



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

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Received: 26 July 2020 / Accepted: 17 November 2020
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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 are 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

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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 11 March 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 respiratory infections of varying severity and ease of contagion (Wilder-Smith and Freedman 2020; UN 2020a).

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

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

Historically, it is a generally accepted view that universities have played a key role in transforming societies, by educating decision-makers, leaders and entrepreneurs. McCowan (2016) also emphasizes that universities have been attributed a central role, namely in the post-2015 development agenda and the achievement of the sustainable development goals (SDG). This role in a post-COVID-19 world will only be more urgent. In fact, Karatzoglou (2013:49) goes further when mentioning that “universities continue to cope effectively and sustainably with the dynamic nature of sustainability by displacing barriers, changing teaching paradigms, developing social competencies, communication skills, and community relations”.

Concerning the international debate, Bizerril et al. (2018) mention the significant contributions to sustainability in HE (Higher Education), especially in the dimensions of education, research and assessment and reporting. This article in part attempts to further the understanding of how higher education institutions can continue to contribute to such contributions, especially in a post-COVID 19 context.

The COVID-19 shutdown also presents an opportunity to reflect on challenges encountered by higher education institutions to date. Universities face various barriers concerning Sustainable Development (SD) implementation, such as a lack of financial and human resources, and lack of trained personnel (Farinha et al. 2020). Moreover, there are also other barriers that may be regarded as preconditions for universities to successfully implement long-term sustainability initiatives. These include:

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

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

Higher education does have a track record of using technology to aid pedagogical goals. Distance Learning Universities already offer degrees in e-learning and Open Education Resources (Azeiteiro et al. 2014, 2015) based on their pedagogical models. And presence-based teaching universities had to respond to the COVID-19 epidemic with an immediate transition to Online Distance Teaching. The situation configures what Hodges et al. (2020) refer as a situation of “*Emergency Remote Teaching*”. E-learning is a challenge for presence-based teaching Universities, however, given the historical pedagogical model of face-to-face education utilized by presence-based teaching practices. COVID-19 also created an opportunity for collaboration and sharing experiences in presence-based university contexts. Successful responses include Sustainability and Climate Change teaching (Azeiteiro et al. 2014, 2018) and *b*-Learning Teaching for the after COVID-19 global crisis (Dans 2020).

2 COVID-19: facts, figures and impacts on sustainability teaching

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

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

One likely development post-COVID-19 is an increased dependency on online teaching, even in historic presence-based teaching universities. Online pedagogical practices can enhance face-to-face learning and online educational spaces can offer new opportunities for higher education (House-Peters et al. 2019). While online learning and teaching methods to improve access to education have been adopted worldwide (Panigrahi et al. 2018), the proportion of online courses compared to face to face courses offered by universities prior to the pandemic remained low (Bao 2020). Globally, lecturers are reminded to ensure that they reach out to students who do not have stable Internet connections at home for logistical or financial reasons, so as not to run the risk of deepening inequities in educational opportunities and social inequalities more broadly as a result of online teaching (Anguelovski et al. 2020). After all only around 60% of the globe’s population is online (Tam and El-Azar 2020).

Among the challenges to a rapid shift to online delivery in response to the pandemic, mention can be made to a lack of online teaching experience, the limited time to make the transition, technical obstacles and poor learning environments for students when working remotely (Bao 2020). Furthermore, a rapid transition to remote delivery may present particular challenges. For example, while the potential for using virtual field trips, virtual labs or immersive virtual reality for environmental education is promising (Stainfield et al. 2000; Jones 2018; Markowitz et al. 2018), to date, the use of virtual reality to simulate learning environments varies globally and by discipline (Salmerón-Manzano and Manzano-Agugliaro 2018). Evidence also suggests that environmental field-based projects have been halted or postponed as a result of COVID-19 (Kimbrough 2020). To date, no studies have systematically explored potential impacts

of the COVID-19 shutdown on technology-enabled teaching and learning practices for education for sustainable development.

