sustainability

MDPI

Article

Challenges of Online Higher Education in the Face of the Sustainability Objectives of the United Nations: Carbon Footprint, Accessibility and Social Inclusion

Mikel Perales Jarillo *, Luis Pedraza, Pablo Moreno Ger and Elvira Bocos

School of Engineering, Universidad Internacional de La Rioja, 26006 Logroño, Spain

* Correspondence: mikel.perales@unir.net

Received: 18 September 2019; Accepted: 8 October 2019; Published: 10 October 2019

Abstract: This article analyses three of the Sustainable Development Goals (SDGs) gathered by the 2030 Agenda and adopted by the United Nations, and how online educational models may help to reach these goals. Specifically, the three goals discussed through this article are: i) Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (Goal 4); ii) reduce inequality within and among countries (Goal 10); and iii) take urgent action to combat climate change and its impacts (Goal 13). This work delves fundamentally into aspects related to online engineering education, such as the impact of the carbon footprint in online education, the reduction of geographical barriers and the social gap, and the complete online accessibility to the educational environment. Finally, this article presents the case of the International University of La Rioja with its 100% online methodology, and approximately 42,000 students distributed throughout the world. This institution is supported by tools that facilitate engineering training for people with reduced mobility and who are geographically dispersed, reducing the carbon footprint through remote training.

Keywords: online education; carbon footprint; sustainability education; engineering education; online labs

1. Introduction

Towards the 1970s, governments around the world became fully aware of the need to address economic growth from a sustainable and inclusive point of view, necessarily linked to a full social and environmental development. Likewise, after the Stockholm Conference of 1972, education began to play a very important role to achieve this development. In 1992, the Earth Summit was celebrated, and a series of binding documents for the signatory countries, such as Agenda 21 and the United Nations Framework Convention on Climate Change (UNFCCC) were created. These documents represent an appeal whose global objective was to strengthen public awareness of the alarming increase in greenhouse gases and the importance of education as a means to achieve this awareness. Since then, European society's awareness of the environment and in particular, the dangers of the emission of greenhouse gases (GHGs) has increased, especially as a result of the Paris Summit in 2015 [1].

In September 2015, countries from all continents signed Agenda 2030, with the aim of reaching a sustainable development, which allows current generations to develop without compromising the opportunity of future generations to meet their own. The Agenda 2030 contained 17 Sustained Development Goals (SDG) and 169 objectives. Among these goals, there were three especially related to this study: i) Quality education for all (SDG 4); ii) reduction of inequalities in and between countries (SDG 10); and iii) climate action (SDG 13) [2]. Overall, the goals established a general consensus that, in order to achieve full development, it is necessary for actions that stop the degradation of the planet are accompanied by a reduction of social inequality and better education and awareness of citizenship [3].

The new digital technologies are gaining great relevance in all social and economic activities [4]. In this context, education acts as a fundamental component for the success of sustainable development initiatives, as they must adequately combine innovative practices, knowledge assurance and new technologies. University education provides a bridge between these three factors and society [5].

Education is crucial when it comes to connecting global development with local policies and with isolated populations, especially disadvantaged or at-risk populations. In Sweden, for example, the initiative TheGoals.org has emerged through the International Foundation for the Young Masters Programme, a pioneering non-government organization in search for innovative educational processes in the information and communications technology sector (ICT) to achieve sustainable development [6]. Likewise, the Plenipotentiary Conference of the International Telecommunication Union (ITU) highlighted in its 2018 declaration the importance of ICT in the provision of goods and services in the field of education and the environment [7].

The incidence of ICT on climate change and the environment has been pointed out by various authors [6,7] that denoted its potential as an alternative to alleviate global warming. In this sense, many public and private educational institutions have already taken measures to address these type of emissions [8]. European universities such as Sheffield, Oxford or Cambridge have included plans to create a more sustainable campus, detailing their own strategies to reduce their carbon footprint. In the same way, American universities, such as St. Edward in Austin, are used as an example in studies such as the one developed by Bailey [9] to analyze the amount of greenhouse gases they emit compared to other Texas universities.

In fact, it is necessary for higher education institutions to provide models of civic responsibility and commitment at the organizational level, setting an example for the rest of society [10]. Although the new emerging literature on sustainability in higher education is varied, it is dominated by empirical and descriptive studies adopting specific approaches, strategies and initiatives at specific institutions [11,12]. However, the literature also includes prescriptive studies that often call on universities to play a more prominent role in sustainability and sustainability education [13–15]. A considerable amount of the descriptive literature to-date has focused on specific strategies or actions taken at specific institutions [16,17].

The impact of the carbon footprint left daily by the educational community of a university, mainly by students, can be significant. The impact of the emission of greenhouse gases such as CO_2 in daily trips to the study center could be reduced or even completely eliminated in the case of a university with a purely online model. Even experimental learning activities, such as engineering laboratory sessions, could be virtualized so that students do not have the need to move from remote places to the laboratory. This approach could potentially cut down harmful emissions to the environment.

Focusing on laboratory assignments, their transformation into online or remote experiences present a number of advantages and disadvantages [18]. The main benefit of online laboratories is the ability to explore reactions and procedures that are too expensive or simply too dangerous to perform in a practical environment. In addition, depending on the approach, these laboratories may run without generating any waste or carbon footprint other than the electricity required to run them. In turn, in online laboratories, there are often safety oversights and oversimplifications in regard to hazardous waste. This means that sometimes the waste management standards established by the Law of Conservation and Recovery of Resources [19] are not followed, setting a poor example of good practices even though no real waste is produced.

In this context, the relevance of online education in general and online engineering education in particular has increased steadily in the past few years. International University of La Rioja (UNIR) is a paradigmatic example that demonstrates how the social gap and inequality can be reduced by providing online education services to students distributed in more than 77 countries. Its online model provides students with teaching-learning experiences not only theoretical, but also applicable to laboratory experimentation. Another aspect to consider is the amount of waste and the use of materials that is saved through the virtualization of a technical lab (chemistry, physics, electronics, etc.), also reducing the carbon footprint.

