

Article

# Implementing Innovation on Environmental Sustainability at Universities Around the World

Walter Leal Filho <sup>1,2</sup>, Kay Emblen-Perry <sup>3</sup>, Petra Molthan-Hill <sup>4</sup>, Mark Mifsud <sup>5</sup>,  
Leendert Verhoef <sup>6</sup>, Ulisses Miranda Azeiteiro <sup>7</sup>, Paula Bacelar-Nicolau <sup>8,9</sup>,  
Luiza Olim de Sousa <sup>10</sup>, Paula Castro <sup>9</sup>, Ali Beynaghi <sup>11</sup>, Jennifer Boddy <sup>12</sup>,  
Amanda Lange Salvia <sup>1,13,\*</sup>, Fernanda Frankenberger <sup>14,15</sup> and Elizabeth Price <sup>2</sup>

- <sup>1</sup> European School of Sustainability Science and Research, Faculty of Life Sciences, Hamburg University of Applied Sciences, 21033 Hamburg, Germany
  - <sup>2</sup> School of Science and the Environment, Manchester Metropolitan University, Manchester M1 5GD, UK
  - <sup>3</sup> City Campus, University of Worcester Business School, Worcester WR1 3AS, UK
  - <sup>4</sup> Nottingham Business School, Nottingham Trent University, Nottingham NG1 4FQ, UK
  - <sup>5</sup> Centre for Environmental Education and Research, University of Malta, MSD 2080 Msida, Malta
  - <sup>6</sup> Program Lead Living Labs, Amsterdam Institute for Advanced Metropolitan Solutions, 1018 JA Amsterdam, The Netherlands
  - <sup>7</sup> Department of Biology & CESAM Centre for Environmental and Marine Studies, University of Aveiro, 3810-193 Aveiro, Portugal
  - <sup>8</sup> Department of Science and Technology, University of Alberta, 1269-001 Lisboa, Portugal
  - <sup>9</sup> Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, 3000-456 Coimbra, Portugal
  - <sup>10</sup> Department of Geography Education and Environmental Education, North-West University, Potchefstroom 2520, South Africa
  - <sup>11</sup> Office of Sustainability, Amirkabir University of Technology, Tehran 15875-4413, Iran
  - <sup>12</sup> Menzies Health Institute, School of Human Services and Social Work, Griffith University, Gold Coast QLD 422, Australia
  - <sup>13</sup> Graduate Program in Civil and Environmental Engineering, University of Passo Fundo, BR 285, São José Passo Fundo 99052-900, Brazil
  - <sup>14</sup> Business School PUCPR, Pontifical Catholic University of Paraná, 1155 Curitiba, Brazil
  - <sup>15</sup> Business School, Positivo University, 5300 Curitiba, Brazil
- \* Correspondence: amandasalvia@gmail.com

Received: 30 May 2019; Accepted: 5 July 2019; Published: 11 July 2019



**Abstract:** Innovation is known to be an important and influential factor in fostering sustainable development. Yet, there is a paucity of literature on the extent to which universities are successfully implementing innovation in this field. This paper addresses this gap, by examining the role of innovation in the field of environmental sustainability in universities, and by reporting on the results of an international study, in which examples of successful experiences and good practice were identified. The paper outlines the lessons learned from such examples, with the aim of motivating other universities to engage in this rapidly growing field.

**Keywords:** innovation change; experiences; good practice; innovation for sustainable development; higher education

## 1. Introduction

To achieve sustainability, innovation needs to be applied to emerging challenges. Innovation is commonly defined as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices workplace

organization or external relations” [1]. Additionally, sustainable innovation reflects innovation that “balances the long-term influences of the process and the output with the needs of people, societies, the economy and the environment” [2].

Innovations can not only change societal behaviours and environments, but also ensure that organisations, institutions, communities, and society as a whole can become more sustainable [3]. According to Dormann and Holliday [4], in a report for the World Business Council for Sustainable Development, innovation is fundamental for creating a sustainable human society and not focusing merely on more efficient approaches. Thus, radical and systemic innovations to products, services, and business models are needed [5,6].

Over the last decade, sustainability and the importance of sustainable development are increasingly acknowledged by academics, policy-makers and industry (e.g., [7,8]). This is due, in part, to current global environmental challenges, such as increasing extreme weather events [9], food and water shortages [10], degradation of ecosystems and biodiversity [11], and a widening gap between the rich and poor [12]. These global challenges were also discussed in the Global Environment Outlook (GEO)-6 [13], which highlighted the importance of innovation for transformative change.

UNESCO initiatives [14], the Halifax Declaration [15], the Talloires Declaration [16], and Europe’s independent Copernicus-Campus [17] are examples of schemes which show that higher education institutions (HEIs) have become conscious of their sustainability practices and performance among faculty, students, and the community. Many international strategies, declarations, and university commitments offer support to the implementation of sustainability in HEIs [18], but despite several political initiatives and the important role played by higher education for sustainable development, education for sustainable development is not yet very well widespread [19]. A call for greater collaboration in HEIs is thus necessary. Faculty and administrators, together with environmental practitioners, could develop interdisciplinary approaches to curricula, research initiatives, operations, and outreach activities that support an environmentally sustainable future [16].

In order to yield the expected benefits, sustainability in higher education requires whole-university approaches [20–22], yet its incorporation into HEI practices is often fragmented. More often than not, sustainability finds itself positioned in discipline-based sustainable development courses. Such initiatives are often not multidisciplinary nor transdisciplinary [23] and do not consider sustainable development in institutional policy [20] which could enhance innovation. The education taking place in HEIs is often not seen as a catalyst for innovation and social change aiming to create a sustainable society [24]. Yet, HEIs need to include education for sustainable development into broader activities so that they may pursue sustainability and create opportunities for innovation [25]. Innovations taking place at HEIs include emphasising the idea of campus well-being where activities that promote sustainability feature inter- and transdisciplinary approaches [22]. The freedom to design innovative transdisciplinary sustainable development-oriented content in HEIs is limited by elements such as accreditation procedures, institutional conditions that include disciplinary structure, the dependence on a few specific experts, and the financing of courses that mostly considers student interest (and attendance) in some disciplines [20].

Sustainability practices can be incorporated into the formal HEI curricula by offering students the opportunity to become leaders for change through the experience of contributing to change, also known as a curriculum and operational innovation [26]. Coursework that requires students to integrate knowledge across the boundaries of disciplines can lead to higher levels of transdisciplinarity and competence development. Initiatives which require students to integrate knowledge across the boundaries of disciplines may include provisions for initiatives within the organisation (e.g., on energy conservation, waste prevention or emissions reductions). Combined, these may feed into the whole institutional approach.