The World Health Organisation emphasizes that quality education needs to be supported, even in case of closures and shutdowns. For example, the use of online/e-learning strategies, assigning reading and exercises for home study, radio, podcast or television broadcasts with academic content, assigning teachers to conduct remote daily or weekly follow-up sessions with students, and reviewing/developing accelerated education strategies are all suggestions to improve online education (WHO 2020c). Furthermore, the COVID-19 pandemic has occurred in the middle of UN efforts to achieve the Sustainable Development Goals (SDGs) (SDG-Education 2030 2020). It can disrupt the progress toward SDG 4 targets since quality education can be compromised (UN 2020a). For example, the achievement of the targets 4.3 and 4.5 highlights the urgent need for all students to have a computer or tablet to attend online courses and all other forms of e learning. This fact may represent a barrier for an equal education (World Education Blog 2020). Nevertheless, with the right action, the COVID-19 crisis can mark the rebirthing of society as we know it today to one where we protect present and future generations, where part of this protection is providing them with a quality, affordable education tethered to the SDGs (UN 2020a). Universities play a profound role in a century in which society will be judge by its capacity for self-transformation in response to pandemic crises (Baker-Shelley et al. 2017; Disterheft et al. 2013; Leal Filho et al. 2018b). Students, academics, researchers and practitioners co-create knowledge and skills to promote sustainable development (Baker-Shelley et al. 2017), but one of the main challenges for lecturers is to design learning activities that will allow students to effectively acquire sustainability competences (Molderez and Fonseca 2018).

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

Conservationists recognize that in order to stop biodiversity loss, trends on global consumption needs to change (Adams 2020). Education can encourage students to become advocates for social, environmental and economic issues impacted by COVID-19, by encouraging students to become advocates for disease prevention and control at home, in school, and in their community, by talking to others about how to prevent the spread of viruses (WHO 2020c). This may include students advocating on behalf of protecting

biodiversity in part to protect from future virus outbreaks, given that some viruses may be passed on to humans from species residing in remote and protected biodiverse areas.

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

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

By means of a worldwide survey involving higher education institutions, this study investigates patterns in remote delivery of education for sustainable development in response to COVID-19 and means by which university teaching on sustainability may be improved in future, taking greater advantage of existing technologies for remote learning. To date findings on the impact of coronavirus on higher education (QS 2020) demonstrated that a large part of respondents have changed their plans to study abroad as a result of the coronavirus. Students have to face many difficulties such as travel restrictions; university closures; flight cancellations; difficulties with obtaining scholarship interviews, visa applications, or language tests; exam cancellations or postponements; and health concerns. Through this survey other aspects related to institutions' responses are investigated such as ways to embrace online learning, student recruitment, changes on student mobility and international partnerships, ways for communicating with international students and the revision of crisis management plans.

3 Methods

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

A set of questions was developed to collect qualitative and quantitative data on the impacts that the COVID-19 pandemic is having on teaching sustainable development issues. The first list of items was reviewed by the authors to minimize redundancies and similar items and to ensure that all relevant questions were considered. The instrument was pre-tested by a panel of academics within sustainability areas at different universities. The

main focus was to do a study that would indicate personal views, opinions and perceptions of the various respondents on the COVID-19 impacts. Based on the feedback received, an on-line questionnaire, composed of 29 questions was designed and disseminated through Google Forms, to collect data from teachers and students. A total of 29 questions were grouped into three parts. The first part focused on the “background” of the respondents and their local university context, and was constituted by three open-ended questions and 2 closed-ended; the second part focused on the implications of “the shutdown and your work”, was more extensive and utilized 19 questions, in which two were dichotomous, seven closed-ended and nine involved the use of a five point Likert scale. The last part focused on the “future” implications for teaching pertaining to sustainable development, and contained two open-ended questions, three dichotomous and one closed-ended. The questionnaire also collected some sociodemographic characteristics of the respondents.

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 13 April to 19 May 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.

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.

