Updating and Assessing the Universality of the Higher-Ed Sustainability Evaluation Tool

An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
degree of Bachelor of Science

by
Rory Cuerdon
Daniel Matthews
Harrison Saperstein
Scott Weber

Date:
26 April 2019

Report Submitted to:

Dr. Heather Barrett
University of Worcester

Dr. Victoria Hands
Kingston University

Dr. Dominic Golding
Worcester Polytechnic Institute

Abstract

Existing sustainability benchmarking tools for universities are resource intensive and do not adequately address curriculum and research content. Our sponsors, the University of Worcester and Kingston University, are interested in easily evaluating the curriculum and research of their universities. Previous WPI project teams developed a sustainability benchmarking tool to fulfill these needs. We improved the benchmarking tool through revision, application, and evaluation with the help of our sponsors. We found that the benchmarking tool was useful to the University of Worcester but was challenging to implement at other universities due to inconsistencies with how data was stored. We recommend the tool be improved through interaction with more universities in the United Kingdom.

Acknowledgements

We would like to thank and acknowledge the following people for their help in completing our project, without whom it would not have been possible.

Members of the University of Worcester Community:

Dr. Heather Barrett, Project Sponsor, for advice and guidance on our project

Katy Boom, Director of Sustainability, for assisting in implementing the benchmarking tool and providing feedback

Greg Dobbins, Data Analyst, for assistance in implementing the curriculum tool

Karen Dobson, Research Knowledge and Exchange Facilitator, for assistance in implementing the research tool

Lynne Bailey, Data Management Unit Manager, for assistance in implementing the curriculum tool

Members of the Kingston University Community:

Dr. Victoria Hands, Project Sponsor, for guidance and feedback about the benchmarking tool

Dr. Richard Anderson, Operations Sustainability Manager, for recommendations on questions

Members of the WPI Community:

Dr. Dominic Golding, Project Advisor, for advising and guiding our project through 2 terms

Isaac Woods and the Previous Benchmarking IQP Team, for explaining the intricacies of the research and module analyzing software

Liz Tomaszewski, Associate Director of Sustainability, for explaining STARS

We would also like to thank Keele University for giving us insight on how they benchmark sustainability in their curriculum.

Lastly, we would like to thank the Association for the Advancement of Sustainability in Higher Education for allowing us to use their benchmarking tool, STARS, as the basis for our questions.

Executive Summary

Background

Following the Brundtland Report of 1987, concerns about environmental degradation, resource depletion, and equitable environmental development have been at the forefront of national policy agendas (WCED, 1987). In recent years, world leaders have developed a plan of action to address the concerns of sustainable development. Most recently, the United Nations has identified 17 Sustainable Development Goals (SDGs) to achieve sustainable development by the year 2030 (United Nations, 2015). The SDGs address all aspects of sustainability including education, human equality, poverty, and resource depletion. Many governmental and non-governmental organizations are adopting these goals and making strides to achieve them.

The University of Worcester and Kingston University are committed to promoting sustainability and the SDGs in their curriculum, research, operations, and community engagement activities. There are a number of benchmarking tools that exist to examine sustainability in these aspects but they all have different focuses. Tanaka and Yarime (2012) claim that "existing sustainability assessment tools are not sufficiently addressing the importance of education, research and outreach activities in HEIs [Higher Education Institutions]". Our project aimed to use the sustainability benchmarking tool created by a past WPI project (Bermin-Jolton, Kuros, Madhurkar, Rockcress, 2017) to evaluate the integration of sustainability in curriculum and research at the University of Worcester and Kingston University and to develop the tool for application to other higher education institutions in the United Kingdom.

Project Goals

The overall goal of this project was to develop a revised version of the Sustainability Benchmarking Tool for general application at UK universities. We achieved this goal through the following four objectives:

- Reviewing the existing benchmarking tool and clarifying with stakeholders how to refine it for application.
- Applying the benchmarking tool to the University of Worcester and Kingston University.
- Evaluating the effectiveness of the benchmarking tool and recommending enhancements for the packaged tool.

- Assessing how the tool can be modified and packaging the tool for use at other universities.

We improved the questions and keywords used by the tool to enhance the comprehensibility, validity, and accuracy of the assessment based on input from our sponsors. We also consulted with staff at the University of Worcester, Kingston University, and other universities to clarify the availability of pertinent data. Finally, we revised the software and created a website interface with instructions to enhance the applicability and availability of the benchmarking tool for other universities.

Conclusions and Recommendations

We found there are a number of different ways to benchmark sustainability at a university. Several sustainability benchmarking tools are currently in use but each has strengths and limitations. Simpler tools use quasi-automated assessments of publicly accessible data (e.g. People and Planet[1]). Universities do not need to spend any time inputting data but the results are limited primarily because publicly accessible university websites have only limited information about their sustainability activities. More comprehensive benchmarking tools (e.g. STARS[2] and THE[3]) provide a wider spectrum of information about university activities related to sustainability, but require considerable effort from participating institutions to gather and submit data in appropriate forms.

Other universities have taken a different approach to tracking their progress promoting sustainability. For example, in 2014-15 Keele University devoted substantial time and resources through Green Keele, its Office of Sustainability, to manually establish a baseline assessment of all its efforts regarding sustainability, including all aspects of their curriculum and research. With somewhat less additional effort each year, the university can now update the baseline information and assess year-to-year progress on sustainability across university courses and modules. This is arguably the most accurate way to assess progress on sustainability at a university but many universities do not have the resources to conduct manual sustainability assessments annually. Such a customized approach also limits the ability to compare progress across the higher education sector.

[1] People and Planet conducts a sustainability evaluation of 154 UK universities to create the University League

[2] STARS is the Sustainability Tracking, Assessment & Rating System, a benchmarking tool run by the Association for the Advancement of Sustainability in Higher Education

[3] Times Higher Education (THE) conducted a new sustainability impact evaluation at universities around the world in April 2019

The sustainability benchmarking tool developed at the University of Worcester was intended to address two limitations of previous benchmarking tools. Namely, it was designed to (1) explicitly assess the sustainability content of the research and curriculum at universities and (2) to do so in a manner that was semi-automated and required relatively little staff time and resources. The two limitations require a fine balance between achieving the desired richness of analysis without making the data gathering unnecessarily burdensome.

The sustainability benchmarking tool consists of two sets of questions, one set focusing on the curriculum and the other on research. It utilizes module and research analyzing software to semi-automate sections of the tool. The software uses a set of SDG-related keywords and phrases to scan either module titles and descriptions or research titles and abstracts to determine which are related to sustainability. The software is supplemented with questions answered by pertinent faculty and staff.

The module and research analyzing software was easy to update to the newest academic year for the University of Worcester and did not require any major modifications. It only required the newest list of research publications from the University website and the web app to the module directory, both of which were easy to gather. The software makes the tool very efficient and valuable to the University of Worcester.

The University of Worcester scores highly in the benchmarking tool, with a perfect 45/45 on the research tool and a 41.4/55 on the curriculum tool. The university only lost points in some parts of the formal curriculum and for not having a sustainability literacy assessment. The University of Worcester's scores are not surprising since the university has focused on sustainable development for many years and has scored highly on other independent assessments, such as THE and People and Planet. The sustainability benchmarking tool provides a good way to measure the University of Worcester's current efforts and future progress in promoting sustainability. We recommend that the University of Worcester continue to use the modified tool to track their progress.

Making the tool more universally applicable, however, will require a substantial effort primarily because universities store data on their curriculum, research, and other activities in many different forms. Kingston University uses the same database tools (SITS[4]) for modules as the University of Worcester but they enter their data for their modules without the descriptions. This made the module analyzing software unusable and would require major software changes to fix. We

[4] SITS stands for Strategic Information Technology Systems and is a database software developed and maintained by the Tribal Group that universities use to store module information.

were able to run the research analyzing software on Kingston University's research publications. Their research publications are available in a JSON file format, which is similar to the University of Worcester's, which made the software usable. However, many publications did not include the abstract, an important piece that is analyzed. Without it, only titles are examined which would lead to less accurate percentages. We recommend that Kingston University examines their policies regarding how research publications are listed. We also recommend that Kingston University use the benchmarking tool when module descriptors are included in a file type (CSV) usable with our software and abstracts are included with published articles.

Universities throughout the United Kingdom use a number of different databases for each of their module directories and research publications, and adapting software to accommodate all the different formats would be very challenging. JSON was a common file type used for research publications that the University of Worcester, Kingston University, and Keele University all used. Other universities used different file types to store information about their research. Within this file type, universities can name descriptors differently or leave them out entirely. This problem is exacerbated with module directories. We posed the solution to instead use a more common file type, a CSV file. However, many universities are unable to provide it and using commas in a module description would break the file. It is unlikely that the universities will adopt a uniform approach to storing such data, so any comprehensive tool will need to be designed to accommodate a variety of data formats, or it will require university staff to output existing data into a standard format that the tool can process. We recommend that future teams explore other universal file types and converse with other universities in the United Kingdom to determine which file types are possible to create.