The promotion of Education for Sustainable Development (ESD) is taking place due to critical transition factors beginning with the acceptance of environmental principles, sustainable development perspectives through individual initiatives that policy-makers are aware of, new transdisciplinary

programs, networking, and whole-institution approaches that include practical green campus initiatives. Transdisciplinary initiatives, changes in teaching and learning processes, and innovation in the content of university curricula may then occur [20].

HEIs are often fragmented in their efforts, with little sign of holistic implementation [27] despite the call by UNESCO to move towards whole-university approaches. The shift needed is in organisational culture, including developments in sustainability practices in teaching and learning, research, community engagement [20,22,28], and campus management. Leadership is fundamental to the integration of sustainability in HEIs maintaining consistency, collaboration, and systemic approaches to management [29]. However, university management may not appreciate the importance of innovation and sustainability with regard to addressing social and economic inequalities throughout the university [30]. Many universities work towards securing funding that allows for research outputs and they may not take the social and environmental aspects of sustainability into consideration [20]. The latter issue is the focus of this paper.

The engagement of all members of the university, especially, but not only, senior administration is crucial in order to ensure top-down and bottom-up support [22,30]. Those managers with a sustainability vision need to also allow innovation to emerge bottom-up. Communication between stakeholders both on and off campus is essential to the success of HEI sustainability initiatives. HEIs that showcase innovative examples of sustainability stimulate innovative potential and become a testing field for change. HEIs should move toward collaborative development of knowledge and initiate dialogue in their respective communities. This collaboration will project the HEI's vision and put forward its ethical position. HEIs can then become an example of sustainability in society [22]. Adjustments to academic priorities, organisational structures, financial and audit systems, advanced strategic integration, staff development, collaborative partnerships and dialogue amongst stakeholders are required for HEIs to become learning organisations that progress sustainability [31] and do justice to the environmental potential of sustainability practices.

Strategies to advance innovation in sustainability in HEIs as a whole, and on environmental sustainability in particular, have many obstacles and challenges. Some of the main barriers to innovation and sustainability at HEIs are associated with management [30]. Other barriers are identified as: resistance to change; lack of support from institutional administrators [32]; lack of specific working groups, committees and sustainability offices; cultural and behavioural change; lack of financial resources; lack of engagement between municipalities, companies and universities; lack of reporting and accountability mechanisms; and institutional culture [30].

Other authors have focused on eco-social innovation connected to sustainability in higher education and explored how to apply these new forms of learning [33]; this paper is interested in examining the role of innovation in the field of environmental sustainability and reports on the results of an international study, in the context of which examples of successful experiences and good practice are identified. The paper outlines the lessons learned from such examples, with the aim of motivating other universities to engage in this rapidly growing field.

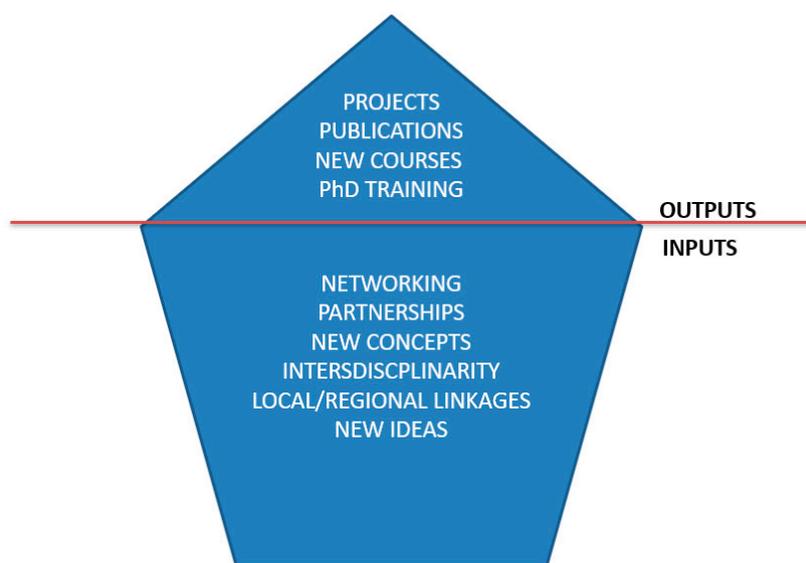
## 2. State of the Art: Innovation and Sustainability at Universities Today

Innovation in sustainability must be grounded in research and knowledge generation. Consequently, universities have a role to play in finding solutions to sustainability problems [34]. While universities might be aware of how research can contribute to sustainable innovation, the role of the student population in finding social, economic, legislative, and technological innovations to help address what are sometimes known as contemporary 'wicked problems', is less understood [2].

Innovation in sustainability on campuses can be in respect to operations, education, and/or (the impact of) research. Verhoef and Bossert [35] state that "For many university operations departments, changing to sustainability and/or circularity principles is (very) new and requires (big) changes". The authors highlight that this process may take some time and requires innovative efforts, such as the

use of ambitious standards for buildings in order to contribute to CO<sup>2</sup> reduction targets and circular systems, for example.

Living labs, another approach to innovation, are well suited for ‘wicked’ multi-stakeholder problems or solutions. They build on three cornerstones: learning integral elements in the projects, involvement of users, and innovation as a goal. A systematic organisational and management approach to urban living labs was recently published by Steen and van Bueren [36] and for household-related living labs by Keyson et al. [37]. At a university campus, the unique possibility exists to have researchers deploy their findings on their own premises, and for students to be both experimenters and users of the services provided, thus enriching their learning. Combining research, education, and campus operations in the form of living labs has been discussed in various international sustainable university workshops (e.g., International Sustainable Campus Network -ISCN 2017, Hamburg Sustainable Development Summit—HSDS 2017). Approaches employing living labs at universities are also emerging, leading to frameworks for living labs for sustainability on campuses [38]; successful examples, amongst others, are at Delft University of Technology [39], Eidgenössische Technische Hochschule Zürich [40], and the European School of Sustainability Science and Research (ESSSR) in Hamburg. A recent book produced by a team led by the ESSSR also handled this topic [41] and explored the connection with the Sustainable Development Goals. The ESSSR pays a special emphasis to innovation and Figure 1 explores the various innovation dimensions of its works.



**Figure 1.** Innovation dimensions of the European School of Sustainability Science and Research (ESSSR) works.

Universities have a responsibility to not only drive innovation, but also role model the use of innovative technologies that promote sustainability as a whole, and environmental sustainability in particular. Their role as education institutions allows universities to teach students about the importance of sustainability [42,43] and modern and socially relevant themes such as climate change mitigation tools and techniques [44], while providing opportunities for students to explore innovative solutions to environmental degradation [45]. Thus, by making use of sustainable innovations, universities can potentially instil values that are grounded in environmental sustainability at local, national, and international levels [46]. This is significant given the fact that many decision makers in communities, organisations and politics are university graduates who work across multiple sectors, thus generating flow-on effects on sustainability [47].

