities (b) and disciplines with practical classes, internships or final course reports (c)



**Fig 4** Main strategies to address information needs for teaching during the shutdown

**Fig 5** Main challenges of COVID-19 to teaching

**Fig 6** Ways in which COVID-19 may influence teaching in the long-term