Another important factor regarding online university education is its inclusive and equitable nature. A teaching model in an online environment can promote life-long learning opportunities for students distributed in very diverse geographical areas [20].

It is also true that distance education has grown significantly and is constantly gaining supporters among educators, students and legislators. As shown by Bates (University of British Columbia), the assimilation of multimedia resources during the course work raises fundamental questions about the target groups, the teaching methods, cost accounting, educational effectiveness and, above all, the objectives and purpose of the academic institution [21]. Although this growth could be attributed initially to the flexibility offered to working adults, subgroups of individuals with disabilities appear in this population. Higher education institutions from all over the world are welcoming flexible online methodologies that can increase their community with the inclusion of people with mobility and accessibility difficulties [22].

In this context, it is becoming increasingly evident that online education is a significant contributor towards achieving the SDGs. This article addresses how this model can impact those goals related to quality education for all (SDG 4) and the reduction of inequalities in and between countries (SDG 10) in the section "Inclusion, accessibility and social gap in the online university". However, our attention is first focused on how online education models also impact relevant initiatives related to climate action (SDG 13) by studying the carbon footprint impact of an online university.

2. Carbon Footprint in Online University.

In relation to the goal to "take urgent action to combat climate change and its impacts" (Goal 13), affordable, scalable solutions are now available to enable countries to leapfrog to cleaner, more resilient economies. The pace of change is quickening as more people are turning to renewable energy and a range of other measures that can reduce emissions and increase adaptation efforts. Climate change, however, is a global challenge that does not respect national borders. It is an issue that requires solutions that need to be coordinated at the international level to help developing countries move toward a low-carbon economy [2].

The signing of the Kyoto protocol [23] fostered the growing awareness of the environment and the successive generation of new policies aimed at promoting the reduction of CO_2 emissions. In response to this justified social concern for the environment, the call to look for a transition to a sustainable society has been intensified [24]. In particular, the role of higher education within this social transition is of great importance for the academic community [14].

In order to understand the types of emissions the term carbon footprint includes, it would be correct to define it based on the World Resources Institute definition, "a representation of the effect on climate in terms of the total amount of greenhouse gases that are produced, measured in units of CO_2 that accumulate as a result of the activities of an organization" [25]. The establishment of a measurable footprint is essential to manage gas emissions and their impact on the environment. A general analysis of the impact that universities have on the carbon footprint could set a precedent as an exercise in transparency and social awareness. Increasing awareness of students is a factor to be taken into account when developing a university sustainability plan [23].

The application of online educational models in higher education is especially appropriate to provide solutions to this since the online environment not only promotes savings in the carbon impact generated by each student and therefore improves sustainability [26]. Further, it also generates a motivating learning model that improves academic performance [27]. Mixed or hybrid learning is becoming a dominant scenario in terms of educational models [28].

Several authors have highlighted in their studies the importance that universities should act as catalysts at the forefront of research. They should become the spearhead in the continuous search and transition of society towards sustainability in the world [26,29]. For many universities, the road to sustainability must begin by creating an ecological campus [24].

An ecological campus, or eco-campus, can be defined as "a green campus with relatively high ecological level, rational resource distribution and multi-utilization and beautiful humanity landscapes, which meets environmental demand of high education and research activities" [30]. An ecological campus should meet some requirements, such us rational resources utilization, high greening rate, and the pollutants discharged by laboratories and canteens must meet the emission standards and environmental protection must be taken into consideration. Ecological campuses belong to universities that are committed to sustainability and maintain an ecological commitment [31]. Further, the open and natural spaces of universities provide opportunities for outdoor education and in particular, for ecological education [32].

A completely online university campus provides the opportunity to reach a notable decrease in the carbon footprint due to the very nature of the teaching modality with respect to the traditional physical university and, therefore, represents a great shortcut in this search for sustainability. This construction of a university campus itself has a considerable impact on the environment [33]. It is already frequent to find universities that publish their recommendations related to energy and the environment. Specifically, as shown in Table 1, countries such as the United Kingdom have already extended this, explaining their measures, with the aim of raising their students' awareness on the importance of halting the degradation of the planet.

As mentioned before, Table 1 shows some examples of European universities that have implemented environmental regulations.

Table 1. Some European universities with environmental regulations.

University	Country	Link	Category
De Montfort	UK	https://www.dmu.ac.uk/about-dmu/sustainability/sustainability.aspx	Sustainability strategy
Cambridge	UK	https://www.cam.ac.uk/research/subjects/sustainable-earth?ucam-ref=home-focuson	Sustainable earth
Oxford	UK	https://www.ox.ac.uk/about/building-our-future/environmental?wssl=1	Environmental sustainability
Barcelona	Spain	http://www.ub.edu/ossma/	Environmental Quality Plan and Office
Valladolid	Spain	http://www.uva.es/export/sites/uva/	Environmental Quality Plan and Office
Sapienza Di Roma	Italy	https://www.uniroma1.it/en/pagina/sapienza-energy-plan-pes	Environment and Energy Plan

Some of the most recognized Universities of United Kingdom (UK) are included on this table. On the one hand, the University of Montfort manages its environmental impacts through an environmental management system (EMS). This university has set a series of targets as part of its EMS related to biodiversity, transport, community involvement, construction and refurbishment or emissions and discharges. On the other hand, the University of Cambridge is fully aware about the necessity to respond to climate change by building resilient infrastructures and making the transition from fossil fuels to renewable sources. Likewise, Oxford University has constructed a building making use of the high sustainability Passivhaus design approach. Passivhaus is the leading international low energy design standard which encourages entities to design energy efficient buildings.

In the same way, Spanish and Italian universities such as Barcelona, Valladolid or Sapienza have created specific offices and plans with the aim of implementing environmental quality plans, waste management and reduction, energy sustainability, etc.

The information on sustainability provided by different universities in their websites denotes the lack of common measures based on homogeneous standardization criteria, such as those developed by the International Organization for Standardization (ISO) in terms of structure and specific content. As the consulted literature demonstrates, there is growing concern by educational entities for the implementation of green measures capable of slowing down the continuous degradation that is affecting the environment.