Finally, many universities also own large estates where the potential for environmental improvements is significant. The potential alone for carbon savings is significant, estimated at 0.7 Gton/yr equivalent to approx. 1.5% of global CO<sub>2</sub> emissions in a recent publication [35,48]. In addition, innovative solutions implemented by one university and then shared with the sector might have the potential to contribute to carbon savings and other positive impacts on social, environmental, and economic sustainability. The Green Gown Awards in the UK are such an example. They started in the UK in 2004 and moved to Europe in 2006 and Australasia in 2010. They involve universities competing for awards linking campus and curriculum innovations, and through the award process they promote examples of good sustainable practices [49].

### **3. Methodology: A Survey of Innovation and Sustainability at Universities**

#### *3.1. Survey Design*

In order to address the research question: “To what extent are universities using innovation as a tool to implement sustainability?” and fill in the research gap on specific information about the implementation of innovation and sustainability at universities around the world, a questionnaire survey was undertaken. The aim of the survey was to understand whether and how universities innovate with regards to environmental issues. This was based on the assumption and definition given above that innovation in relation to sustainable development is strongly linked to improved products, processes, and services. When it comes to the context of universities, the focus of our study, the survey aimed to portray the opinions and realities at different institutions with regard to their outlook of innovation and sustainability in addition to associated attitudes, practices, and beliefs. The first list of items was reviewed by the authors to minimize redundancies and similar items and to ensure that all important questions were added. The questionnaire survey was pre-tested by a panel of academics within sustainability areas at different universities, as already performed by other studies [50]. The survey instrument was composed of 20 questions (15 closed questions and 5 open questions) and structured in a way that it could gather information on the universities’ experiences. Table 1 presents the topics and issues covered in the questionnaire.

**Table 1.** Summary of the topics and issues covered by the questionnaire survey.

Area	Topic	Assessed Issues	Options
General	Sociodemographic characteristics of the respondent and university	Country, region, role	–
Sustainability	University's participation in awareness-raising activities	My university participates in awareness-raising activities and assists with distributing information and advice.	Strongly disagree, Disagree, Do not know, Agree, Strongly agree
	Environmental sustainability team and environmental sustainability policy	My university has an environmental sustainability team who raise awareness of environmental sustainability across the organisation. My university has an environmental sustainability policy.	
	Importance given to programme development to achieve the commitments of its environmental sustainability policy and plan	My university participates in program development and in implementing ideas to achieve the commitments of its environmental sustainability policy and plan.	
	Actions planned to demonstrate the commitment to reduce the university's environmental footprint and to improve the environmental performance	My university has planned its actions for the next three years to demonstrate its commitment to reducing the university's environmental footprint and seeking to continually improve its environmental performance.	
	Promotion of waste, energy, and water management and the benefits of active travel	My university promotes improved waste, energy, and water management and the benefits of active travel.	
	Carbon reduction targets at the university	My university contributes in its operation to achieve the carbon reduction targets set by the government.	
Innovation	Education of students about the impact of climate change	My university educates its students about the impact of climate change on the discipline chosen by the student.	university-wide, faculty, department, support services, other new buildings, renovations, mobility, services, other technological, organisational, educational, financial, other living lab tools, technology readiness levels (TRLs), research and development (R&D) management, adoption theories, other BREEAM, WELL, ISO14000, in-house standard, other
	Scope of last/current project of innovation and the objectives involved in the project	What scale is the scope of your current or last project/programme? What objectives were involved in this project?	
	Innovation implemented in the program and how the innovation was managed	What kind of innovation was implemented? How did you manage/organise innovation?	
	Standards used to reach a better performance	Which standards were used to come to new/better performance?	
	Open questions	Description of the most successful project/program on innovation and sustainability, their nature, innovative aspects, benefits, challenges/problems and publication of results.	–

The online survey was carried out from 28 September to 4 December 2017 using SurveyMonkey.

### 3.2. Sampling

The survey was disseminated via a web link through email to the following groups, based on Leal Filho et al. [50]: rectors and office managers of a wide range of universities, including those which participated in the Green Sustainability Metrics 2016; authors of publications on the subject “sustainability at universities” in the Web of Science between 2007–2016; participants in the World Symposium on Sustainable Development at Universities, held in September 2016 at the Massachusetts Institute Technology in the United States of America; rectors of Brazilian federal public universities; rectors of Portuguese public universities; representatives of universities (rector, sustainability office manager, researcher/teacher) participating in the Inter-University Program for Sustainable Development Research (IUSDRP); representatives of the universities participating in the Copernicus Alliance; rectors and managers of the sustainability office of the universities participating in the Association for the Advancement of Sustainability in Higher Education (AACHE). Approximately 1000 people were contacted in 40 countries (distributed approximately as follows: 40% in Europe, 30% in Asia/Oceania, 15% in Africa, 10% in South America, and 5% in North America). Responses were obtained from 73 universities in 17 countries, spread among all continents. The validity of the data was assured since it derived from bona fide academic institutions and was supplied by well-informed sources. The reliability of data was also assured, since those who replied are very familiar with the concept of sustainability and have an understanding of the emphasis to this topic in their own institutions. The same data can be verified in a few years’ time, which is also a characteristic of valid studies.

There are two main limitations with this approach: firstly, the answers derived from people who are motivated and knowledgeable enough to reply, so many others were not included. Secondly, only 17 countries took part and the spread of the responses does not allow conclusions to be drawn about the implications of the work to different geographical regions. On the other hand, a study on innovation on matters related to sustainable development in 17 countries is so far unparalleled in the literature, hence adding a degree of innovation and new insights into this key topic.

### 3.3. Data Analysis

A total of 73 responses were received and analysed. The numerical data collected were analysed using SPSS 23<sup>®</sup> (IBM, NY, USA) in order to perform descriptive statistics. The five open-ended questions were analysed through content analysis [51], allowing (i) development of a classification of the answers in unit categories, and (ii) integration of categories and their meaning, to provide data interpretations.