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 were 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

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
Total	47	147	238

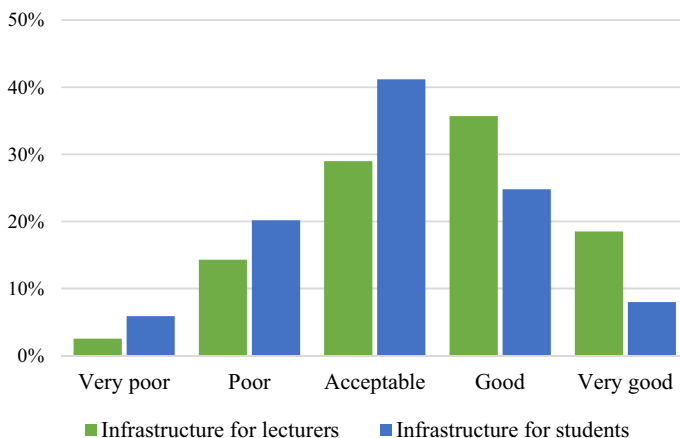
Table 2 Distribution of respondents by knowledge area in which they work

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
Total	293	100

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 majority (84%) of the university staff answering the questionnaire, the support provided by their respective institution to staff and students was either acceptable (36%), good (33%) or very good (15%). However, Fig. 1 shows that when evaluating the available infrastructure for lecturers and students to perform their activities from home, considering

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

the challenges of distance learning, although there is a tendency for more positive responses, students are considered to have less appropriate conditions when compared to lecturers. This reaffirms the focus of this study is on faculty (and faculty who are also staff/administrators) perceptions of COVID-19, and not student perceptions. A similar study on student perceptions would help aid our collective understanding and the authors invite other researchers to undertake such research.

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

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

Although the need to revert to these online communication tools was short notice and quite rapid, over 91% of the university staff involved in the study rated their skills in dealing with these tools for teaching as acceptable, good or very good. Nevertheless, none commented whether they already possessed these skills prior to the shutdown or whether they had received training from the university as part of the COVID-19 contingency plan. This suggests many faculty teaching sustainability in higher education have strong competencies in digital literacy. This also suggests a layer of resiliency in faculty in their ability to adapt their teaching; and that at least for the universities represented in our sample size, that higher education as a whole has adequate infrastructure to continue to deliver its services in the middle of a “black swan” emergency, at least in the short term. This does leave aside the question of increased carbon emissions from universities due to higher demand on server clouds and grids (although some of this may

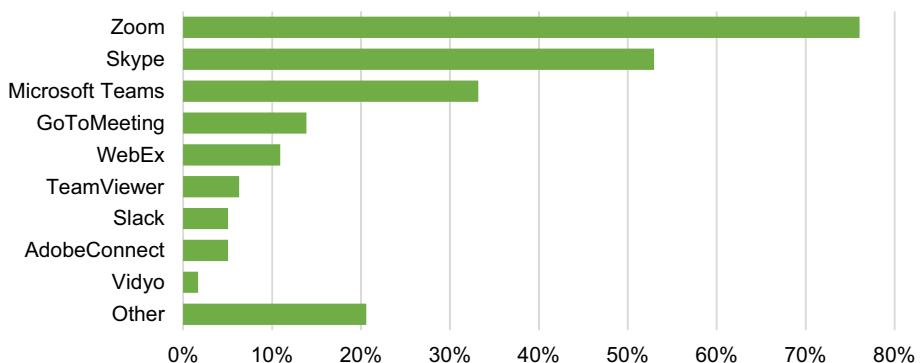


Fig. 2 Main tools used for synchronous communication during the shutdown

be offset by less faculty, staff, and student travel to conferences and athletics), which is outside of our research purview, but important to further explore.

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

In a different question, the respondents were asked about the problems experienced in teaching activities during the shutdown. One of the problems that most respondents (63%) faced during the shutdown was the radical alterations they had to go through—in a very short time period—to adapt the content and the methods of their lectures. On top of the challenges related to the new mode of teaching, respondents reported problems related to timetabling (i.e. delays—44% and lecture cancellations—27%) and technological glitches (i.e. disruption of communication—50%). Respondents also offered other problems they experienced: difficulties in assessing students' engagement; cancellation of practical activities (usually preferred by students); different performances of students with different resources to work from home (e.g. Internet connection); and the time-consuming preparation of online classes. Consequently, respondents claimed that the increased work resulting from the teaching and assessment activities mentioned above, had a significant effect on their teaching workload. The majority indicated a moderate (42%) and great (31%) increase. Some respondents (10%) pointed out that there was no impact on their workload, possibly indicating that these lecturers might have already been used to online classes. Other respondents indicated that their workload decreased (17%)—a possible indication of the cancellation of practical classes or field trips as well as events that could not be shifted to the online version or the ability to have institutional distance learning platforms that automatically grade student work.