Keywords also pose problems. Each university emphasizes different aspects of sustainability that reflect their particular curriculum and research activities. As a result, the keywords that might accurately detect all the sustainability activities at one university may not be as valid at another university. On the other hand, making the list of keywords too general will result in a large number of false positives and an inflated assessment of the sustainability content of the curriculum or research activities. We recommend that future versions of the module and research analyzing software explore the use of machine learning and artificial intelligence to scan for SDG-related modules and publications. This would increase the accuracy of the tool and remove the need to continuously enhance the keywords for every institution. The tool would be able to learn text patterns that pertain to sustainability and use them to determine which modules or articles were related to sustainability, greatly reducing the errors associated with specific keywords and phrases.

We recommend that the benchmarking tool be continuously updated. Sustainability is ever-changing and the questions need to maintain relevance to global policy. The Sustainable Development Goals are currently the driving force behind sustainability and each of the questions should be related to them in some way. For example, we changed question C10 to incorporate each of the 17 SDGs instead of miscellaneous areas of sustainability and we believe this greatly improves the specificity and clarity of the benchmarking tool. As the benchmarking tool is used at other universities in the United Kingdom, the scoring (i.e., weighting factors) needs to be updated as well. The scores were largely based on universities in the United States reporting on sustainability with STARS. The scoring of the benchmarking tool will need to be changed based on the data collected from other UK universities to provide a score weighting that will continuously encourage universities to improve but not make it so hard to achieve a reasonable score that it discourages them from using the tool.

Authorship

Section	Authors	Editors
Abstract	All Members	All Members
Executive Summary	Scott	All Members
Introduction	All Members	All Members
Literature Review		
History and Importance	Harrison	Daniel, Rory, Scott
Promoting Sustainability	Rory	Daniel, Harrison, Scott
Benchmarking Sustainability	Scott	Daniel, Harrison, Rory
Sustainability at UW	Daniel	Harrison, Rory, Scott
Sustainability at KU	Daniel	Harrison, Rory, Scott
Curriculum and Research	Scott	Daniel, Harrison, Rory
Methods		
Objective 1	Rory	Daniel, Harrison, Scott
Objective 2	Scott	Daniel, Harrison, Rory
Objective 3	Daniel	Harrison, Rory, Scott
Objective 4	Harrison	Daniel, Rory, Scott
Findings		
Updating	Daniel, Rory	Harrison, Scott
Applying	Rory, Scott	Daniel, Harrison
Evaluating	Daniel	Harrison, Rory, Scott
Assessing	Harrison	Daniel, Rory, Scott
Conclusions	Scott	All Members

Table of Contents

List of Figures

List of Tables

Introduction

Following the Brundtland Report of 1987, concerns about environmental degradation, resource depletion, and equitable environmental development have been at the forefront of national policy agendas (WCED, 1987). In recent years, world leaders have developed a plan of action to address the concerns of sustainable development. Most recently, the United Nations has identified 17 Sustainable Development Goals (SDGs) to achieve sustainable development by the year 2030 (United Nations, 2015). The SDGs address all aspects of sustainability including education, human equality, poverty, and resource depletion. Many governmental and non-governmental organizations are adopting these goals and making strides to achieve them.

The University of Worcester and Kingston University are committed to promoting sustainability in their curriculum, research, operations, and community engagement activities. Our project aimed to use the sustainability benchmarking tool created by a past WPI project (Bermin-Jolton, Kuros, Madhurkar, Rockcress, 2017) to evaluate the integration of sustainability in curriculum and research at each university and to develop the tool for application to other higher education institutions in the United Kingdom.

The overall goal of this project was to develop a revised version of the Sustainability Benchmarking Tool for general application at UK universities We achieved this goal through the following four objectives:

- Reviewing the existing benchmarking tool and clarifying with stakeholders how to refine it for application.
- Applying the benchmarking tool to the University of Worcester and Kingston University.
- Evaluating the effectiveness of the benchmarking tool and recommending enhancements for the packaged tool.
- Assessing how the tool can be modified and packaging the tool for use at other universities.

We improved the questions and keywords used by the tool to enhance the comprehensibility, validity, and accuracy of the assessment based on input from our sponsors. We also consulted with staff at the University of Worcester, Kingston University, and other universities to clarify the availability of pertinent data. Finally, we revised the software and created a website interface with instructions to enhance the applicability and availability of the benchmarking tool for other universities.

Literature Review

The Sustainable Development Goals (SDGs) were created to address sustainable development concerns the world is facing. Our background begins by discussing how the SDGs were created, followed by a discussion on how universities have been working to integrate the SDGs into their institutions. Next, we explain the need for benchmarking tools to show the areas where universities need to improve their sustainability efforts. Lastly, we explain the efforts of the University of Worcester and Kingston University in promoting and benchmarking sustainability.

History and Importance of the Sustainable Development Goals

Academics, politicians, business leaders and the public have become increasingly concerned about sustainable development since the Brundtland Report was published in 1987. Prompted by concerns about environmental degradation, resource depletion, and equitable environmental development, the World Commission on Environment and Development (Brundtland Commission) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). In 1992, following publication of the Brundtland Report, representatives from more than 178 countries met at the United Nations Conference on Environment and Development, better known as the Earth Summit, and started to construct a plan of action to address the world's sustainability challenges. The plan, known as Agenda 21, serves as a "comprehensive blueprint to be taken globally… from now into the twenty-first century" (United Nations, 1992). One hundred and seventy-eight countries adopted Agenda 21 and reaffirmed their commitments at the World Summit on Sustainable Development held in Johannesburg, South Africa in 2002. For the last three decades, this agenda has been the backbone supporting global, national, and local research, policies, and programs aimed at creating a more sustainable future for the world.

At the turn of the millennium, 149 world leaders met at the Millennium Summit to address the challenges of sustainable development in the twenty-first century. The Millennium Document, affirmed by the world leaders at the Summit, proposed goals to address these challenges within 15 years (United Nations). The Millennium Development Goals (MDGs) consisted of eight main objectives (Figure 1) and 21 targets.

Figure 1: Millennium Development Goals (United Nations, n.d. a)

The MDGs became the standard to achieve sustainable development for the first 15 years of the 21st century, until the new Sustainable Development Goals (SDGs) were adopted in 2015. In 2014, to further ongoing efforts in promoting sustainability, the United Nations Open Working Group OWG, proposed "17 Sustainable Development Goals [SDGs] and 169 associate targets to be achieved by the year 2030" (United Nations, 2015). The goals are built on the same principles as those enshrined in the eight MDGs and Agenda 21. The SDGs comprise two broad categories of sustainability and development (Figure 2). Each category has three sub categories. *Nature*, *life support*, and *community* fall under sustainability (i.e., what needs to be sustained) and *people*, *economy*, and *society* fall under development (i.e., what needs to be developed). The 17 SDGs range from ending worldwide poverty to gender and human equality rights to forest conservation. The goals were adopted in 2015 and an ambitious target of 2030 was established for their achievement.

Figure 2: Sustainable Development Goals (United Nations, n.d. b)

Promoting Sustainability in Higher Education

Universities are working to implement sustainability initiatives in their institutions in order to further sustainable development under the SDGs. Integrating sustainable development into the curriculum, research, and operations at universities is no small task. In the past, a lack of awareness about the issues, limited funding, and a general institutional resistance to change have limited the wholesale adoption of sustainability as a guiding principle at many universities around the world. Sustainable development is not yet a priority at many universities and in some cases promoting sustainability is even seen as impeding the progress of education and research (Velazquez, Munguia, & Sanchez, 2005). Universities that are leaders in sustainability, however, can help other universities to better integrate sustainability into their institutions by serving as models.

Several universities have been at the forefront of integrating sustainable development into all aspects of their operations, curriculum, and research, particularly in Europe. "Across the world, but particularly in Europe, some universities have become leaders in the field with very good practices" (Filho et al., 2017). Table 1 shows there are still many challenges to address in order to fully integrate sustainable development into universities. The figure shows the average level of importance on a scale of 1 to 5, for each of the challenges evaluated by surveying 269 experts in sustainable development. However, "collective efforts are underway to improve the outdated curriculum, policies and standards, which will sustainably transform higher education" (Filho et al., 2017).

United Kingdom universities are working with support agencies to develop sustainability policies. For example, the Higher Education Funding Council for England (HEFCE), now the Office for Students works with universities to promote student engagement in sustainable practices and encourage students to pursue a future in creating positive change. The Research Councils UK (RCUK) work to improve communication between researchers and the general public in order to ensure a relevant and positive impact from the research (Hands & Anderson, 2017b).