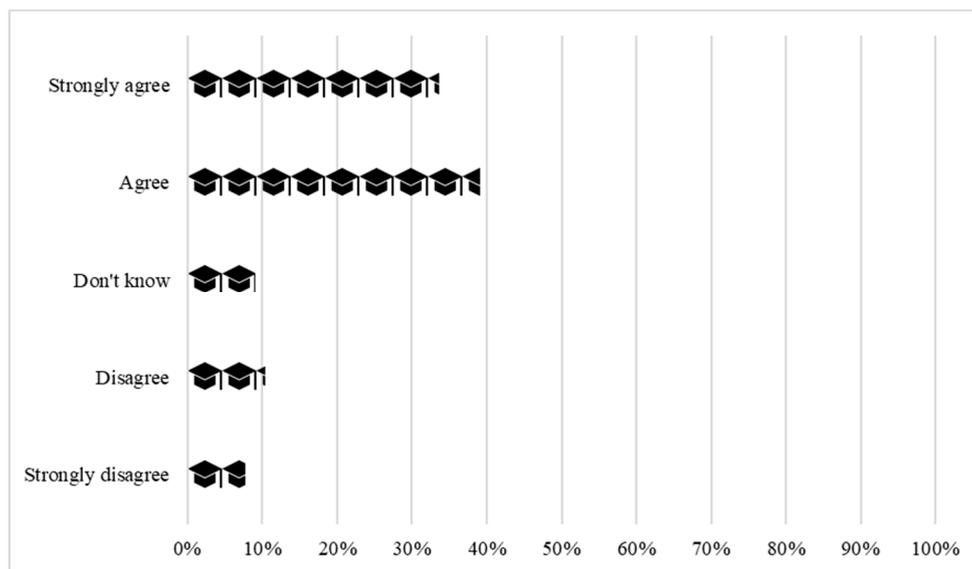
## 4. Results and Discussion

Most of the questionnaire’s respondents were from European universities (47%). North American, South American, African, and Asian universities were represented by 10–16% of the respondents and Australasian were only 1%. Figure 2 shows the countries represented in the study.

The respondents were mostly lecturers (37%) and researchers (26%), a few were sustainability officers (16%), and a minor proportion were operation managers (3%), university board members (3%), and procurement officers (1%). A minor number of students (4%) also responded to the questionnaire, as well as “other respondents” (10%).

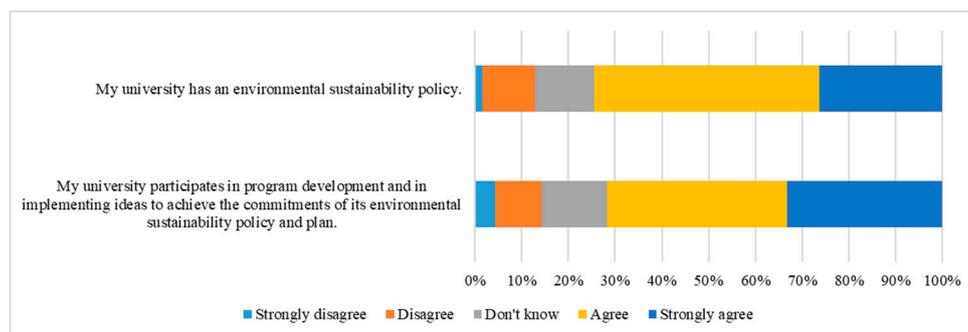


The next step to raise awareness of environmental sustainability across the organization is to have an environmental sustainability team. A total of 73% of respondents strongly agree or agree that their university has such a team contributing to the university involvement. Figure 4 presents all answers for this question. One example of an innovative approach related to the sustainability team is the Green Office Model [54] which empowers not only staff, but also students and academics.



**Figure 4.** Comparison between university responses in relation to environmental sustainability team (percentage of respondents, N = 73).

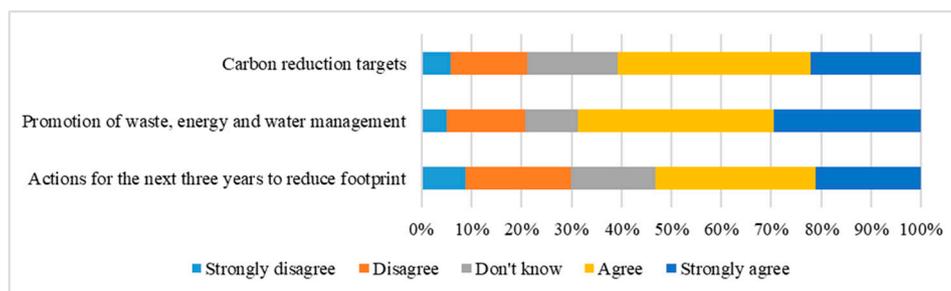
Communication is an important part of university involvement for innovation and sustainability. The inclusion of such topics in the environmental sustainability policy drives the strategy, which roots sustainability in the core of the university. In this matter, 75% of the respondents strongly agree or agree that the university has an environmental sustainability policy, while 72% strongly agree or agree that the university participates in program development and implementing ideas to achieve the commitments of its environmental sustainability policy and plan. These two questions refer to communication of environmental sustainability and innovation, and Figure 5 shows their outcomes. It is important to highlight, however, that these policies cannot be totally regarded as preconditions for universities to engage on sustainability issues [55], but they may support the process of management of resources and support innovation.



**Figure 5.** Comparison between university responses in relation to environmental sustainability policy (percentage of respondents, N = 73).

#### 4.1.2. Operations

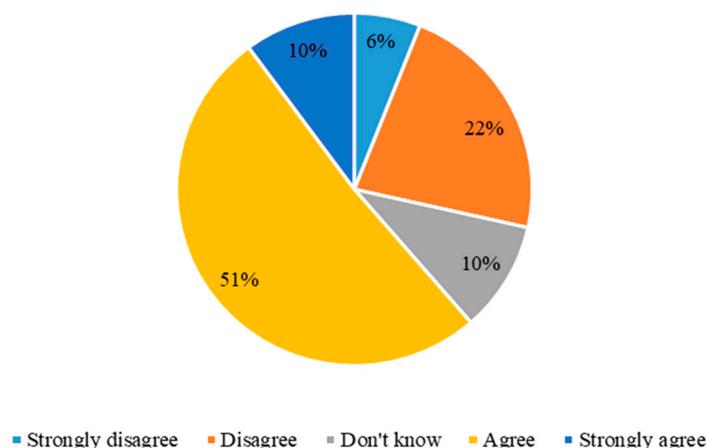
Working for environmental sustainability is commonly related to the operations on campus. In this sense, three questions were proposed in order to identify how the university is working with campus operations for sustainability. In total, 69% of responses (strongly agree or agree) indicated that the university promotes improved waste, energy, and water management and the benefits of active travel; 61% of all responses (strongly agree or agree) informed that the university contributes in its operation to achieve the carbon reduction targets set by the government. These results show that the universities are aware of the importance of investing in campus operations in the short term and reinforce the attention paid by many universities especially in issues related to energy, waste, water, and climate action [56,57]. In the longer term, 53% of responses (strongly agree or agree) indicated that the university has planned its actions for the next three years to demonstrate its commitment to reducing the university's environmental footprint and seeking to continually improve its environmental performance. Even though this last result is lower than the first two, it still shows a good direction in favour of sustainability. All results of these questions are shown in Figure 6.



**Figure 6.** Comparison between university responses in relation to campus operations (percentage of respondents, N = 73).