It is also common to find institutions and studies that specify the impact of the carbon print per student or per university, as shown in the study, "Estimation of the Carbon Footprint on Student Halls of Residence in the University of Strathclyde" [23].

The map displayed in Figure 1 is a good way to represent the generation of greenhouse gases, specifically CO_2 in tonnes per person. Here, it is possible to see a concentration of CO_2 consumption in Europe and the Middle East and already more disaggregated CO_2 consumption in Asia and America.

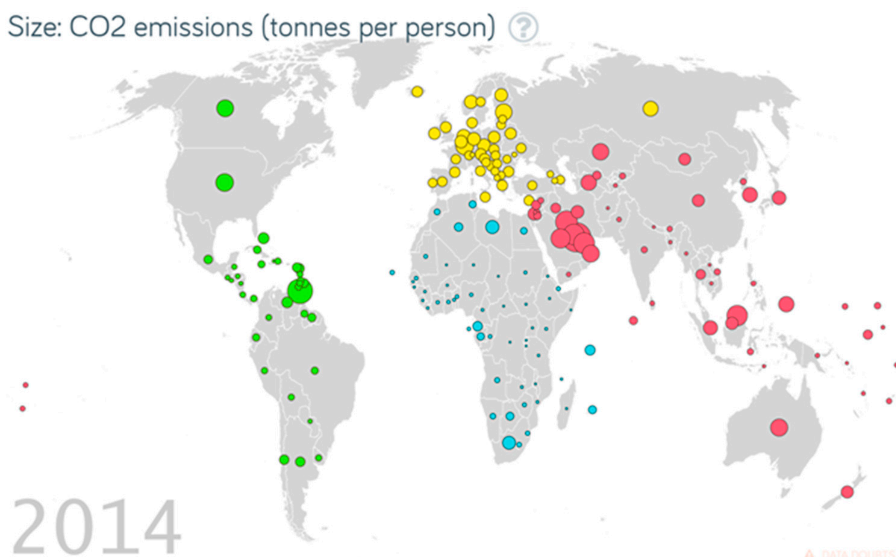

Figure 1. Distribution of CO_2 generation in the world 2014. The colours emphasize the distribution by continents.

Although the map reflects the concentration of CO_2 generation in the world in 2014, there are recent calculations on emissions per student. The average annual carbon footprint is 3.84 tonnes of CO_2 per student, and the data being attributable to daily life, transportation and academic activities [34]. In a country such as the United Kingdom, taking into account factors such as residential energy consumption, campus expenses and travel between residence and university, an online teaching model could help to reduce an estimated 88% of energy consumption and 83% the of carbon footprint [35]. The study on the carbon footprint provides an overview of the CO_2 generating resources associated with a single building without having to specify multiple parameters related to this CO2 emission [23]. There are several authors who specify the university activities of a student and their percentages of generation of greenhouse gases, such as CO_2 and nitrogen [23,26,34,35]. Table 2 represents a summary of several studies that analyze the most relevant activities in relation to CO_2 generation. In this table, the transport category englobes all activities related to commuting and the transport of students, teachers and other personnel between their homes and the campus. Academic activities encompass activities, such as laboratory operation and maintaining, teaching activities and resources employed during the daily campus operation. Finally, daily life represents resources consumed during the daily activities not strictly related to the learning process (food, housing, etc.).

Table 2. Comparative studies. University CO_2 expenditure.

Title and University	Reference	Transport	Academic Activities	Daily Life
"Design of higher education teaching models and carbon impacts," (University of Mahidol)	[32]	40%	31%	16%
"Carbon footprint analysis of student behavior for a sustainable university campus in China," (University of Tongji)	[31]	20%	15%	65%
"Estimation of the carbon footprint of student halls of residence in the University of Strathclyde" (University of Strathclyde)	[23]	58%	42%	
"Investigating the Carbon Footprint of a University - The case of NTNU,"	[33]	16%	19%	65%
Journal of Energy in Southern Africa., vol. 22, no. 2. University of Cape Town (University of Cape Town)	[34]	18%	1%	81%
"Measuring carbon performance in a UK University through a consumption-based carbon footprint: De Montfort University case study," (University of Cape Town)	[35]	28%	34%	38%
"Carbon Footprint of Environmental Science Students in Suan Sunandha Rajabhat University, Thailand," (University of Rajabhat)	[36]	15%	41%	44%

In order to better understand the disparity that the table reflects in the percentages of CO_2 consumption per student, Li, Tan, and Rackes' study present the analysis at a Shanghai university. This university has some particularities that could explain this disparity of percentages. Specifically, in China it is common for students to spend most of their daily life on university campus, so it is reasonable that their daily life has a higher percentage. Given that there are internal students in the facilities of the University of Shanghai, the concept of daily life includes activities such as communal showers, canteens and rooms [34].

On the contrary, the study of Bezyrtzi et al. has taken into account national travels of students within the United Kingdom whereas the rest of the concepts have been unified in a single percentage, disregarding the data that does not have a significant impact on this general evaluation [23].

In [36], there are many activities that are identified in the study of CO_2 consumption. However, some of them could be included in the three activities detailed in Table 2. In the Norwegian University of Technology and Science, the 20 elements with a higher contribution to energy consumption are carefully analyzed.

The analysis of Caird et al. considered travels, residential energy consumed and university campus operations as the main sources of carbon emission [35].

Mungwe, Guma, and Marquard analyzed how the University of Cape Town (UCT) has endeavored to set an example of environmental responsibility through the establishment of respectful policies and practices with the environment and the development of curricula and research initiatives to support an environmentally sustainable future [37]. The low percentage that academic activities represent in the generation of $CO_{2.}$ is especially noteworthy. This can be explained because electricity consumption alone represents approximately 80% of all emissions associated with university activities. This concept is included in the category, daily life, and that explains the excessive quota.