Table 1: Challenges in Integrating Sustainable Development into Universities (Filho et al., 2017)

	Evaluation Scale	
	1 2 3 4 5	
Lack of support from management		3.94
Lack of appropriate technology		2.79
Lack of awareness and concern		2.65
Lack of Environemental Committee		2.62
Lack of buildings with sustainable performance		2.62
Government barriers		2.5
Lack of research and development		2.47
In the introduction of control systems		2.41
Lack of legislation and guidelines		2.38
Social barriers		2.38
Lack of knowledge and educations on the topic		2.32
Lack of training and collaboration		2.29
Lack of defined practices and policies		2.29
Lack of support from the academic community		2.29
Institutional Barriers		2.29
Lack of incentives for innovations		2.24
Many restrictions and bureaucracy		2.21
Strong culture and conservatism		2.18
Lack of planning and focus		2.18
Lack of entrepreneurship and public private partnerships		2.09
Lack of dialogue		2.06
Lack of capacity and decisions		1.97
Lack of commitment and discipline		1.97
Lack of integration in teaching, research and extension		1.91
Lack of applicability and continuity of the actions		1.82

The Office for Students works with the National Union of Students (NUS) in the United Kingdom to focus on students in higher education. Their major objectives are improving student rights, education, and sustainability. Their program, Responsible Futures, focuses on "putting sustainability at the heart of every curriculum" (National Union of Students, 2017). Many UK universities have placed this goal at the center of their sustainability engagement in line with the UN Goal 4.7, which states:

> By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development. (United Nations, 2015).

The NUS assists universities in implementing Goal 4.7 by offering support and information on how to improve their curriculums. The NUS program also includes an accreditation scheme to show that a university is working towards the goal of enhancing curriculums with sustainability.

Benchmarking Sustainability in Higher Education

As sustainability has become more intimately incorporated in university curriculums, research endeavors, operations, and community engagement activities, universities have sought to benchmark both their own improvements in sustainability over time and to compare themselves to other higher education institutions. In turn, a number of benchmarking tools have been created to evaluate different aspects of sustainability at universities.

The most common benchmarking tools created for universities focus on the management of estates and operations. Utilities, sustainable construction, and resource use are commonly looked at in these areas. There are dozens of sustainable operations benchmarking tools throughout the world. In the United Kingdom, the Green Scorecard by the Association of University Directors of Estates, BREEAM, ECOCAMPUS, and many more look only at estates and operations. Other areas of sustainability are underrepresented even though they are important to higher education institutions. For example, Tanaka and Yarime (2012) claim that "existing sustainability assessment tools are not sufficiently addressing the importance of education, research and outreach activities in HEIs [Higher Education Institutions]". Several tools are being developed and applied, however, to assess other important areas of sustainability at universities.

The Sustainability Tracking, Assessment & Rating System (STARS) covers more than just operations. STARS was created by the Association for the Advancement of Sustainability in Higher Education (AASHE) in 2010. STARS is widely used with over 400 universities reporting their sustainable efforts, mainly in the United States but with some universities internationally. Table 2 shows the universities that have been rated between July and December of 2018. The tool was created to engage a wide range of institutions and enable them to improve their sustainability practices. It is meant to address sustainability in "four categories: Academics, Engagement, Operations, and Planning & Administration" (AASHE, n.d.). Users have said that, "It [STARS] has opened lines of communication and has expanded sustainability understanding across campus"

(AASHE, n.d.). STARS covers a large range of sustainable topics and has a significant amount of data on university sustainability in its database making it very useful when evaluating benchmarking tools. Many other general benchmarking tools similar to STARS exist in other parts of the world that specifically focus on the area for which they were originally created.

Table 2: STARS University Rankings (AASHE, 2019)

Institution	Location	Version	Rating	Submission Date
University of Buffalo	United States, NY	2.1	Gold	Dec. 14, 2018
Clemson University	United States, SC	2.1	Silver	Nov. 26, 2018
Virginia Theological Seminary	United States, VA	2.1	Reporter	Nov. 15, 2018
University of Wisconsin- Whitewater	United States, WI	2.1	Silver	Nov. 13, 2018
University of Waterloo	Canada, ON	2.1	Silver	Nov. 6, 2018
University of Washington, Seattle	United States, WA	2.1	Gold	Oct. 12, 2018
Butler University	United States, IN	2.1	Bronze	Oct. 10, 2018
Simon Fraser University	Canada, BC	2.1	Gold	Oct. 5, 2018
Illinois Institute of Technology	United States, IL	2.1	Bronze	Sept. 25, 2018
American University of Sharjah	United Arab Emirates, Ash Shariqah	2.1	Bronze	Sept. 16, 2018
University of California, Berkeley	United States, CA	2.1	Gold	Aug. 16, 2018
University of Manitoba	Canada, MB	2.1	Gold	Aug. 16, 2018
The New School	United States, NY	2.1	Silver	Aug. 6, 2018
California State University, Dominguez Hills	United States, CA	2.1	Bronze	July 27, 2018
Wake Forest University	United States, NC	2.1	Gold	July 27, 2018
University of Iowa	United States, IA	2.1	Silver	July 24, 2018
University College Cork – Nation University of Ireland, Cork	Ireland, Co. Cork	2.1	Gold	July 20, 2018
University of Illinois at Chicago	United States, IL	2.1	Silver	July 17, 2018
Sheridan College (Ontario)	Canada, ON	2.1	Silver	July 12, 2018

People and Planet conducts a sustainability evaluation of 154 of the universities in the United Kingdom yearly to develop the University League. Figure 3 shows the top ten universities ranked in 2018. The People and Planet University League evaluates sustainability in a wide range of thirteen different categories from environmental policy to engagement. Education for sustainable development is only a small portion of the University League despite its inclusion. Half the information is taken from publicly available information on the university's website and the other half is from statistics released for public consumption by the Higher Education Statistics Agency. Any sustainability information that is private to the university or not easily accessible is not used to score which can lead to some universities scoring poorly even if they have a substantial focus on

sustainable development. The People and Planet ratings include every university in the United Kingdom whether they want to be included or not (People & Planet, 2018).

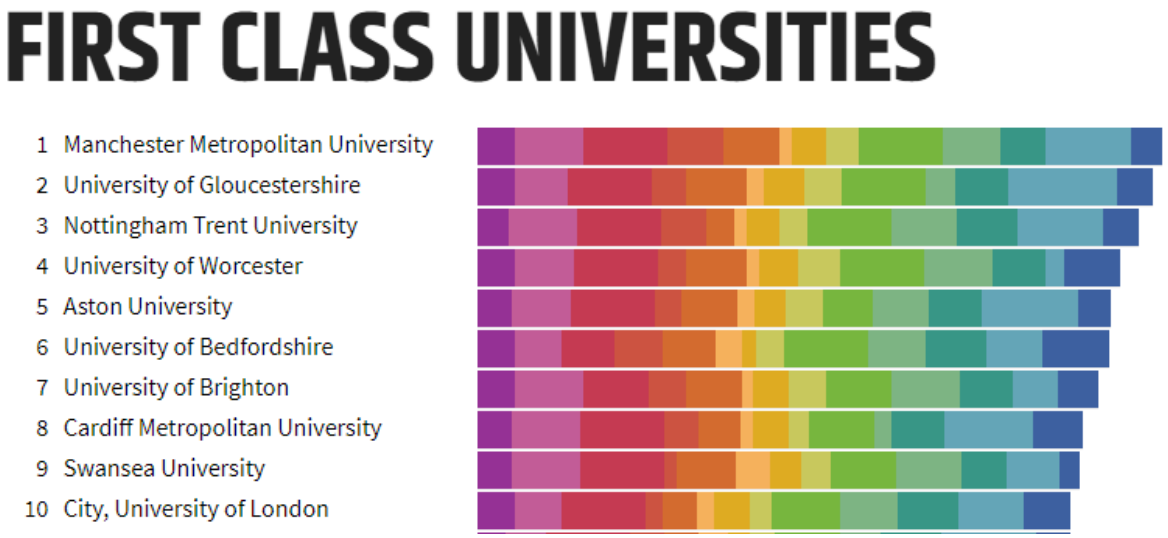

Figure 3: Top Ten People and Planet Universities (People & Planet, 2018)

Times Higher Education (THE) is implementing their first University Impact League to monitor sustainability in higher education. THE is collecting data from Elsevier, an information and analytics company, as well as asking universities to report their efforts in 11 of the 17 SDGs. THE states their ranking is "based on institutions' success in delivering the United Nations' Sustainable Development Goals" (Times Higher Education, 2018) and they hope to eventually include all 17 SDGs in the future. Their benchmarking tool was designed to directly relate to the SDGs. The overall scoring and rankings will be based on a university's best three SDGs as well as the SDG goal of global partnerships to allow universities of all sizes to be included in the metric. THE began collecting data in September 2018 and released the first set of rankings in April 2019 (Times Higher Education, 2018). The University of Worcester ranked 33rd overall in the university impact rankings, receiving high marks in areas of gender equality and quality education.

The Alliance for Sustainability Leadership in Education partnered with the Association of University Directors of Estates (AUDE) to create the Sustainability Leadership Scorecard (SLS). It is based on the Green Scorecard that was initially created by AUDE in 2016. The Green Scorecard however only focused on estate management which is only one aspect of sustainability at universities. The SLS was designed to expand into three other sections that many benchmarking tools are lacking (i.e., leadership and governance, partnership and engagement, and learning,

teaching, and research). Like the Impact League, data is currently being collected through university submissions and a report will be released in the spring of 2019 (EAUC, 2018).