#### 4.1.3. Student Involvement

As the university promotes sustainability through internal communication and campus operations, students want to be involved and participate in sustainability practices, which highlights the importance of the campus as a living laboratory [38]. In order to verify this topic, the respondents were asked if the university educates its students about the impact of climate change on the discipline chosen by the student. Although 61% answered they strongly agree or agree with this question, still 22% disagree with it. It shows that the student involvement is lacking attention regarding environmental sustainability. Figure 7 presents these results.



**Figure 7.** Comparison between university responses in relation to student's involvement (percentage of respondents, N = 73).

#### 4.2. Innovation

The development of projects and/or programmes with specific sustainability aims and outcomes represents a way to influence the university, their students, and operations towards sustainability and innovation.

Regarding the current or last project/programme in which the respondents were involved, most of these were implemented at the university-wide level (45%) and faculty level (10%), while fewer were at the departmental and support services' level (16% and 12%, respectively). Still, nearly one-fifth of the respondents (17%) were involved in projects/programmes identified as "other" level, mainly involving links to society (local administration, private sector, community and social networks outside the university campus). This is in line with the key points presented by Müller-Christ et al. [22], regarding the importance of universities having society-wide dialogue with other key players and thinking beyond their physical boundaries to provide transferable models for the surrounding community.

The main issues involved in these projects/programmes were services and new buildings (31% and 18%, respectively), while renovations of existing buildings and mobility issues accounted for lesser importance (9% and 6%, respectively). The greatest proportion of objectives in these projects/programmes (37%) was identified as "other". These innovations were mostly of an educational (34%), technological (29%), and organisational nature (19%). Some of the implemented innovations were also identified as financial (4%) and of "other" categories (13%).

Specifically, the innovative aspects which were implemented via these projects/programmes were identified as living lab tools (13%), adoption of theory (18%), research and development management (15%), and technology readiness levels (TRLs) (2%). However, most of the innovative aspects were not identified through the questionnaire (53%), which suggests that innovation can be practiced, but may not be perceived as such.

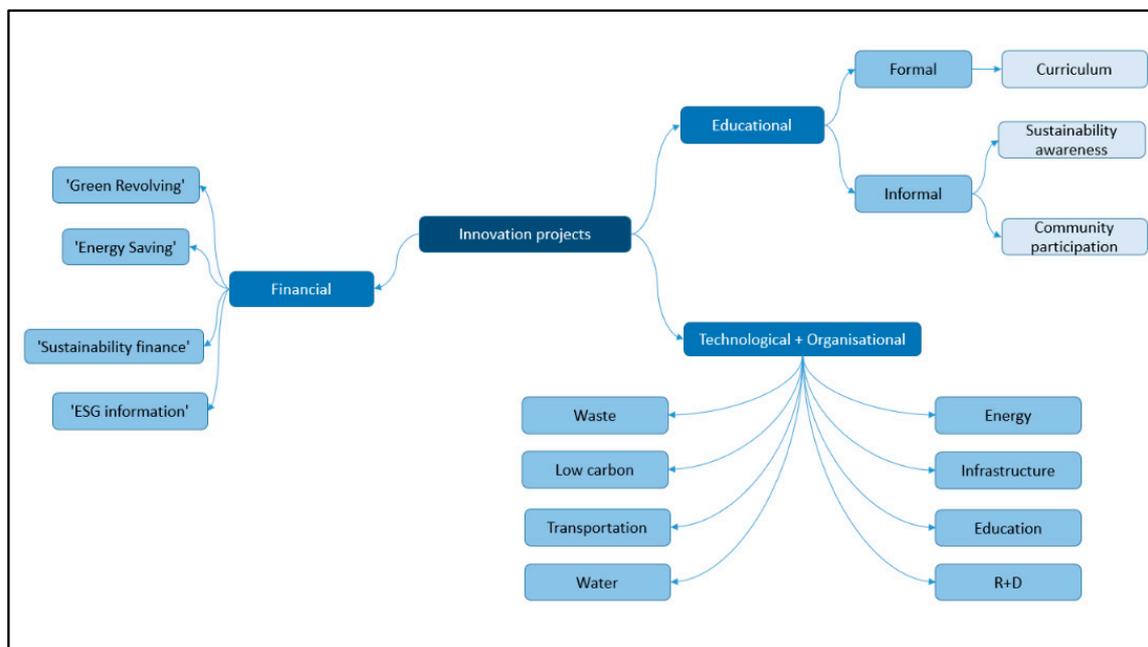
Standards used in the projects/programmes to attain new or better performances and promote innovation were mainly "in house standards" (35%) and ISO 14,000 (18%); BREEAM and WELL standards were also identified in fewer cases (8% and 3%, respectively). In most cases, however, the project/programme standards were identified as "Other" by the respondents (43%).

Descriptions of the most successful innovation and sustainability projects/programmes that respondents were currently implementing (open-ended questions), enabled a more in-depth understanding of these projects, their nature, and their innovative aspects.

Educational projects were subdivided into formal education at university (18%, mainly relating to curriculum) and informal education (i.e., sustainability awareness and community participation projects, 13% and 6%, respectively). This latter category appeared with a strong emphasis, on projects involving local schools, museums, tourism organisations, local administration or business/private sector (on issues such as waste, energy, water, resources, low carbon, transport and mobility). Also, projects within the categories of research and development, and environmental management research (mostly related to waste, energy resources and low carbon, but also to a lesser extent related to food waste, water and risk) were identified as the most successful ones (10% and 13% of the respondents, respectively).

Projects on financial innovation were related to dedicated funds such as "Green revolving" and "Energy saving", or to "Sustainable finance and ESG (Environmental, Social and Governance) information". It was also noticeable that the organisational and technological programmes mentioned were mostly complex and transversal to various sustainability aspects of the university campuses, such as waste (e.g., "implementation of institutional and standardised waste reduction strategies, covering technological, behavioural and organisational issues"), water (e.g., "WaterHub that purifies over 40% of the university waste water"), energy (e.g., Energy neutral buildings), low carbon (e.g., low to zero carbon emissions), infrastructures (e.g., green buildings) transport, research and development (R&D), and education (formal and informal). Some of these sustainability aspects were certified by a variety of standards. On one organisational programme, the aim was the development of collaborative communities in the university management: "a collaborative management system for the university

should allow transversal issues as innovation, sustainability, equity, inclusion or so to be developed and implemented easier in the whole university" (...); "this is focusing at the (invisible) core of a sustainable organisation." An overview of the main projects related to innovation are in Figure 8.