The analysis of Ozawa-Meida et al. focused on Monfort University in the United Kingdom and also maintains the disparity with the Asian universities because of the difference of assigned concepts in the category, daily life [38].

Finally, Utaraskul analysed the case of the Suan Sunandha Rajabhat University in Thailand. In this country, many sectors, such as academics, raise awareness about the process and also about the activities to reduce the GHGs. According to the author, the most important method to reduce GHGs is to change behavior by focusing on the carbon footprint [39]. As in the study of the University of Shanghai, the percentage related to daily life is very high due to the intense life that students spend on the university campus.

3. Inclusion, Accessibility and Social Gap in the Online University.

In relation to the goal to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (Goal 4), obtaining a quality education is the foundation to creating sustainable development. In addition to improving the quality of life, access to inclusive education can help equip locals with the tools required to develop innovative solutions to the world's greatest problems [2]. During the last years, the number of students with disabilities accessing higher education has increased significantly. This is related to the removal of physical barriers and also to the development of universities with an online methodology [40]. The online nature of these universities naturally leads to more accessible and inclusive learning experiences, by removing all mobility barriers and many other inclusion challenges.

Similarly, the online approach is free of distance barriers, and allows a cross-fertilization of educational practices among countries. This also has an important impact in favor of Goal 10: Reduce inequality within and among countries.

Therefore, this section discusses the different perspectives on how online universities promote inclusion, accessibility and bridging social gaps among and within countries. This approach aligns with the growing consensus that economic growth is not sufficient to reduce poverty if it is not inclusive and if it does not involve the three dimensions of sustainable development—economic, social and environmental

In terms of inclusion, different universities have carried out projects specifically designed to favor the access of students with disabilities to the contents of the campus [41–43]. The Partnerships in Education and Resilience (PEAR) project, for example, was carried out by the prestigious University of Massachusetts with the aim of making it easier for disabled students to access of virtual laboratories, resembling the access to real ones [43]. Likewise, in 2013, the European Union launched a project destined to facilitate access for disabled people to higher education [42]. In Australia, a law was created to prevent discrimination and to generate policies that facilitate social inclusion in education and access to equitable employment for disabled people [44].

Similarly, most people working in the higher education sector understand the importance of making online learning accessible to students with disabilities, however, this is not always easy to achieve [36]. It is very common that the use of technology by people with some type of disability is hindered by the use of various technological tools and that the content related to learning may be inaccessible [37]. For example, synchronous tools that require a real-time communication such as chats, do not meet the accessibility requirements because the action time of a disabled person can suffer continued delays. In the same way, basic phone conversations are a problem for deaf or speech impaired people. This explains why it is very important that there are teachers with adequate training or even language translators. On the other hand, while some disabilities do not affect reading ability, adaptation is necessary for blind people, otherwise this task would be complicated. The same applies to people who, despite not suffering from blindness, have disabilities that complicate this task, such as dyslexia [40].

It is the responsibility of the university or the educational institution to ensure that the education, information and registration they provide are accessible to the widest possible audience [45]. Even so, it is not surprising that many online courses are not accessible to people with some type disability. Some studies, such as [46], strive to improve the accessibility of students in studies with an online modality. In any case, in these scenarios, there is the possibility of facilitating personalized access based on the needs detected on an individual basis. It is common to find a small department dedicated to providing a service of attention to the special needs of the student.

In the same way, students with diverse characteristics, such as those defined by age, gender, native language and the level of ability to listen, see, move and speak [47], can access the online learning courses that incorporate accessibility functions [48,49].

The online teaching models require that all activities and student assignments are to be submitted by electronic means. This can free students from spending time and resources related to the consumption of physical resources [22]. Several media, such as chat, discussion forums, and email can be considered as tools that favor inclusion and break down the barriers of disabled students. The students with mobility problems, limited motor control or visual impairment cannot use a keyboard or mouse normally. There is a tendency to favor the generalized accessibility of any webpage, regardless of whether it is explicitly dedicated to users with or without disabilities. There are several legal regulations that gather these types of recommendations and in some cases obligations, and it is common to find countries that already have some kind of law or legal regulation related to accessibility and disabilities [50]. More than 150 governments have already signed the Committee's guidelines on the rights of persons with disabilities that was published in 2006 [51]. It contains 244 guidelines framed in 33 articles that broadly develop recommendations aimed at defending the rights of persons with disabilities through simplified reporting procedures.

These recommendations, including the Web Content Accessibility Guidelines (WCAG) and its section, Accessibility (https://www.w3.org/standards/webdesign/accessibility) were created to help web developers to generate accessible sites that favor social inclusion and accessibility. The assessments collected go beyond purely functional considerations and online learning environments must meet specific accessibility requirements. The fact that students can have a pleasant experience in terms of accessibility not only guarantees their rights as a user but, but also promotes the best online learning practices for all students [52,53].

Along the same lines of continuous improvement in the accessibility of websites, there are indicators of good practice in terms of accessibility, for example involving all different agents that participate in the learning process [54]. This would include teachers, students with and without recognized disabilities, web developers, evaluators, etc.

In any case, there are no major differences in academic results of students with disabilities and those of students without them [55]. A study from the University of Athabasca showed that the population of students with disabilities was divided as it follows: 52% had a physical disability, 20% had a learning disability, 20% had a psychological disability, 4% had some type of visual impairment and 3% had hearing impairment. The completion rate of these students was 45.9%, only a little lower than the one from the rest of general university population, 52.5%. It can therefore be said that an online learning model helps normalize the learning process [55].

It seems obvious that online education model offers differentiating advantages for many students with disabilities. In [56], it is pointed out that flexibility in the location, programming and delivery of distance education programs can provide disabled students with what may be their first real access to higher education. A specific educational service for the disabled makes a fundamental contribution to achieve success in university education. Studies show that students with disabilities who receive appropriate support persist in their studies and reach academic goals at the same rate as students without disabilities [57].