Respondents might have experienced an increased workload because of the preparations of teaching and learning sessions and materials. Indeed, it is well documented that preparation of distance learning requests not only a definition of a pedagogical model but a great effort in materials preparation, since students should be more autonomous in their study

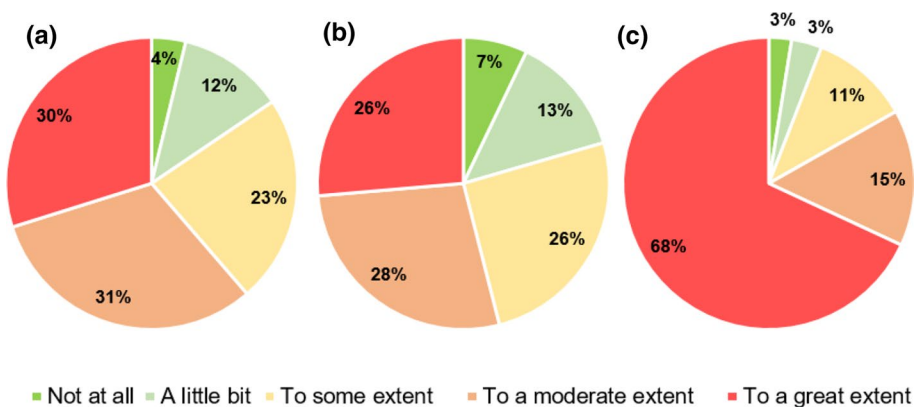


Fig. 3 Extent to which the shutdown has influenced teaching activities (a), assessment activities (b) and disciplines with practical classes, internships or final course reports (c)

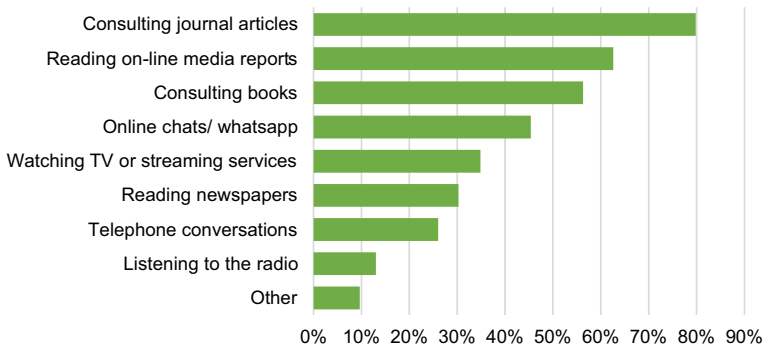


Fig. 4 Main strategies to address information needs for teaching during the shutdown