Sustainability at the University of Worcester

The University of Worcester is committed to creating a sustainable campus where students can learn about sustainability and social responsibility. The University Strategic Action Plan (SAP) provides goals for improvement in all functions of the university as well as incorporating sustainability policies. The SAP emphasizes sustainability in curriculum, research, and community outreach. "Through our teaching, research and knowledge exchange activities we will promote sustainable communities, services, businesses and use of physical resources" (University of Worcester, 2013, p. 28).

The curriculum is the University's means to promote the values they see as being essential to society. Graduates will go on to hold up the positive values they have acquired at the University. "We will offer a curriculum that promotes ethical and responsible behaviours and promotes an understanding of the values of sustainability, inclusion and mutual respect." (University of Worcester, 2013, p. 23). The University of Worcester recognizes that the best way to have an impact on sustainability in the world is to instill the ideas of sustainability in its students. The university comprises seven institutes/schools, the largest of which is the Institute of Health and Society which encompasses 34% of enrollment. This institute along with the Institute of Science and the Environment (6% of student enrollment) are the most involved in the delivery of the sustainability curriculum presently (University of Worcester, 2019). The inclusion of sustainability in these areas and other knowledge exchange activities is implemented by the Sustainability Department of the University of Worcester. In a sustainability audit, run with the sustainability auditing tool STAUNCH, the number of sustainability-related modules offered increased by 42% between 2010 and 2013. The University has also created the Learning for Sustainable Futures program. Started in 2014, this program awards "£3,000 to individuals or small teams for collaborative projects working across the organisation and the community to connect sustainability thinking and practice" (University of Worcester, 2018a).

Another main objective outlined in the SAP is to "undertake teaching, research and scholarship that improves society and reflects our long-standing commitment to social responsibility, is informed by and informs practice; influences and informs key policies on educational, social care

and environmental issues" (University of Worcester, 2013, p. 21). The university has academics across many disciplines solving environmental and social issues. They are currently conducting research to address the world's water supply due to the impacts of climate change, increasing the food supply in Africa, and helping to address crime and nutrition in communities around the world (University of Worcester, 2018b).

Lastly, the University is committed to creating a positive contribution to society through community engagement. The University contributes to the physical development of Worcester (e.g., the Hive), allows the community to use its facilities, and encourages faculty and students to engage in volunteer activities in the community (University of Worcester, 2013). The University of Worcester follows a communications and community engagement strategy to promote sustainable approaches in the community. The university works with its student body to encourage and raise awareness of sustainable practices through projects such as Energize Worcester and Go Green Week in Worcester City. The university also holds the University Community Forum three times each year to hear concerns from the Worcester community and give a sustainability report to a University of Worcester committee (University of Worcester, 2018a).

The University of Worcester has been recognized for these efforts and was ranked 4th out of 154 universities in the People & Planet University League (Figure 4), achieving the rating of a first-class university. The University of Worcester received full marks in several of the categories such as Education and Auditing & EMS. However, the University has room to improve with carbon reduction and workers' rights receiving low grades of 10% and 15% respectively. The University of Worcester has also achieved NUS Responsible Futures accreditation and was the first English university to have Ecocampus Platinum Status (University of Worcester, 2018a).

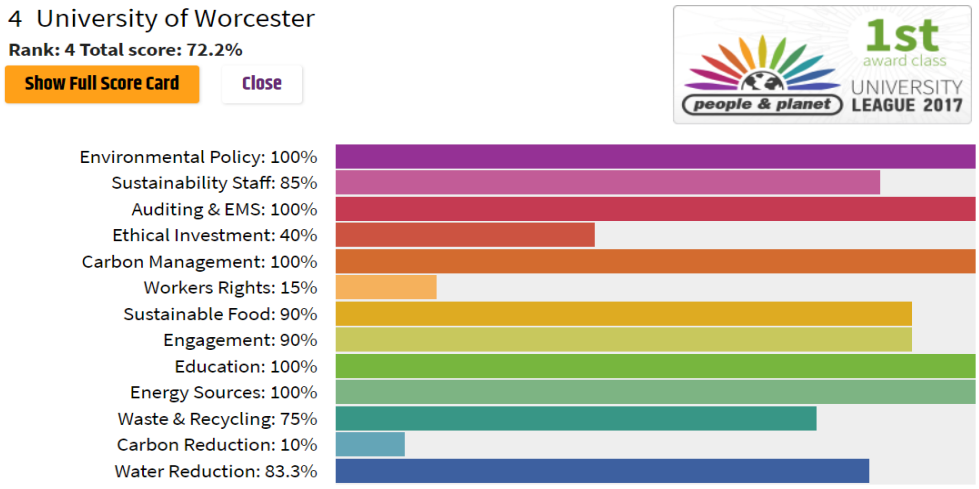

Figure 4: People & Planet Scoring for the University of Worcester (People & Planet, 2018)

Sustainability at Kingston University

Kingston University opened its doors in 1899 as Kingston Technical Institute. Kingston is located in South-West London and in 1992 changed its name to Kingston University (Kingston University, a). The current student population is 16,499 in its four campuses spread around Kingston upon Thames (Kingston University, b). Sustainability at Kingston University is primarily handled by the Sustainability Hub. The group operates in a similar manner to the Sustainability Department of the University of Worcester. The Sustainability Hub seeks to improve how sustainability is achieved at Kingston through goals outlined in the Education for Sustainable Development (ESD).

Kingston University believes sustainability to be an essential part of their educational experience. "At Kingston University, sustainability and ethics are at the core of our teaching and learning, our research and our enterprise activities" (Kingston University, c). The University uses the Sustainability Hub to help integrate sustainability throughout the institution including in their curriculum. At the Sustainability Hub they "offer advice to faculties as part of the quality assurance procedures with an aim to embed sustainability and ethics in the new and revised courses" (Kingston University, c). Through these efforts, several undergraduate and postgraduate sustainability-related courses have been developed, such as Biological Sciences, Environmental Management with Business, and Renewable Energy Engineering Masters (Kingston University, c). Currently, the University is working to integrate sustainability into all courses beyond those that are

directly related to sustainability. The Sustainability Hub also tests how well its students are learning with the Sustainable Literacy Test (SULItest). This tool assesses students on their knowledge of all aspects of sustainability as outlined in the SDGs and ESD. It is part of the Sustainability Hub's effort to benchmark itself on how effective its sustainability curriculum is (Kingston University, c).

Kingston University outlines its commitment to sustainable research in its ESD, "Support and promote research related to sustainability and ethics through a bank of research questions and project work topics" (Kingston University, c). Kingston understands that research is central to quality teaching and learning, and enhances the university's reputation. The Sustainability Hub seeks to drive more sustainability-related research at the University as well as reduce the environmental impact of how research is conducted (Kingston University, c). The Sustainability Hub promotes sustainable research through the establishment of sustainability research centres and projects. Centres such as the Center for Earth and Environmental Sciences Research and Materials Research Centre provide students an opportunity to work, learn, and debate the ideas of sustainability (Kingston University, c).

Kingston University maintains the importance of engaging its student in sustainability outside of the curriculum to "create a number of co-curricular learning opportunities for students with an aim to harness sustainability awareness, project management and communication skills" (Kingston University, c). Kingston's sustainable community interactions are primarily with or through the student body. Student clubs, groups and unions aimed at sustainability such as Green Connectors and Green Impact Students Union share ideas on sustainability with the student body and the surrounding community as a whole (Kingston University, c). These clubs have been so effective that Green Impact Students Union has also been awarded a 'Very Good' accreditation with the NUS for their efforts to make a green campus and community. As a whole, Kingston University is working towards being accredited by the Responsible Futures program. The NUS organization is looking to see that Kingston University has provided their graduates with the knowledge to "contribute positively to social responsibility and sustainability" (NUS, 2017). Unlike the University of Worcester, Kingston University is unranked by the People and Planet University League since 2016 "due to ongoing concerns over methodology" (Kingston University, d). Despite this, Kingston is still making efforts to improve overall sustainability at the University.

Curriculum and Research Sustainability Benchmarking

The University of Worcester and Kingston University are searching for sustainability benchmarking tools that are specific to the curriculum and research at their institutions and in the United Kingdom. In 2010 and 2013, the University of Worcester used STAUNCH, or the 'Sustainability Tool for Auditing UNiversities Curricula in Higher Education', to audit their curriculum. STAUNCH was developed by Rodrigo Lozano "to quantify curriculum content by scoring sustainability course content" (Glover, Peters, & Haslett, 2010, p.128). It works by collecting data on the curriculum and scoring it based on sustainability related keywords. The tool, however, is no longer updated making it less valuable for continued benchmarking.