4. Case Study: The Model of International University of La Rioja.

UNIR is an online university that promotes online higher education with different approaches depending on the type of study: law, economics, education, social sciences, health and engineering. Among them, engineering degrees are especially interesting, since these studies typically require an important amount of laboratory work [58]. Offering a fully featured engineering education online is a significant technological challenge that the University approaches using a compendium of technologies and tools for experimentation in engineering education. These types of tools, normally integrated into a collaborative environment, are part of the progress in online training and are essential in breaking down geographical barriers.

Many systems in engineering, especially those providing circuitry, can be simulated using a variety of software simulation tools [59]. This approach presents special advantages in those laboratories involving chemical or hazardous waste, or dangerous activities. Many universities, both traditional and online, are increasingly adopting these alternative virtualized laboratories, either by providing students with licenses for simulation software or by installing the software in computer laboratories. UNIR adopts both models: allowing the students to install the simulation software on their own computers as well as having preinstalled versions on remote workstations. The software employed is varied but includes typical reference software in this field, such as Mentor's software suite or Xillinx simulators.

A remote laboratory is "is a software and hardware tool that allows students to remotely access real equipment located in the university" [60]. Remote laboratories have been deeply described in the literature as an alternative tool to hands-on-lab sessions. UNIR also focus on models that allow the configuration and remote operation of real equipment. To do this, the VISIR toolkit [61] was used that combines the flexibility of a simulator to build and interact with a circuit, with the outputs provided by a real system under observation. This approach offers some advantages in terms of maintainability, sustainability and adoption [62]. Figure 2 shows a remote laboratory for measuring radioactivity.

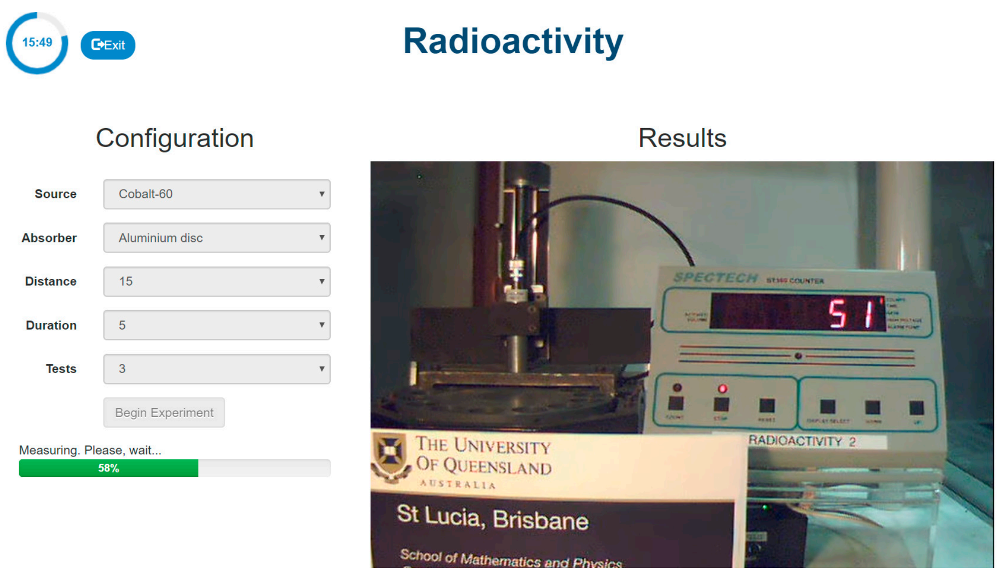

Figure 2. Remote laboratory for measuring radioactivity.

Admittedly, it would be very difficult to measure the savings in gas emissions in an online university such as UNIR, but a general boundary analysis can be performed accepting a number of premises.

Firstly, this article assumed that if UNIR students had to attend an on-site university, these students would generate an impact on the carbon footprint and therefore on the system's own sustainability. There are a few studies that consider the environmental impact throughout the whole system with a complete analysis of energy sources. In the "Designing low carbon higher education systems" study, Roy, Potter, and Yarrow identify the key sources of energy consumption and carbon emission related to online and on-site education systems. This study found that educational systems based on distance learning consumed 90% less energy and produced 85% less CO_2 emissions per student [63]. These results are aligned with the aforementioned in the case of the United Kingdom, which states that an estimated amount of 88% of energy consumption and 83% of carbon footprint could be saved in a purely online teaching model [35]. If this hypothesis is considered and extended to the UNIR student group, the impact in gas emission generated by a university with an online teaching model can be determined. It is therefore understood that by assessing a set of 41,870 students with an energy consumption of 3.84 tons of CO_2 per student, a consumption of 160,780.8 tonnes of

CO_2 could be attributed to all UNIR students. Finally, by assessing the estimations reflected in the aforementioned study, and applying an 85% of emission reduction, it can be affirmed that students of UNIR save an impact on the atmosphere of 136,663.68 tonnes of CO_2.

Another issue that this article intends to address is related to inequality and the capacity of an online university to fight against the social gap. This aspect was approached by analyzing the origins of the students enrolled in the 2018–2019 academic year and their possible economic and social links.

Although UNIR is represented in more than 77 countries, it is also true that 96.6% of the students are in 5 countries (Spain 53.6%, Ecuador 20.6%, Colombia 11.9%, Mexico 9% and Peru 1.5%). In order to be able to analyze the inclusive power of online education in a university such as the UNIR, it is very important to consider the per capita income (PCI) at least of these 5 countries. Table 3 relates the attractiveness of an online higher education modality for students residing in countries that not necessarily have a large purchasing power. Of these 5 countries, four of them do not reach the world average of PCI which according to the International Monetary Fund (2018) is 11,570 USD. It can then be deduced that, with regard to the economic field, it is also attractive to study in a distance modality for students residing in countries with a PCI below the world average and considered less developed.

Table 3. Per capita income chart according to the International Monetary Fund (2018).