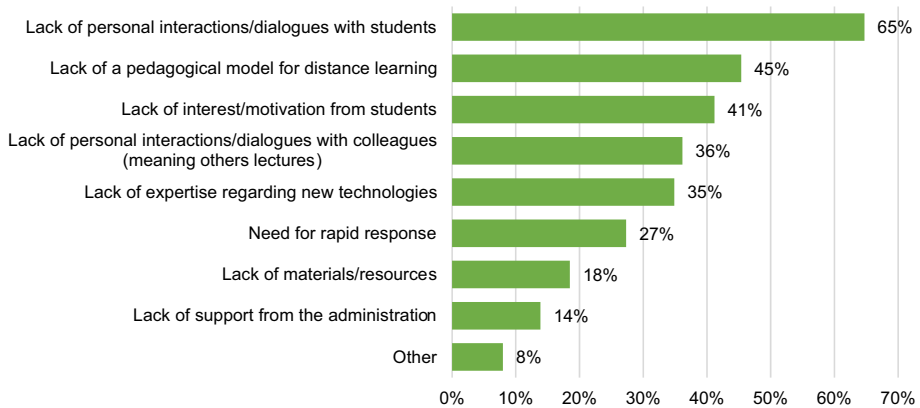


Fig. 5 Main challenges of COVID-19 to teaching

(Azeiteiro et al., 2014, 2015; Pereira et al., 2008). Figure 4 summarizes the array of methods used by the respondents to address their information needs. Consultation of journal articles was the most common method reported by 80% of the respondents, followed by the use of online media reports (63%) and book consultation (56%). The other options (10%) included mainly the use of webinars, online conferences and training sessions provided by the universities. One predicted outcome of COVID-19 on universities suggested by the below is that universities will invest more in developing faculty expertise in distance learning teaching so as to be better prepared for future pandemics. A longitudinal study on the impact of COVID-19 on universities would help tease out this possible response dynamic.

Figure 5 shows that the primary concerns of the majority of respondents revolved around the effectiveness of their teaching. In fact, 65% of respondents were concerned about the lack of communication with students and subsequent reduction in motivation (41%). Others felt that their teaching suffered because they were not sufficiently prepared for the sudden change (i.e. a lack of a pedagogical model, indicated by 45% of the respondents; lack of expertise, indicated by 35% of the respondents; and lack of resources, indicated by 18% of the respondents). While the main challenge of the pandemic induced lockdown was the lack of communication with students, for a substantial group of respondents (35%) was the lack of personal interactions/dialogues with students, the lack of interactions

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

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

The second part of the survey was related to the future and how teaching will be deployed after the pandemic. An overwhelming 82% of the respondents claimed that their experience of the COVID-19 crisis will have a long-term effect on their teaching. When asked to elaborate on the nature of this long-term effect, the majority of responses (36%) signalled a shift towards the adoption of blended learning. A significant amount (34%) foresee a shift towards a "home office" approach, i.e. a move towards teleworking with all its implications on the university's provision of office space, lecture rooms and in situ resources (Fig. 6).

The above responses contain continuity with findings from education researchers namely Jennie De Gagne and Kelley Walters (2010). Their study of distance learning educators generated five key themes that are germane to distance learning teaching: that it "offers flexibility and convenience"; "is time-consuming and labor-intensive"; that "strong communication skills are essential" for guiding student engagement and success; that "is learner-centered"; and that "requires continuing education and training" (ibid). The last finding is consistent with the above data point where 82% of our respondents claimed that they will most likely continue to train in and engage with some type of distance learning element as part of their teaching portfolio. This fact can lead to new challenges with

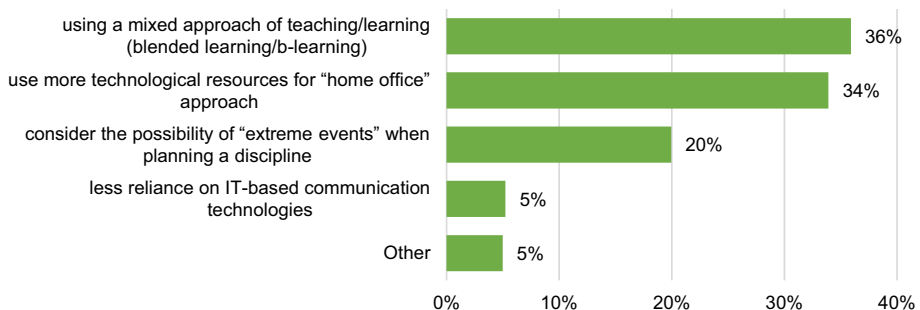


Fig. 6 Ways in which COVID-19 may influence teaching in the long term

acquired competences for sustainability. Earlier studies demonstrate that distance learning can be quite effective within education for sustainable development and problem solving in Higher Education, if well planned and prepared (e.g. Azeiteiro et al. 2014, 2015; Oliveira et al. 2019). Besides distance learning supported by a well-grounded pedagogical model, allow the use of teaching approaches like problem based learning, case studies, role playing and gaming that are pedagogical approaches strongly linked with competences acquisition for sustainability (Lozano et al. 2017).