**Figure 8.** Overview of innovation projects based on university responses.

When asked which benefits were obtained from the most successful projects/programmes, the most evident dimensions reported were, again, increased awareness of environmental and sustainability issues (18%) and training on environmental and sustainability issues (13%), which endorses the answers obtained in relation to university and student's involvement [42,43]. The importance of societal networking and of community engagement (external and internal to campus, with governance issues included) were also pointed as major benefits (17% and 6%, respectively). Innovative research on sustainability topics and natural resources conservation, low carbon emissions, and waste reduction were informed as project benefits by, respectively, 11%, 5%, and 4% of the respondents. Although the respondents indicated previously that universities promote waste, energy, and water management (72%), innovation is still not so strongly applied in practice. Financial benefits were identified, such as operational cost reduction and institutional marketing and student enrolment (11%). Social benefits of the involved communities (e.g., charities, Non-Governmental Organisations) were reported by a few respondents (4%), which may indicate that the potential for contributing to sustainability at local, national, and international levels [46] is not being sufficiently realised.

Most problems found in the implementation of these successful projects were of a motivational nature (37%; mainly due to cultural differences, participation on a voluntary basis, and time constraints of individuals, either for students, university staff or other partners) as well as financial (30%) and governance and organisational nature (20%; mainly due to communication between organisations and decision instances, as well as other staff of the faculty or department; and also bureaucratic procedure hinders), aligned with the findings presented by Ávila et al. [30]. These challenges are to a greater or lesser extent connected to barriers to organisational change towards sustainable development in higher education, which include lack of explicit funding flows between organisations [58] and departmentalism, conservative management, stakeholders' involvement and lack of interdisciplinarity [59]. Technological and R&D limitations were reported by a minority (7%) and also a minority reported no limitations in the implementation of their projects (7%).

Finally, 69% of the respondents stated that they have published their project results in peer reviewed scientific journals, but 31% did not do so (some expressing that their project had just started). This suggests that projects related to sustainability and innovation are mainly focused on research for publication, and not necessary only related to benefits to the university. In this way, more support for research in sustainability and innovation could bring higher benefits for the university without it having to have a specific organisation (i.e., a centre) to act in these fields.

## 5. Conclusions

This paper has analysed some examples of how innovation in a sustainable development context is being practiced in a group of universities from different countries, and presented some factors that tend to contribute to the relation between innovation and sustainability in HEIs.

The innovative nature of this study lies in the fact that it tried to relate perceptions on the role of innovation as it related to sustainable development, with the ways in which sustainability is practiced. One limitation of the study is that it refers to responses obtained from a set of 73 universities and, as such, it cannot be regarded as comprehensive. However, bearing in mind that the sample encompassed higher education institutions from European universities, North America, South America, Africa, and Asia/Australasia, it enables a profile to be built of the extent to which innovation and sustainability are perceived across the sample.

The study presented a diversity of innovation projects in connection to institutional attitudes, practices, and beliefs. This explains, for instance, why many universities have systematically designed and implemented sustainability policies, whereas others have not. Also, innovative aspects implemented by means of specific projects/programmes take place by means of living lab tools (e.g., green offices demonstrating sustainability in practice), the adoption of theories such as the organisational programme identified in one of the surveyed universities (whose aim was the development of collaborative communities in the university management), by means of research (including research on sustainability innovation per se) or by deploying project management technology readiness levels (TRLs) much like the European School of Sustainability Science and Research, which led the research.

The study has a limitation in the sense that the answers derive only from people who are motivated and knowledgeable enough to reply. Also, with 17 countries only, it does not allow definitive conclusions about the implications of the work to different geographical regions. On the other hand, the sample is robust enough to allow a profile to be built, on the extent to which innovation on matters related to sustainable development are perceived and being pursued, providing new insights into this key topic.

The implications of this paper are two-fold. Firstly, it shows that in order to become more conspicuous, innovation should be more often applied with a view to handling sustainability challenges. This means going over and above and tackling issues of a motivational, financial, and organisational nature. In this sense, more beneficial outcomes can be reached, as awareness on environmental and sustainability issues increases, which may lead to actual changes in attitudes and behaviours.

Secondly, innovation needs to be perceived as creating value for stakeholders, so that they may become more aware of its potential. It is clear from the study that the potential for improvements is significant and that universities should endeavour to take greater advantage of innovation not only with a view to pursue sustainability objectives, but to also ensure that their surrounding communities and society can become more sustainable. Here, systemic innovation can play an important role.

**Author Contributions:** Conceptualization, W.L.F.; writing—original draft preparation, K.E.-P., M.M., L.V., U.M.A., P.B.-N., L.O.d.S., P.C., A.B., J.B.; writing—review and editing, P.M.-H., A.L.S, F.F., E.P.; supervision, W.L.F.

**Funding:** This research received no external funding but was supported by the European School of Sustainability Science and Research.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## References