Rank	% International University of La Rioja (UNIR)	Country of residence	Per Capita Income (PCI) USD
1	53.6%	Spain	30697
2	20.6%	Ecuador	6315
3	11.9%	Colombia	6684
4	9%	Mexico	9807
5	1.5%	Peru	7002

This way, UNIR actively participates in the fourth goal detailed in the General Assembly of the United Nations approved on 25 September 2015 [1]. This goal aims to guarantee quality inclusion and equitable education and promote life-long learning opportunities for all. The United Nations Educational, Scientific and Cultural Organization (UNESCO) indicates that there are approximately 600 million people with any type of disability [64]. Being able to facilitate access to higher technical university education to this group of people, as long as they meet the access requirements, may result definitively in the fight for educational inclusion. It is also true that it is not only about facilitating an online, distance, virtual or remote modality, but it is also fundamental that students with disabilities are satisfied with accessibility standards and with the capacity to be academically successful within these learning modalities [65].

On the other hand, UNIR has a service for the special needs of the students and maintains direct contact with all agents of the academic community in order to provide direct and accurate help to the student. The student communicates to the tutor a specific need related to his or her disability and through this special service, the teachers of each subject are aware about this condition.

UNIR offers Bachelor, Master and PhD courses. The methodology in the university is purely online for lectures and course activities. Different learning platforms are chosen taking into account special characteristics of different courses. Currently, the authors use Sakai, Canvas, Blackboard and a proprietary internal software development called S-Training.

At the end of the course, students must take and pass an on-site final exam. UNIR provides different locations across the world to facilitate the displacement of the students. This final exam provides an extra quality guarantee to our degrees. For this reason, exams represent an issue of paramount importance, and extra help is provided to these students when attending their exams.

During the 2018–2019 academic year, 430 UNIR students have received specialized support from the University regarding different types of accessibility problems. This represents the 1.029% of students and 87.4% of these students, with some type of problem, have a recognized disability. They are categorized in 5 blocks: visual, auditory, physical, cognitive and other disabilities. Some students are accounted in two or more of these categories.

Table 4 shows the types of disabilities and their percentage in UNIR students. Furthermore, the table provides some information about the most frequent support actions provided to students with special needs.

Table 4. UNIR disabled students 2018–2019.

Disability	% Over UNIR Disabled Students	Most Frequent Support
Visual	4.5%	Documents adaptation Extra time to perform exams and activities
Auditory	48.4%	Oral information support
Physical	24.2%	Physical adaptations (wheelchairs, special chairs and furniture) Extra time to perform exams and activities
Cognitive	9.8%	Schedule adaptations Extra time to perform exams and activities
Others	12.2%	Extra time to perform exams and activities

The map image (Figure 3) reflects the volume and distribution of students that UNIR has around the world. This dissemination of students indicates that the online modality offers the appropriate tools to win the battle of geographical distance between the teaching source and the student as a recipient in learning.

Figure 3. International University of La Rioja in the world. 2019.

5. Conclusions

This article addresses one of the sustainable development goals set out in the 2030 Agenda and adopted by the United Nations [2], "action for climate change". This goal is evaluated from the perspective of online university education. This way of creating wider learning environments and including new digital modalities has enormous potential to reduce harmful emissions to the environment. In addition, the generation of waste with this modality is considerably reduced and eliminated in many cases. Many studies relate the daily habits, such as academic activities and transportation of students between their home and the study center, as sources of energy consumption and CO_2 generation. Al these activities within an online training environment contribute to reduce the carbon footprint.

On the other hand, every university or higher education institution must be responsible for guaranteeing accessible training for as many students as possible. In the same way, every online university must maintain the same guarantees but have different ways of acting. In an online environment, it is a priority to provide a set of digital tools accessible for all students. Throughout this article, it has been discussed how many universities, either online or face-to-face, have taken some actions related to student accessibility. With regard to accessibility in online models, there are many studies that highlight a clear decrease in geographical barriers and therefore contribute to reduce the social gap.

Finally, by analyzing the purely online UNIR educational model, the authors outlined how this University actively participates in several of the objectives detailed in the General Assembly of the United Nations approved in 25 September 2015 [2]. UNIR promotes quality, inclusion and equitable education and provides lifelong learning opportunities for all its students. As previously mentioned, an online learning modality of this kind directly encourages students with disabilities to have greater satisfaction and the ability to be academically successful throughout their formative stage.

In conclusion, online universities, such as UNIR, can have a positive impact towards the identified sustainable development goals, can potentially be more effectively than on-site universities, and they represent an important approach in the construction of a more sustainable future.

Author Contributions: M.P.J. worked on the conceptualization and general orientation of the paper and took care of most of the bibliographical analysis. E.B. provided valuable insight, literature and text about sustainability aspects. L.P. and P.M.G. worked on the supervision and review of the paper. All authors contributed to the writing of the article.

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflicts of interest

References

1. United Nations. In Proceedings of the United Nations Framework Convention on Climate Change in 2015, Paris, France, 30 November–11 December 2015.
2. United Nations. *Transforming our world: The 2030 agenda for sustainable development*; 2015.
3. Mora, H.; Pujol-López, F.A.; Mendoza-Tello, J.C.; Morales-Morales, M.R. An education-based approach for enabling the sustainable development gear. *Comput. Hum. Behav.* **2018**, 1–5, doi: https://doi.org/10.1016/j.chb.2018.11.004.
4. Rao-Nicholson, R.; Vorley, T.; Khan, Z. Social innovation in emerging economies: A national systems of innovation based approach. *Technol. Forecast. Soc. Chang.* **2017**, *121*, 228–237.
5. Rieckmann, M. Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures* **2012**, *44*, 127–135.
6. Chin, A.; Jacobsson, T. TheGoals.org: Mobile global education on the Sustainable Development Goals. *J. Clean. Prod.* **2016**, *123*, 227–229.
7. International Telecommunication Union. *Final Acts of the Plenipotentiary Conference (Dubai, 2018): Decisions, Resolutions and Recommendation.* ITU Publications: Geneva, Switzerland, 2019.
8. Versteijlen, M.; Perez Salgado, F.; Janssen Groesbeek, M.; Counotte, A. Pros and cons of online education as a measure to reduce carbon emissions in higher education in the Netherlands. *Curr. Opin. Environ. Sustain.* **2017**, *28*, 80–89.
9. Bailey, G.; LaPoint, T. Comparing Greenhouse Gas Emissions across Texas Universities. *Sustainability* **2016**, *8*, 80.
10. Boyle, M.-E. Learning to Neighbor? Service-learning in Context. *J. Acad. Ethics* **2007**, *5*, 85–104.
11. M'Gonigle, R.M.; Starke, J. *Planet U : Sustaining the World, Reinventing the University*; New Society Publishers: Gabriola Island, Canada, 2006.
12. Barlett, P.F.; Chase, G.W. *Sustainability on Campus: Stories and Strategies for Change*; MIT Press: Cambridge, MA, USA, 2004.
13. Orr, D.W. *Earth in Mind: On Education, Environment, and the Human Prospect*; Island Press: Washington, DC, USA, 1994.
14. Leal Filho, W. Sustainability and University Life. *Int. J. Sustain. High. Educ.* 2000, 1–5, doi: 10.1108/ijshe.2000.24901aae.005.