Only 54% ($n=129$) of the respondents confirmed that they included references to the COVID-19 crisis when teaching about sustainable development. When asked to explain what this inclusion involved, university staff cited various examples that were quite dependent on their specialization. As expected most of these inclusions involved using the COVID-19 crisis as an illustration of certain phenomena such infectious diseases, health procedures, exponential growth, isolation techniques and media reporting. However, there were a substantial number of responses indicating the creation of opportunities for reflection, systems analysis, critical analysis of decisions and policies adopted, and ethical considerations. What is rather worrying is that 46% of the respondents did not feel the need to mention the COVID-19 crisis in their teaching about sustainable development, irrespective of the worldwide environmental, social and economic impacts of this pandemic, namely the decrease in CO₂ emissions in main cities and decrease in consumption.

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

Lastly, the questionnaire also asked respondents' reactions to a set of statements using a 5-point Likert Scale. Responses were scored (i.e. from 1—Strongly Disagree to 5—Strongly Agree) and the average for each statement calculated. A high average score indicates a high level of agreement. Table 3 summarizes these results. An overall analysis of the responses in Table 3 reveals a general consensus that the COVID-19 crisis has presented an opportunity to reimagine the future of the global sustainability agenda, improve the quality of the environment and improve teaching. However, this level of 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

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

Description	Average	SD	Variance
The incidence of COVID-19 has offered new opportunities to reimagine the future world and this may benefit the global sustainability agenda	4.18	.896	.804
Despite all challenges, COVID-19 provided some positive impacts (reducing carbon emissions, saving time, etc.)	4.06	1.01	1.02
COVID-19 may change the way universities teach (for adding more online classes instead of fully in-class curricula)	3.96	.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

in such short notice that teachers add no time yet to reflect or change their speeches and materials to students.

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

The challenges of e-learning stressed earlier (including the potential for natural resources saving compared to face-to-face education, as stressed for example by Roy et al. 2008) and of the new ways and paradigms of thinking and living due to COVID-19, can be important drivers and opportunities to enhance education for sustainable development.

5 Conclusions

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

Even though the speed with which actions had to be taken has not resulted in a full stop of teaching, it has required a rapid switch from teaching in the classroom, to trying to deliver content and student experience through distance learning technologies. Most

respondents have found this adaption a big challenge because it had to be achieved in a very short space of time, resulting in an increased workload. Laboratory based courses, field work and student placements have been particularly impacted, and assessments in general have required re-thinking. However, many courses have been able to continue in a virtual mode and respondents also suggest that they felt that they had the necessary skills to adapt to different modes of delivery, with a range of technological approaches deployed to support the continuation of learning.

In the context of learning from home, many responses suggest that students and staff have been heavily reliant on accessing journal articles, online media reports and resorting to the use of books. However, concern was shared about the effectiveness of their teaching, the lack of personal communication with students, along with worries about students' motivation. A lack of an overall pedagogical model for distance learning has hindered progresses. But respondents also suggested that the experience has been positive on occasions, to the extent that creativity has been enhanced. In the future, respondents foresee the increased use of distance/blended learning approaches and the greater use of technology in the home office.

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

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

There are two main limitations to this study. The first relates to the number of responses. From the total of 238 individuals from 147 different universities in 47 different countries, Africa was under represented with only a few universities. Therefore, more research is needed to identify trends in that part of the world. Also, the second limitation relates to the timing of the study; the study was undertaken during the lockdown, rather than at the end of the lockdown. Therefore, whilst it is strongly situated to report a unique snapshot of the implications of COVID-19, it does not report on the full extent of the impact of the pandemic (which is currently unknown).

The data and evidence gathered from the study are nonetheless robust, in the sense that it offers unprecedented insights into how higher education institutions have been coping

with the COVID-19 epidemic, and how the teaching on sustainable development has been influenced by it.

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

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

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

Funding Not applicable.

Availability of data and materials Not applicable.

Code availability Not applicable.

Compliance with ethical standards

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

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Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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