1. OECD/Eurostat. *Oslo Manual, Guidelines for Collecting and Interpreting Innovation Data*; OECD Publishing: Paris, France, 2005.
2. Hautamäki, A.; Oksanen, K. Sustainable innovation: Solving wicked problems through innovation. In *Open Innovation: A Multifaceted Perspective*; Mention, A.-L., Torkkeli, M., Eds.; World Scientific Publishing Company: Singapore, 2016; pp. 87–110.
3. Silvestre, B.S. A hard nut to crack! Implementing supply chain sustainability in an emerging economy. *J. Clean. Prod.* **2015**, *96*, 171–181. [[CrossRef](#)]
4. Dormann, J.; Holliday, C. *Innovation, Technology, Sustainability and Society*; World Business Council for Sustainable Development: Geneva, Switzerland, 2002; Available online: <http://www.bvsde.paho.org/bvsacd/cd30/society.pdf> (accessed on 30 October 2017).
5. Boons, F.; Montalvo, C.; Quist, J.; Wagner, M. Sustainable innovation, business models and economic performance: An overview. *J. Clean. Prod.* **2013**, *45*, 1–8. [[CrossRef](#)]
6. Seebode, D.; Jeanrenaud, S.; Bessant, J. Managing innovation for sustainability. *RD Manag.* **2012**, *42*, 195–206. [[CrossRef](#)]
7. United Nations. Sustainable Development. Available online: <https://www.un.org/ecosoc/en/sustainable-development> (accessed on 30 October 2017).
8. European Union. Report on the EU and the Global Development Framework after 2015. European Union. Committee on Development. Available online: <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-/EP//TEXT+REPORT+A8-2014-0037+0+DOC+XML+V0//EN> (accessed on 30 October 2017).
9. Lubchenco, J.; Karl, T.R. Predicting and managing extreme weather events. *Phys. Today* **2012**, *65*, 31–37. [[CrossRef](#)]
10. Hsiang, S.M.; Keng, K.C.; Cane, M.A. Civil conflicts are associated with the global climate. *Nature* **2011**, *476*, 438–441. [[CrossRef](#)] [[PubMed](#)]
11. McManus, B. An integral framework for permaculture. *J. Sustain. Dev.* **2010**, *3*, 162–174. [[CrossRef](#)]
12. Nolan, B.; Salverda, W.; Checchi, D.; Marx, I.; McKnight, A.; Tóth, I.G.; Van de Werfhorst, H.G. *Changing Inequalities and Societal Impacts in Rich Countries: Thirty Countries' Experiences*; Oxford University Press: Oxford, UK, 2014; p. 784.
13. UN Environment. *Global Environment Outlook GEO-6: Healthy Planet, Healthy People*; Cambridge University Press: Cambridge, UK, 2019; Available online: <https://www.unenvironment.org/resources/global-environment-outlook-6> (accessed on 18 June 2019).
14. United Nations. Conference on Environment and Development: Agenda 21, 1992. Available online: <https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf> (accessed on 20 May 2019).
15. Halifax Declaration. Creating a Common Future, 1991. Available online: [www.iau-aiu.net/content/rtf/sd\\_dhalifax.rtf](http://www.iau-aiu.net/content/rtf/sd_dhalifax.rtf) (accessed on 20 May 2019).
16. ULSF-University Leaders for a Sustainable Future. The Talloires Declaration 10 Point Action Plan, 2015. Available online: <http://ulsf.org/wp-content/uploads/2015/06/TD.pdf> (accessed on 20 May 2019).
17. COPERNICUS-CAMPUS. Education for Sustainable Development, 2012. Available online: [http://webarchive.unesco.org/20161026153813/http://portal.unesco.org/education/en/ev.php-URL\\_ID=34756&URL\\_DO=DO\\_TOPIC&URL\\_SECTION=201.html](http://webarchive.unesco.org/20161026153813/http://portal.unesco.org/education/en/ev.php-URL_ID=34756&URL_DO=DO_TOPIC&URL_SECTION=201.html) (accessed on 28 May 2019).
18. Holm, T.; Sammalisto, K.; Grindsted, T.S.; Vuorisalo, T. Process framework for identifying sustainability aspects in university curricula and integrating education for sustainable development. *J. Clean. Prod.* **2015**, *106*, 164–174. [[CrossRef](#)]
19. Michelsen, G. Policy, politics and polity in higher education for sustainable development. In *Handbook of Higher Education for Sustainable Development*; Barth, M., Michelsen, G., Rieckmann, M., Thomas, I., Eds.; Routledge: London, UK, 2016; pp. 40–55.
20. Dlouhá, J.; Glavič, P.; Barton, A. Higher education in Central European countries-Critical factors for sustainability transition. *J. Clean. Prod.* **2017**, *151*, 670–684. [[CrossRef](#)]
21. Hancock, L.; Nuttman, S. Engaging higher education institutions in the challenge of sustainability: Sustainable transport as a catalyst for action. *J. Clean. Prod.* **2014**, *62*, 62–71. [[CrossRef](#)]

22. Müller-Christ, G.; Sterling, S.; Van Dam-Mieras, R.; Adomßent, M.; Fischer, D.; Rieckmann, M. The role of campus, curriculum, and community in higher education for sustainable development—A conference report. *J. Clean. Prod.* **2014**, *62*, 134–137. [[CrossRef](#)]
23. Scholz, R. *Environmental Literacy in Science and Society*; Cambridge University Press: Cambridge, UK, 2011; p. 656.
24. Sterling, S.; Maxley, L.; Luna, H. *The Sustainable University: Progress and Prospects*; Abingdon: Routledge, UK, 2013; p. 334.
25. Winter, J.; Cotton, D.; Warwick, P. The university as site of socialisation for sustainability education. In *Teaching Education for Sustainable Development at University Level*; Leal Filho, W., Ed.; Springer: Cham, Switzerland, 2016.
26. Chalmers, D.P.; Walker, C.; Williams, K.; Rayner, J.; Farrell, C.; Butt, A.; Rostan-Herbert, D. Engaging students with environmental sustainability at a research intensive university: Examples of small successes. In *Teaching Education for Sustainable Development at University Level*; Leal Filho, W., Pace, P., Eds.; Springer: Cham, Switzerland, 2016.
27. Lozano, R.; Ceulemans, K.; Alonso-Almeida, M.; Huisingh, D.; Lozano, F.J.; Waas, T.; Lambrechts, W.; Lukman, R.; Hugé, J. A review of commitment and implementation of sustainable development in higher education: Results from a worldwide survey. *J. Clean. Prod.* **2015**, *108*, 1–18. [[CrossRef](#)]
28. Thomas, I. Challenges for implementation of education for sustainable development in higher education institutions. In *Routledge Handbook of Higher Education for Sustainable Development*; Barth, M., Michelsen, G., Rieckmann, M., Thomas, I., Eds.; London: Routledge, UK, 2016; pp. 56–71.
29. Buckler, C.; Creech, H. *Shaping the Future We Want: UN Decade of Education for Sustainable Development; Final Report*; UNESCO: Paris, France, 2014; Available online: <https://unesdoc.unesco.org/ark:/48223/pf0000230171> (accessed on 20 May 2019).
30. Ávila, L.V.; Leal Filho, W.; Brandli, L.; Macgregor, C.J.; Molthan-Hill, P.; Özuyar, P.G.; Moreira, R.M. Barriers to innovation and sustainability at universities around the World. *J. Clean. Prod.* **2017**, *164*, 1268–1278. [[CrossRef](#)]
31. Ryan, A.; Tilbury, D.; Corcoran, P.B.; Abe, O.; Nomura, K. Sustainability in Higher education in the Asia-Pacific: Developments, challenges and prospects. *Int. J. Sustain. High. Educ.* **2010**, *11*, 106–119. [[CrossRef](#)]
32. Larrán Jorge, M.; Herrera Madueño, J.; Calzado Cejas, M.Y.; Andrades Peña, F.J. An approach to the implementation of sustainability practices in Spanish universities. *J. Clean. Prod.* **2015**, *106*, 34–44. [[CrossRef](#)]
33. Wals, A.E.; Tassone, V.C.; Hampson, G.P.; Reams, J. Learning for walking the change: Eco-social innovation through sustainability-oriented higher education. In *Routledge Handbook of Higher Education for Sustainable Development*; Barth, M., Michelsen, G., Rieckmann, M., Thomas, I., Eds.; London: Routledge, UK, 2016; pp. 25–39.
34. Hart, D.D.; Bell, K.P.; Lindenfeld, L.A.; Jain, S.; Johnson, T.R.; Ranco, D.; McGill, B. Strengthening the role of universities in addressing sustainability challenges: The Mitchell Center for Sustainability Solutions as an institutional experiment. *Ecol. Soc.* **2015**, *20*, 1–18. [[CrossRef](#)]
35. Verhoef, L.A.; Bossert, M. *The University Campus as Living Lab for Sustainability—A Practitioners Guide and Handbook*; TU Delft: Delft, The Netherlands; Fachhochschule fur Technik Stuttgart: Stuttgart, Germany, 2019; ISBN 978-3-940670-68-7.
36. Steen, K.Y.G.; Van Bueren, E.M. *Urban Living Labs: A Living Lab Way of Working AMS Research Report*; AMS Institute: Amsterdam, The Netherlands, 2017; Available online: <https://www.ams-amsterdam.com/wordpress/wp-content/uploads/AMS-Living-Lab-Way-of-Work-print.pdf> (accessed on 25 May 2019).
37. Keyson, D.V.; Guerra-Santin, O.; Lockton, D. *Living Labs: Design and Assessment of Sustainable Living*; Springer: Cham, Switzerland, 2016. [[CrossRef](#)]
38. Verhoef, L.A.; Bossert, M.; Newman, J.; Ferraz, F.; Robinson, Z.P.; Agarwala, Y.; Wolff, P., III; Jiranek, P.; Hellinga, C. Towards a learning system for University Campuses as Living Labs for sustainability. In *Universities as Living Labs for Sustainable Development: Supporting the Implementation of the Sustainable Development Goals*; Leal Filho, W., Salvia, A.L., Pretorius, R., Brandli, L., Manolas, E., Alves, M.F.P., Azeiteiro, U., Rogers, J., Shiel, C., Paço, A., Eds.; Springer: Cham, Switzerland, 2020; pp. 135–149.