15. Bowers, C.A. *University Reform in an Era of Global Warming and Other Essays*; Eco-Justice Press: Eugene, Oregon, USA, 2008.
16. Davis, G.; Wolski, M. E-waste and the sustainable organisation: Griffith University's approach to e-waste. *Int. J. Sustain. High. Educ.* **2009**, *10*, 21–32.
17. Beringer, A. The Lüneburg Sustainable University Project in international comparison. *Int. J. Sustain. High. Educ.* **2007**, *8*, 446–461.
18. Faulconer, E.K.; Gruss, A.B. A review to weigh the pros and cons of online, remote, and distance science laboratory experiences. *Int. Rev. Res. Open Distrib. Learn.* **2018**, *19*, 19.
19. Agency, E.P. Hazardous Waste Rules. Available online: https://www.epa.gov/rcra (accessed on 16 July 2019).
20. Rodríguez Baena, L. Accesibilidad y en la web y entornos de e-learning: La experiencia UNIR. In Proceedings of the Memorias del II Simposio Virtual Internacional TIC en la Educación y el Desarrollo Sostenible; Universidad de Manizales: Caldas, Colombia, 5–6 October, 2017; pp. 181–183.
21. Bates, T. *Managing Technological Change: Strategies for College and University Leaders*; Jossey-Bass: San Francisco, CA, USA, 2000.
22. Pearson, E.J.; Koppi, T. Inclusion and online learning opportunities: Designing for accessibility. *Res. Learn. Technol.* **2002**, *10*, 17–28.
23. Bezyrtzi, G.; Strachan, P.; Simpson, R.; Shanks, R. Estimation of the carbon footprint of student halls of residence in the University of Strathclyde. *WSEAS Trans. Environ. Dev.* **2006**, *2*, 1152–1156.
24. Stephens, J.C.; Graham, A.C. Toward an empirical research agenda for sustainability in higher education: Exploring the transition management framework. *J. Clean. Prod.* **2010**, *18*, 611–618.
25. Huang, Y.A.; Lenzen, M.; Weber, C.L.; Murray, J.; Matthews, H.S. The Role of input-output analysis for the screening of corporate carbon footprints. *Econ. Syst. Res.* **2009**, *21*, 217–242.
26. Townsend, J.; Barrett, J. Exploring the applications of carbon footprinting towards sustainability at a UK university: Reporting and decision making. *J. Clean. Prod.* **2015**, *107*, 164–176.
27. Su, C.H.; Cheng, T.W. A sustainability innovation experiential learning model for virtual reality chemistry laboratory: An empirical study with PLS-SEM and IPMA. *Sustainability* **2019**, *11*, 1027.
28. Johnson, L.; Adams, S.; Cummins, M. *Technology Outlook for Australian Tertiary Education 2012- 2017: An NMC Horizon Report Regional Analysis*. The New Media Consortium: Austin, Texas, USA, 2012.
29. Aleixo, A.M.; Leal, S.; Azeiteiro, U.M. Conceptualization of sustainable higher education institutions, roles, barriers, and challenges for sustainability: An exploratory study in Portugal. *J. Clean. Prod.* **2018**, *172*, 1664–1673.
30. Li, H.; Xu, Q.; Ge, H. Environmental engineering: Selected, peer reviewed papers. In Proceedings of the 3rd International Conference on Energy, Environment and Sustainable Development (EESD 2013), Shanghai, China, 12–13 November 2013.
31. Tsai, J.-H.; Tang, Y.-T. National Taipei University of Technology Development of Ecological Campus. In *Design for Innovative Value Towards a Sustainable Society*; Springer: Dordrecht, The Netherlands, 2012; pp. 1049–1054.
32. Orenstein, D.E.; Troupin, D.; Segal, E.; Jennifer, M.; Holzer, J.; Hakima-Koniak, G. Integrating ecological objectives in university campus strategic and spatial planning: A case study. *Int. J. Sustain. High. Educ.* **2019**, *20*, 190–213.
33. Alshuwaikhat, H.M.; Abubakar, I. An integrated approach to achieving campus sustainability: Assessment of the current campus environmental management practices. *J. Clean. Prod.* **2008**, *16*, 1777–1785.
34. Li, X.; Tan, H.; Rackes, A. Carbon footprint analysis of student behavior for a sustainable university campus in China. *J. Clean. Prod.* **2015**, *106*, 97–108.
35. Caird, S.; Lane, A.; Swithenby, E.; Roy, R.; Potter, S. Design of higher education teaching models and carbon impacts. *Int. J. Sustain. High. Educ.* **2015**, *16*, 96–111.
36. Larsen, H.N.; Pettersen, J.; Solli, C.; Hertwich, E.G. Investigating the Carbon Footprint of a University-The case of NTNU. *J. Clean. Prod.* **2013**, *48*, 39–47.
37. Letete,C.M.L.; Mungwe, N.W.; Guma, M.; Marquard, A. Carbon footprint of the University of Cape Town. *J. Energy South Afr.* **2011**, *22*, 2–12.
38. Ozawa-Meida, L.; Brockway, P.; Letten, K.; Davies, J.; Fleming, P. Measuring carbon performance in a UK University through a consumption-based carbon footprint: De Montfort University case study. *J. Clean. Prod.* **2013**, *56*, 185–198.