Kingston University used a customized tool for benchmarking sustainability research at their institution in 2016. Kingston University's Victoria Hands and Richard Anderson created the tool to "...[identify] the extent of research on sustainable development currently being carried out by the university" (Hands and Anderson, 2017a, p.27). The tool scans websites of the university, faculty, and Kingston University's 'Find a Researcher' website directory using sustainability keywords. The keywords are directly derived from the United Nations SDGs. The study was designed to identify "research and researchers to work with in future" (Hands and Anderson, 2017a, p.39), rather than give a score of sustainability at the university.

The University of Worcester also performed the Higher-Ed Sustainability Evaluation created by Worcester Polytechnic Institute students for the university in 2018. The tool was created to address issues with previous tools such as being too specific to a certain university or having different grading schemes for each topic area (Bermin-Jolton et al., 2017). The team that created the tool compared nine different benchmarking tools to determine the most relevant parts to benchmarking a university's sustainability in curriculum and research, the two aspects of sustainability most important to the University of Worcester. STARS was the most prominent benchmarking tool in these categories and "many of the questions found in our custom tool were derived or inspired by STARS" (Bermin-Jolton et al., 2017, p.22). The tool uses a questionnaire style with either a grade based on a scale from 0 to 5 or yes/no responses. The scoring gradient largely comes from the STARS database of university responses. The Higher-Ed Sustainability Evaluation can be found in Appendix A.

Through our research we have found that universities are trying to improve their sustainability efforts. There are many difficulties involved when trying to improve sustainability at

universities. In order to increase sustainable development, universities need to benchmark their current achievements. In the next chapter, we will discuss how we will be applying the benchmarking tool at both universities and improving the tool for future use.

Methods

The overall goal of this project was to develop a revised version of the Sustainability Benchmarking Tool for general application at universities in the United Kingdom. To achieve this goal, our team created four objectives with a set of tasks involved in each. These objectives were:

- Objective 1: Reviewing the existing benchmarking tool and clarifying with stakeholders how to refine it for application.
- Objective 2: Applying the benchmarking tool to the University of Worcester and Kingston University.
- Objective 3: Evaluating the effectiveness of the benchmarking tool and recommending enhancements for the packaged tool.
- Objective 4: Assessing how the tool can be modified and packaging the tool for use at other universities.

Objective 1: Reviewing the existing benchmarking tool and clarifying with stakeholders how to refine it for application.

Our first objective was to review the existing benchmarking tool and clarify with stakeholders how best to refine it for application. The stakeholders (i.e., sustainability staff and faculty at the University of Worcester and Kingston University) were concerned that the current version of the benchmarking tool would not accurately capture and portray the extent to which sustainability is integrated into the curriculum and research agendas at each university. To address this issue, we first conducted our own analysis of the existing benchmarking tool. We reviewed how the tool worked, and the strengths and weaknesses of the results it delivered from the previous WPI project (Woods, Fennick, Morgan & Kornacki, 2018). We reviewed each question in the benchmarking tool (see Appendix A) to determine how each question addressed the Sustainable Development Goals in the curriculum and research. We also reviewed the level of importance of each question to establish a fair weighting of scores.

An important aspect of the benchmarking tool is the module and research analyzing software, which uses a keyword search to scan for sustainability content in curriculum listings. It is used to assist in answering questions C2 and C3 of the curriculum half of the tool. These questions

ask how many curriculum modules contain sustainability elements and the number of students who have taken the modules. The module and research analyzing software is also used in answering questions R2 and R3 of the research half of the tool. These questions ask how many published research reports pertain to sustainability and the number of academic staff involved. The stakeholders were concerned that the program's current keywords (Appendix B) would not accurately assess the sustainability content of a given course or research endeavor. The previous WPI project (Woods et al. 2018) performed a statistical analysis on the outcome of the module and research analyzing software and made recommendations for improvements. We reviewed these recommendations and analyzed the code of the module and research analyzing software to understand how it runs, what information it is capable of gathering, and identify limitations. We also reviewed the list of keywords that were used to determine sustainability content.

Once we understood how the tool works, we consulted with the stakeholders to gather their opinions about possible improvements. We summarized how the tool works and asked them to clarify their thoughts on the strengths and limitations of the current version of the tool as it has been previously applied. The purpose of these initial consultations was to ensure we understood the stakeholders' needs and concerns about how the current tool is or is not meeting those needs.

After we gathered all the information about the benchmarking tool, we adjusted the tool accordingly. Based on our own analysis of how well each question addresses the SDGs in the curriculum and research as well as recommendations from the stakeholders, we refined the questions to have more clarity and depth. Lastly, we made adjustments to the list of keywords used in the module and research analyzing software by both adding and removing keywords in an attempt to reduce the number of false positives and false negatives produced.

Objective 2: Applying the benchmarking tool to the University of Worcester and Kingston University.

Our second objective was to apply the benchmarking tool to the University of Worcester and Kingston University. The benchmarking tool was initially developed for the University of Worcester so the tool can easily be applied to data at the University of Worcester. The structure and content of the data at Kingston University was different and posed a variety of challenges in attempting to gather data and apply the benchmarking tool. We will first discuss the protocols for

applying the data at the University of Worcester, then at Kingston University. A list of all the questions in the tool is provided in Appendix A.

The Sustainability Benchmarking Tool consist of two sets of questions, one set focusing on the curriculum and the other on research. Figure 5 shows how each question in the curriculum section was answered at the University of Worcester. Questions C1 through C4 are called the Formal Curriculum because they address teaching in the classroom. We gathered the module directory for the University of Worcester from our sponsor, Heather Barrett, because module directories are not made public. The module directory was formatted as a web app, which the original module and research analyzing software required. The module analyzing software uses a keyword search to scan for sustainability-related modules in the module directory and provides information on the number of sustainability courses in their curriculum and the number of sustainability modules in each of those courses. An example of a module and course can be found in Appendix C. The module analyzing software answered question C1, the percentage of sustainability-related modules, and C2, the percentage of sustainability-related courses, at the University of Worcester. The module analyzing software also outputs a list of the sustainability-related modules that are found during its keyword search. We sent this list to Greg Dobbins in the data management unit at the University of Worcester. We requested the percentage of students who had taken one of these modules in the past year out of the total enrolled undergraduate students to answer C3. We also requested the number of sustainability-related modules taken compared to all module instances to answer C4 from the data management unit.

Questions C1 to C4 are supplemented by a set of questions called the Informal Curriculum, addressing learning outside the classroom, that were answered by scanning the website and asking questions of the Director of Sustainability, Katy Boom. The University of Worcester's website contained the information we used to answer question C5, the number of students organizations related to sustainability. Originally, we understood a review of the website would answer questions C4, C5, C6, and C10 but the necessary information was not readily apparent. Instead, we met with the Director of Sustainability, Katy Boom, to answer questions C6, how recently the sustainability website was updated, C7, the number of sustainability events, C8, whether or not there is a sustainability literacy assessment, and C9, whether there is an incentive program to develop new sustainability modules. Katy Boom was able to answer each of the questions in an efficient manner. Question C10, sustainability areas exposed to students outside the classroom, was answered with the

website as well as speaking with the Directory of Sustainability and our sponsors. We found sources for many of the events or programs by searching the campus for flyers and posters.

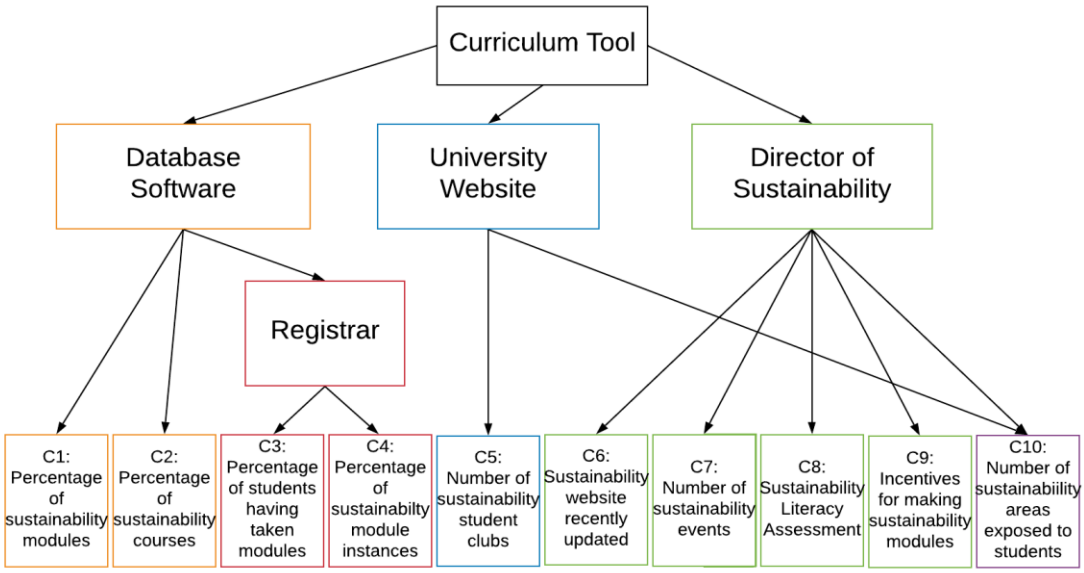

Figure 5: Curriculum Tool Flow Chart

The second part of the benchmarking tool focuses on sustainability-related research. Figure 6 shows which question was answered by each step in applying the tool. Questions R1 through R4 are called Formal Research because they address published research articles. Our first step to grade the university's research was to gain access to their research database. The University of Worcester presented this information in a public database. We downloaded a .JSON file of article titles and abstracts from the University of Worcester website. We ran the research analyzing software on the database file (.JSON) to retrieve the percentage of the research that is relevant to sustainability. The software worked without modification and provided answers to questions R2, the percentage of sustainability articles, and R3, the percentage of sustainability published staff. Our sponsor put us in contact with Karen Dobson, the Research and Knowledge Exchange Facilitator in the Research Department at the University of Worcester. Our team requested information regarding the amount of funding sustainability-related research projects received to answer question R1. The research analyzing software outputs a list of sustainability faculty which was used to crosscheck a list of faculty in each department, found on the website, to answer R4.