39. Verhoef, L.; Graamans, L.; Gioutsos, D.; van Wijk, A.; Geraedts, J.; Hellinga, C. ShowHow: A Flexible, Structured Approach to Commit University Stakeholders to Sustainable Development. In *Handbook of Theory and Practice of Sustainable Development in Higher Education*; Leal Filho, W., Azeiteiro, U., Alves, F., Molthan-Hill, P., Eds.; Springer: Cham, Switzerland, 2017; pp. 491–508.
40. Visschers, V.H.M.; Siegrist, M. Does better for the environment mean less tasty? Offering more climate-friendly meals is good for the environment and customer Satisfaction. *Appetite* **2015**, *95*, 475–483. [[CrossRef](#)] [[PubMed](#)]
41. Leal Filho, W.; Salvia, A.L.; Pretorius, R.; Brandli, L.; Manolas, E.; Alves, F.; Azeiteiro, U.; Rogers, J.; Shiel, C.; Do Paco, A. *Universities as Living Labs for Sustainable Development-Supporting the Implementation of the Sustainable Development Goals*; Springer: Cham, Switzerland, 2020.
42. Ely, A.V. Experiential learning in “innovation for sustainability” An evaluation of teaching and learning activities (TLAs) in an international masters course. *Int. J. Sustain. High. Educ.* **2018**, *19*, 1204–1219. [[CrossRef](#)]
43. Gamage, P.; Sciulli, N. Sustainability Reporting by Australian Universities. *Aust. J. Public Adm.* **2016**, *76*, 87–203. [[CrossRef](#)]
44. Bernheim, A. How green is green? Developing a process for determining sustainability when planning campuses and academic buildings. *Plan. High. Educ.* **2003**, *31*, 99–110.
45. Cortese, A.D. Integrating sustainability in the learning community. *Facil. Manag.* **2005**, *21*, 28–35.
46. 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. [[CrossRef](#)]
47. De Lange, D.E. How do Universities Make Progress? Stakeholder-Related Mechanisms Affecting Adoption of Sustainability in University Curricula. *J. Bus. Eth.* **2013**, *118*, 103–116. [[CrossRef](#)]
48. Verhoef, L.A. De Campus als Living Lab voor de Circulaire Economie. In *Circulariteit, Op Weg Naar 2050*; Luscuere, P., Ed.; TU Delft Open: Delft, The Netherlands, 2018; p. 261. ISBN 978-94-6366-054-9.
49. Green Gown Awards. Available online: <http://www.greengownawards.org.uk> (accessed on 10 May 2019).
50. Leal Filho, W.; Shiel, C.; Paço, A.; Mifsud, M.; Ávila, L.V.; Brandli, L.L.; Molthan-Hill, P.; Pace, P.; Azeiteiro, U.M.; Vargas, V.R.; et al. Sustainable Development Goals and sustainability teaching at universities: Falling behind or getting ahead of the pack? *J. Clean. Prod.* **2019**, *232*, 285–294. [[CrossRef](#)]
51. Bardin, L. *L'analyse de Contenu*; Presses Universitaires de France Le Psychologue: Paris, France, 1993.
52. Hamid, S.; Ijab, M.T.; Sulaiman, H.; Md. Anwar, R.; Norman, A.A. Social media for environmental sustainability awareness in higher education. *Int. J. Sustain. High. Educ.* **2017**, *18*, 474–491. [[CrossRef](#)]
53. Posch, A.; Steiner, G. Integrating research and teaching on innovation for sustainable development. *Int. J. Sustain. High. Educ.* **2006**, *7*, 276–292. [[CrossRef](#)]
54. Adom̄ent, M.; Grahl, A.; Spira, F. Putting sustainable campuses into force: Empowering students, staff and academics by the self-efficacy Green Office Model. *Int. J. Sustain. High. Educ.* **2019**, *20*, 470–481. [[CrossRef](#)]
55. Leal Filho, W.; Brandli, L.L.; Becker, D.; Skanavis, C.; Kounani, A.; Sardi, C.; Papaioannidou, D.; Paço, A.; Azeiteiro, U.; Sousa, L.; et al. Sustainable development policies as indicators and pre-conditions for sustainability efforts at universities: Fact or fiction? *Int. J. Sustain. High. Educ.* **2018**, *19*, 85–113. [[CrossRef](#)]
56. Manchester University. MU’s Sustainability Policy. Available online: <https://www.manchester.edu/about-manchester/university-priorities/green-campus-initiative/sustainability> (accessed on 28 May 2019).
57. Harvard University. Harvard Sustainability Plan. Available online: <https://green.harvard.edu/campaign/our-plan> (accessed on 28 May 2019).
58. Vargas, V.R.; Lawthom, R.; Prowse, A.; Randles, S.; Tzoulas, K. Sustainable development stakeholder networks for organisational change in higher education institutions: A case study from the UK. *J. Clean. Prod.* **2019**, *208*, 470–478. [[CrossRef](#)]
59. Blanco-Portela, N.; Benayas, J.; Pertierra, L.R.; Lozano, R. Towards the integration of sustainability in Higher Education Institutions: A review of drivers of and barriers to organisational change and their comparison against those found of companies. *J. Clean. Prod.* **2017**, *166*, 563–578. [[CrossRef](#)]