39. Utaraskul, T. Carbon Footprint of Environmental Science Students in Suan Sunandha Rajabhat University, Thailand. *Procedia-Soc. Behav. Sci.* **2015**, *197*, 1156–1160.
40. De Cesarei, A.; Baldaro, B. Doing online research involving university students with disabilities: Methodological issues. *Comput. Hum. Behav.* **2015**, *53*, 374–380.
41. Jara, C.A.; Candelas, F.A.; Torres, F. Virtual and remote laboratory for robotics e-learning. *Comput. Aided Chem. Eng.* **2008**, *25*, 1193–1198.
42. Vrăşmaş, T. Adults with Disabilities as Students at the University. *Procedia-Soc. Behav. Sci.* **2014**, *142*, 235–242.
43. Del Alamo, J. iLab: Remote Online Laboratories. Available online: http://icampus.mit.edu/projects/project/?pname=iLabs (accessed on 19 July 2019).
44. Ryan, J.; Struhs, J. University education for all? Barriers to full inclusion of students with disabilities in Australian universities. *Int. J. Incl. Educ.* **2004**, *8*, 73–90.
45. Douce, C. E-learning and disability in higher education. *Open Learn. J. Open. Distance e-Learn.* **2015**, *30*, 89–92.
46. Hashey, A.I.; Stahl, S. Making Online Learning Accessible for Students With Disabilities. *Teach. Except. Child.* **2014**, *46*, 70–78.
47. Schmetzke, A. Online distance education—"anytime, anywhere" but not for everyone. *Inf. Technol. Disabil.* **2006**, *7*, 1–22.
48. Burgstahler, S. Distance Learning: Universal Design, Universal Access. *AACE J.* **2002**, *10*, 32–61.
49. Burgstahler, S.; Corrigan, B.; McCarter, J. Making distance learning courses accessible to students and instructors with disabilities: A case study. *Internet High. Educ.* **2004**, *7*, 233–246.
50. Hricko, M. Understanding Section 508 and Its Implications for Distance Education. In *Design and Implementation of Web-Enabled Teaching Tools*; IGI Global: Hershey, PA, USA, 2011; pp. 25–46.
51. Szmukler, G. The UN Convention on the Rights of Persons with Disabilities: 'Rights, will and preferences' in relation to mental health disabilities. *Int. J. Law Psychiatry* **2017**, *54*, 90–97.
52. Kinash, S.; Crichton, S.; Kim-Rupnow, W.S. A Review of 2000-2003 Literature at the Intersection of Online Learning and Disability. *Am. J. Distance Educ.* **2004**, *18*, 5–19.
53. Opitz, C. Online Course Accessibility: A Call for Responsibility and Necessity. *AACE J.* **2002**, *10*, 81–105.
54. Burgstahler, S. The development of accessibility indicators for distance learning programs. *ALT-J.* **2006**, *14*, 79–102.
55. Moisey, S.D. Students with Disabilities in Distance Education: Characteristics, Course Enrollment and Completion, and Support Services. *J. Distance Educ. L'éducation Distancespring/Printemps* **2004**, *19*, 73–91.
56. Paist, E.H. Serving students with disabilities in distance education programs. *Am. J. Distance Educ.* **1995**, *9*, 61–70.
57. Horn, L.; Berktold, J. *Students with Disabilities in Postsecondary Education: A Profile of Preparation, Participation, and Outcomes*; DIANE Publishing: Washington, DC, USA, 1999.
58. Perales, M.; Pedraza, L.; Moreno-Ger, P. Work-In-Progress: Improving Online Higher Education with Virtual and Remote Labs. In Proceedings of the 2019 IEEE Global Engineering Education Conference (EDUCON), Dubai, UAE, 9–11 April 2019; pp. 1136–1139.
59. Potkonjak, V.; Gardner, M.; Callaghan, V.; Mattila, P.; Guetl, C.; Petrović, V.M.; Jovanović, K. Virtual laboratories for education in science, technology, and engineering: A review. *Comput. Educ.* **2016**, *95*, 309–327.
60. Orduna, P.; Rodriguez-Gil, L.; Garcia-Zubia, J.; Dziabenko, O.; Angulo, I.; Hernandez, U.; Azcuenaga, E. Classifying online laboratories: Reality, simulation, user perception and potential overlaps. In Proceedings of the 2016 13th International Conference on Remote Engineering and Virtual Instrumentation, REV, Madrid, Spain, 24–26 February 2016.
61. Tawfik, M.; Sancristobal, E.; Martin, S.; Gil, C.; Pesquera, A.; Losada, P.; Diaz, G.; Peire, J.; Castro, M.; García-Zubia, J.; et al. VISIR: Experiences and Challenges. *Int. J. Online Eng.* **2012**, *8*, 25–32.
62. Orduna, P.; Rodriguez-Gil, L.; Garcia-Zubia, J.; Angulo, I.; Hernandez, U.; Azcuenaga, E. LabsLand: A sharing economy platform to promote educational remote laboratories maintainability, sustainability and adoption. In Proceedings of the 2016 IEEE Frontiers in Education Conference (FIE), Erie, PA, USA, 12-15 October 2016; pp. 1–6.
63. Roy, R.; Potter, S.; Yarrow, K. Designing low carbon higher education systems. *Int. J. Sustain. High. Educ.* **2008**, *9*, 116–130.

64. Richmond, M.; Robinson, C.; Sachs-Israel, M. *The Global literacy challenge: a profile of youth and adult literacy at the mid-point of the United Nations Decade 2003-2012*; UNESCO: Paris, 2008.
65. Roberts, J.B.; Crittenden, L.A.; Crittenden, J.C. Students with disabilities and online learning: A cross-institutional study of perceived satisfaction with accessibility compliance and services. *Internet High. Educ.* **2011**, *14*, 242–250.