The Formal Research questions are supplemented with the Informal Research questions R5 through R9 which address support for research. We met with Katy Boom, the Director of

Sustainability at the University of Worcester, to answer questions R5, the number of sustainability research centres, R6, whether or not there is a program to encourage students to research sustainability, and R7, whether or not there is a program to encourage staff to research sustainability. We searched the University's websites to answer questions R8, whether or not there is library support for sustainability research, and R9, what incentives there are for open access publishing.

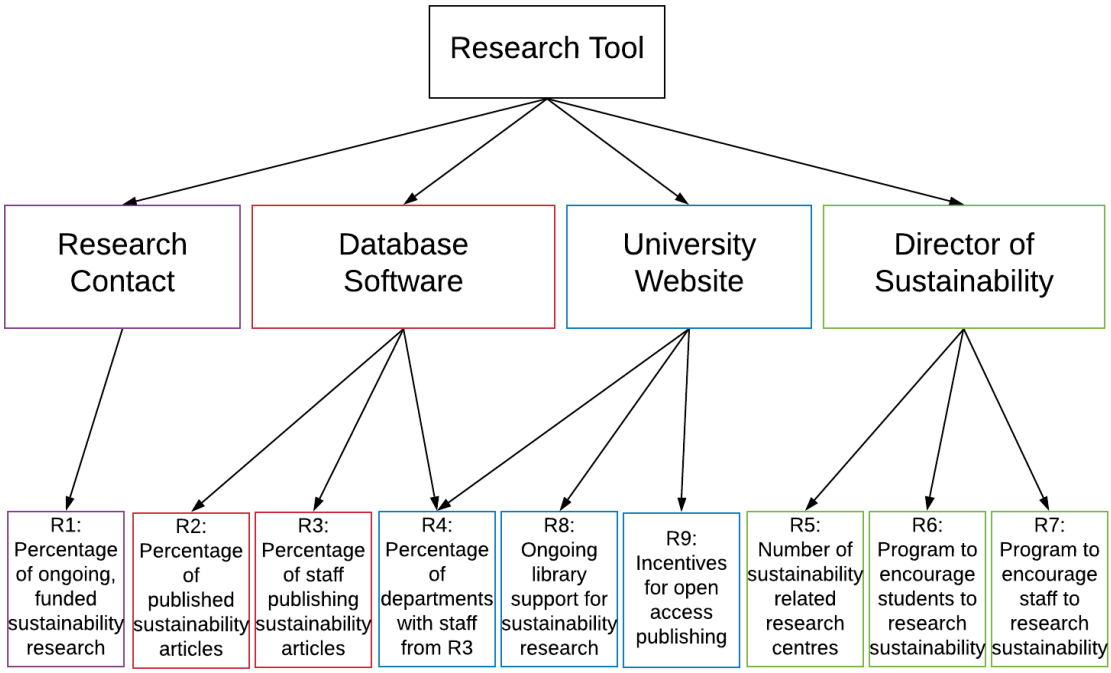

Figure 6: Research Tool Flow Chart

Our next task was to apply the benchmarking tool to all of the data that we gathered. We entered the information gleaned from the software, from the website, and from interviews with staff into the scoring sheet. The total scores (e.g., percentage of all students enrolled in sustainability-related classes or the percentage of research projects that focus on sustainability) are the composite indicators that can be used to compare progress in promoting sustainability within and among universities. We discuss the specific findings in the next chapter.

We trialed the benchmarking tool on Kingston University's data. The University of Worcester and Kingston University hold their module directories with the same database system, SITS, however Kingston University does not enter module descriptions into the database which prevented the module analyzing software from working correctly. This limited our ability to analyze

how the tool performed and evaluate the accuracy of the keywords and software at other universities. We administered the remaining sections of the benchmarking tool as a trial run on the Directory of Sustainability at Kingston University. We provided instructions to perform the tool and oversaw how answers were obtained. We did this to test how the benchmarking tool would be run in the future, by a sustainability-interested faculty member or director of sustainability, and gathered comments to be able to enhance the tool in Objective 3.

Objective 3: Evaluating the effectiveness of the benchmarking tool and recommending enhancements for the packaged tool.

Our third objective entailed tracking our time and effort to implement the tool and a series of iterative discussions with our sponsors to assess the effectiveness of the tool in meeting their needs. To track our efforts, we recorded when we started working on a question, when the question was finished, who was contacted, when that person was contacted, when that person responded with information, if that person had to refer the question to another, who that other person was, and the total time it took to answer that question for every question of the benchmarking tool. This information was then stored in the spreadsheet for scoring the University of Worcester along with the scores for each question. We sought to record the process of answering each question to be as transparent as possible and to look for ways to streamline the application of the tool.

To evaluate and enhance the effectiveness of the tool, we held a series of meetings with our sponsors to discuss the strengths, limitations, and possible modifications of the benchmarking tool as we developed and applied it in real time. We found that some questions were not possible to answer and were impeding our ability to run the benchmarking tool. We discussed with our sponsors why these questions needed to be changed and used their input as well as our own research to develop alternative questions. We also discussed ways to improve the tool in the future.

Objective 4 - Assessing how the tool can be modified and packaging the tool for use at other universities.

Our fourth and final objective was assessing how the tool could be modified and packaged for use at other universities. Previous iterations of the tool were developed with only the University

of Worcester in mind and applying it at other universities would need modifications to make the tool functional and easy to use. In order to accomplish this, we needed to know how other universities stored and managed their module directory, including the module titles and descriptions, and research database. In conjunction with researching how universities store and manage their data, we also worked on developing a platform for the tool that anybody could use to easily apply the tool at their university.

After discussion with our sponsors about how the University of Worcester and Kingston University both store their data, we reached out to the University of Leicester, Coventry University, and Keele University which we knew were already involved in sustainability research and practices. We also contacted Newman University which is much less involved in sustainability research and practices. One of the questions we asked was about what database the university uses to store their modules. If the university stored their data in the exact same format as the University of Worcester, then we would be able to run the original tool on their module directory, however if the modules were stored differently, then a new method would need to be created to run the tool at multiple universities. Another question we asked was if the university would be able to store the module data in a CSV file. We decided to use a CSV file format for the module analyzing software as it would be what we thought was the easiest method for making a universal standard format all the universities would have to follow in order to run the tool.

As proof of concept for using CSV files to store and analyze the modules, we met with the University of Worcester's Data Management Team and discussed if this was possible to create these CSV files in order to test the software. When we received the modules in a CSV file, we ran it against the same keywords with the updated software to see if the results compared properly to the previous method of using a web-extension on a web-app version of the module (Woods et. al, 2018). We also asked them if they were able to produce a file that contained all the modules from their respective course routes, so we could answer C2 with the same software. The current method for answering C2 was to accumulate a list of the first four letters of the module codes, which indicated courses, determine which courses were sustainability related, and compare this list with the total list of module code course indicators. Unfortunately, this method was inaccurate as the module code course indicators did not properly map all the available courses and routes a student could take. Having the list of courses mapped to the list of modules would be useful because it would allow us to directly show which SDGs are related to each course.

As for the research aspect of the analyzing software, the University of Worcester and Kingston University used the same publication services for their research. Through Eprints, we were able to export the research as several different formats, however, decided the JSON format was the easiest to parse. Although, this was the same format that was used in the previous IQP, we needed to update the code to be more accessible and universal (Woods et. al., 2018). Even though both the University of Worcester and Kingston University both could produce the JSON files that were run by the analyzing software, in order to justify the file format, we researched how University of Leicester, Coventry University, Keele University, and Newman University stored and maintained their published research database.

Just as we needed the data files to be in a universal format, we needed to make the tool user friendly. We decided to build a website as it would be an easy way for any university to access the tool and software and apply it to their school. We used Bootstrap, which is a framework library for front end support of web-app development in HTML, JS, and CSS. We used GitHub for version control and for hosting the website during development.

Findings and Analysis

Updating the Benchmarking Tool (Objective 1)

For our first objective, we reviewed the existing sustainability benchmarking tool (Appendix A) to determine what needed to be updated. Overall, we found that the benchmarking tool needed several enhancements in order to accurately capture the appropriate information. We updated the keywords used by the module and research analyzing software to reduce false positive and negative results and improve accuracy. We also modified the questions for the curriculum and research part of the tool to improve comprehensibility and ensure the assessment related more directly to the current SDGs.

Keyword Updating

The first aspect of the tool we looked at was the set of keywords used for searching for sustainability-related modules and research articles. The previous WPI project (Woods et. al., 2018) recommended that some of the keywords they used should be removed. In particular, we removed words that created excessive false positives because they were too general and not specific to sustainability per se, such as "employment" and "work." We reran the software of the tool following the removal of such words and found that the number of false positives was reduced significantly.

We examined the modules that were identified as related to sustainability with the minimally modified list of keywords. We used the module descriptions to collect key phrases that could be added to enhance the accuracy of our search. We found that using specific phrases rather than just keywords was more accurate when searching for sustainability modules. For example, the keyword "land" returned more false positives than using a phrase such as "land degradation." In the previous iteration of the project (Woods et al. 2018), the tool automatically identified 10.8% of modules as addressing sustainability, but a manual count revealed the actual proportion was closer to 16.57%. We hoped that by changing the keywords and phrases, the tool would automatically identify more accurately the complete set of sustainability-related modules. We found, however, that modifying the keywords in this fashion made little difference in the percentage returned, only slightly reducing the number of false positives.

Evidently, to make the search more accurate we needed to expand the list of keywords. We found a list of keywords collected by Australian universities which had been used to conduct a similar assessment of sustainability-related research publications and curriculum modules (SDSN Australia/Pacific, 2017). Initially, we incorporated the entire list of keywords assuming that the list would be more accurate without further changes. This was an incorrect assumption, however, and the search using the expanded list designated more than 80% of the University of Worcester modules as sustainability-related. Clearly, this was an over-estimate. We therefore eliminated general words such as "finance", "pay", and "education" which substantially reduced the number of false positives and the percentage of modules designated as related to sustainability. After multiple tests and modifications of the keywords and phrases, the final percentage returned was 15.48% which is closer to the manually calculated 16.57% that we believe is most accurate for the University of Worcester. The final keyword list can be viewed in Appendix D.

Sections of the Benchmarking Tool

In discussion with our sponsors we agreed that either the weighting or grouping of the current curriculum and research tool questions needed adjustment. We decided that questions C1-C4 provided a different enough area of information than question C5-C10 to warrant breaking them up into two separate sections called formal and informal respectively. The same decision was reached for the research tool with R1-R4 and R5-R10 being given separate sections with the same naming convention as well. The new sections would allow a user to answer questions only for one section and receive a score without needing to answer all the questions in the tool. This would also split up scores in the curriculum and research tool so the user can easily find how they score in a particular section. With these changes both curriculum and research consist of two sub-sections. The formal curriculum section examines data on the courses and modules offered and taken. The formal research section examines data on the research being published year to year. Both formal sections use our analyzing software to examine large amounts of data in these areas. The informal sections examine opportunities to learn about or increase the amount of sustainability in the curriculum and research at a university, outside of the classroom setting. The informal sections are answered by asking questions of pertinent staff members.

Question Updating

We enhanced the tool further by updating questions and how they were asked. Based on the results from last year (Woods et al. 2018), many of the questions were not answered in the manner that the previous WPI group had expected. We discussed with our sponsors how they expected each question to be answered. The opinion was that each of the questions was useful if they had a 'depth' behind them. A question having 'depth' means that the question is insightful and retrieves more specific rather than general information about a university. Yes/no questions provide limited information. Questions that are more open-ended give descriptive information and more insight into progress made on sustainability. We modified the questions to be more specific to the information we required and to create more depth.

For each question, there is a balance that must be met between depth and ease of use. The goal of this tool is to be easy to use, but still allow for as much depth as possible. For each question, we discussed how it could be expanded on to provide more descriptive information. For some questions this was simple to do and did not demand much more work for the evaluator. For other questions, it was more difficult to change the question to provide more depth or it was possible but would require much more work than reasonable to evaluate. In these cases, we accounted for the lack of depth by adjusting the score weightings to be lower than other more insightful questions.

Many of the questions asked in the benchmarking tool are answered using percentages. The method of scoring these questions was a series of ranges with each range assigned to a whole number score. This method of scoring works well for simplicity when trying to apply the tool by hand. However, by moving the platform of the tool to a digital application, we were able to add more 'granularity' and precision to the scoring by having the computer automatically calculate a decimal score based on the exact percentage answered relative to the maximum percentage achievable for each question. The questions that were updated to use ranged scoring were C1 through C4 and R1 through R4, or the formal sections of the benchmarking tool.

Curriculum Question Updating

The first change we made was switching the order of questions C1 and C2. Originally, C1 asked for courses and C2 asked for modules. We switched the order of these because the answer to the modules question was necessary for answering the course question. Note that in the below

headers outlining changes to the original questions, C1 and C2 have been switched in order to stay consistent with future mentioning's of C1 and C2.

C1: Number of modules that include sustainability-related topics or themes, relative to the total number of modules offered at the institution, as a percentage

The first change we made to question C1 was changing the question to ask for a percentage rather than mentioning numbers relative to each other. We felt that this would be more clear for the end user as to what information should be entered for this question. We discussed the content of this question and decided it was clear that this question provided a substantial amount of depth and was reasonable enough to answer assisted by the module analyzing software; therefore, the question needed no further modification. After applying the phrasing change, the question now reads "Percentage of modules that include sustainability-related topics or themes, relative to the total number of modules offered at the institution."

We also discussed the relative importance of question C1 to determine an appropriate score weighting. We decided that the number of sustainability-related modules has a large impact on the opportunity for students to learn about sustainability at a university. Also, using the software analyzing software allows this question to give precise and insightful data making it a very valuable question. For these reasons, we raised the maximum score for C1 from 5 points to 10 points, giving it a larger weight on the overall score relative to other questions.

C2: Number of courses that include sustainability related topics, themes, or modules, relative to the total number of undergraduate courses offered at the institution, as a percentage

Similar to question C1, we changed question C2 to also ask for a percentage rather than mentioning numbers relative to each other. For this question, we discussed its similarity to question C1. We questioned whether asking for the percentage of sustainability-related courses mattered given that we already ask for the percentage of modules which is a much clearer indicator of the university's overall effort to have sustainability-related curriculum content. However, what the module percentage does not take into account is the fact that most of the sustainability-related modules are within a small number of sustainability-related courses such as Environmental Science. It is important for universities to be integrating sustainability into all areas of the curriculum so this question is useful in that regard. We decided that determining sustainability-related courses was still

a good way of measuring the progress of integrating sustainability in the curriculum but is not as directly important as the modules so we left the maximum score as 5 points. The question now reads "Percentage of courses that include sustainability-related topics, themes, or modules, relative to the total number of undergraduate courses offered at the institution."

C3: Number of undergraduate students who have taken a sustainability-related module in relation to total number of students enrolled at the institution, as a percentage.

For question C3 it was unclear as to whether the question was asking for the total number of students who have taken a sustainability-related module in the last year or at all during their time at university. After discussing this with our sponsors, we decided that it was important for universities to encourage all students to take at least one sustainability module every year in order to keep sustainability front and center in their thoughts in the hope that this will ultimately change behaviors. To reflect this desire, we changed the question to "Percentage of undergraduate students who have taken a sustainability-related module in the current year in relation to total number of students enrolled at the institution."

For C3, we decided that having students take at least one sustainability module per year was an important goal for universities. We felt that this question was of equal importance to question C1 because there is little use in offering an array of sustainability modules if the students are not taking them. Therefore, we also raised the maximum score of this question from 5 points to 10 points.

C4: Number of departments at the university that include sustainability in their curricula in relation to the total number of departments/colleges at the university, as a percentage.

After discussing this with our sponsors, we decided it was important to identify the percentage of students who had taken more than one sustainability module. To address this, we removed the previous question C4 which did not provide much useful information. For example, in 2018, the question merely revealed that 100% of departments had at least one module in sustainability, which was not indicative of the amount of sustainability in the curriculum.

We replaced this question with "Percentage of modules taken by students that include sustainability-related topics or themes relative to the total number of modules taken by students." This follows the updated question C3, which counts the number of students that have taken at least

one sustainability-related module with the same weighting, and focuses on how many sustainability-related modules each student takes relative to how many modules are being taken by the entire student body. This allows for a student who has taken multiple modules that are sustainability related to be weighed higher than a student who has only taken only one or no sustainability-related modules.

This means that if ten students had taken, in the last year, ten total modules each, then the total taken module count would be 100. If each of these same ten students had three of their modules be sustainability-related modules, then the total count of taken sustainability-related modules would be 30. Therefore, the percentage of sustainability-related modules relative to the total taken modules would be 30 percent. The updated C4 gives better insight for the university into how many students are taking the offered sustainability-related modules, which we decided was important to show.

We also updated the scoring of this question. The maximum score the previous question could obtain was a 5. We discussed that due to the importance of this question for giving insight into how many offered sustainability-related modules are being taken by students, the maximum score was raised to 10. The score was also updated to be based off a range from 0 to 10 with respect to the percentage used to answer the question.

C5: Does the institution contain one or more student organizations with a purpose directly related to sustainability?

Question C5 was originally answered by a 'yes' or 'no'. Results from the previous implementation of the benchmarking tool showed two problems with this question. That it was too easy to score full points on and did not encourage growth of sustainability related student organizations. We concluded that Yes/No questions might be easier to answer, but were less desirable than questions that revealed more granular data on the number or percentage of the attributes in question. Question C5 originally was scored out of five points with a 'yes' receiving five points and a 'no' receiving zero points.

We changed C5 to ask for the "Number of student organizations with a purpose directly related to sustainability." This question will provide more depth to the assessment and allows greater differentiation among universities and in tracking changes over time. With the changed question, the score is now on a range of zero to four points, where each student organization is worth one point and a maximum score of four could be scored with four or more organizations.

C6: Does the institution maintain a regularly updated sustainability website?

For question C6 the content of the question remained mostly unchanged. The wording of "regularly updated" was changed to "updated at least every six months" to eliminate any vagueness in the question. We discussed changing the question to ask about when the website was last updated but many websites do not have dates posted. Asking for the specific date would increase the difficulty of the question in a manner that only slightly increased the depth of the question. The purpose of the question is to determine if a university is publishing their sustainability efforts consistently and not about exactly when they published. The scoring was also changed in the question. Previously, the question was scored out of 5 points but was changed to be out of two points. We thought that the question should not have similar weighting to questions like C1 and C2 that have a more direct impact on sustainability in a student's learning as well as being a generally easy question to score full marks on. The question we used was "Does the institution maintain a sustainability website updated at least every 6 months?

C7: Does the institution's student union offer at least one university wide sustainability-focused educational program or event at least once a year?

For question C7 we made a similar change to that of C5. The question now takes into consideration multiple events a university could hold in a year. This would ensure that there were multiple opportunities for students to learn about sustainability throughout the year. We discussed making the question about the number of students who attended each event but determined it to be too difficult to answer. It would require event managers to count each student that attended and store that information in a central location. Although, this would be a better indicator of where students were learning about sustainability, the effort required to answer the question is too significant. Scoring for the question was changed to be out of three total points with each event or program being worth one point up to three. The resulting question was "Number of university wide sustainability-focused educational programs or events offered by the student union in the last year."

C8: Does the institution conduct an assessment of the sustainability literacy and knowledge of its students?

Question C8 was not changed but has potential to be changed in the future. The scoring of C8 was reduced with a 'yes' receiving three points and a 'no' receiving zero points. There are a number of ways this question could be improved to provide greater insight into how much students are learning about sustainability. This question could ask about the average scores of a sustainability literacy assessment or the percentage of students who pass a literacy assessment. However, this information is difficult to determine and universities do not currently use a standardized sustainability literacy assessment. Different scorings or tests would limit comparability among universities. Therefore, this question remained unchanged.

C9: Does the institution have an ongoing program that offers incentives for academic staff in multiple disciplines or departments to develop new sustainability modules and/or incorporate sustainability into existing departments?

Based on the recommendations of Woods et. al., (2018), we changed the word 'departments' to 'modules' in question C9 because the benchmarking tool is used to measure sustainability in the curriculum and 'modules' is more pertinent. The scoring of the question was also changed from a total of five points to a total of 3 points to reflect the importance of the question. The new question is "Does the institution have an ongoing program that offers incentives for academic staff in multiple disciplines or departments to develop new sustainability modules and/or incorporate sustainability into existing departments?"

C10: Is the institution utilizing its campus by having physical locations which specialize in the following areas of sustainability?

The last question in the curriculum tool, C10, was reworded significantly. The core concept of the question remained the same but the wording was changed to clarify the kind of information being requested. We removed the 'physical locations' part because non-physical events or programs could expose students to issues of sustainability as well as any building or physical location. Also, the previous WPI project (Woods et. al., 2018) listed some non-physical locations and we believed that it was unreasonable to demand a physical location for each area of sustainability. We incorporated this reasoning into the question by using the phrase "i.e. buildings, year-round events or programs?".

The new question is "How many of these sustainability areas does the institution expose the students to outside of the classroom i.e. buildings, year-round events or programs?"

Research Question Updating

R1: Amount of funding from grants and contracts specifying sustainability-related research, relative to the total funding from grants and contracts at the institution, as a percentage.

Similar to the formal curriculum questions in the curriculum tool, we changed questions R1 through R4 on the research tool to ask for percentages rather than numbers. For question R1, it asks for the percentage of funding from sustainability-related research relative to the total amount of research funding. We noticed the previous WPI project asked this question but the answer they provided was the number of grant funded sustainability research projects relative to the total number of funded research projects. We noticed this was odd, however the implementation guide provided by the previous WPI team did not change this question. We figured the last WPI project answered it in this way because they were unable to acquire the correct information. We discussed whether continuing to ask for funding rather than number of research projects was important. Funding is generally used as a measure of impact for research projects. This is not always the case because many small research projects at smaller universities can still have a large impact. In the end we decided to continue to ask for funding because overall it would still provide more information about sustainability-related research projects than how many there are. We also decided to leave the question score at 5 points. The question we used was, "Percentage of grant or contract funded sustainability-related research, relative to the total number of grant or contract funded research at the institution."

R2: Number of published research articles with a focus on sustainability-related issues, relative to the total number of research publications in all areas, as a percentage.

For question R2, we adjusted the scoring of the question and some of the wording. R2 was initially scored with 10% required to get the maximum of five points. We felt, after seeing the results from the past year which was 22%, that 10% was too low and raised it to 15%. This would not affect the score for University of Worcester but it would make it more difficult to achieve the maximum score. We believe the median used to establish the scoring range underestimated the amount of sustainability-related articles published by higher education institutions in the UK. We

changed the wording by removing "Number" and replacing it with "Percentage". The resulting question was "

R3: Number of the institution's academic staff that are currently engaged in sustainability research, relative to the total amount of academic staff who conduct research, as a percentage.

Question R3 received a minor change. To clarify what the question was asking for we changed the word "Number" to "Percentage". We found no other way or reason to change the question. Since R3 is answered using the research analyzing software any significant changes may derail the software's ability to assist with this question. The new R3 is "Percentage of the institution's academic staff that are currently engaged in sustainability research, relative to the total amount of academic staff who conduct research."

R4: Number of academic departments that include at least one academic staff member that conducts sustainability research compared to other areas of research, relative to the total number of academic departments, as a percentage.

We made a minor wording change to R4, to clarify what the question was asking for. We changed R4 to "Percentage of academic departments that include at least one academic staff member that conducts sustainability research compared to other areas of research, relative to the total number of academic departments." This made the question easier to understand for the user.

R5: Does there exist one or more resource centres on campus providing sustainability-related research or services?

In R5, we added "research groups" because they served similar purposes as "research centres" in expanding or assisting research in a specific area, in this case sustainability. Research groups, also, do not need a physical location, whereas research centres do. We also changed some of the wording of the question to make it easier to understand, from "Does there exist one or more" to "Does the institution have one or more".

R6: Does the institution have an ongoing program to encourage students in multiple disciplines or academic programs to conduct research in sustainability?

This question remained unchanged. We decided to lower the total points of all the Yes/No questions, including R6, from five to four points. We made this change because the Yes/No questions do not provide as much information as the percentage questions and therefore should not be weighted the same.

R7: Does the institution have a program to encourage academic staff from multiple disciplines or academic programs to conduct research in sustainability topics? (To count, the program must provide faculty with incentives to research sustainability and specifically aim to increase faculty sustainability research)

This question remained unchanged. We were unable to increase the depth of this question so we lowered the total points of the question from five to four points. We made this change because the Yes/No questions do not provide as much information as the percentage questions and therefore should not be weighted the same.

R8: Has the institution published written policies and procedures that give positive recognition to interdisciplinary, transdisciplinary, and multidisciplinary research during faculty promotion and/or tenure decisions?

We determined that question R8 regarding policies on faculty promotion and interdisciplinary research was not sufficiently related to sustainability and removed it from the research tool.

R9: Does the institution have ongoing library support for sustainability research and learning in the form of research guides, materials selection policies and practices, curriculum development efforts, sustainability literacy promotion, and/or e-learning objects focused on sustainability?

We discussed creating more depth for this question by determining how many of the sustainability research guides or materials were used at the university. As a manual search, this was determined to be impossible because there were greater than 1 million searches made in the library database in 2018. This question, therefore, remained unchanged. We were unable to change this question to gather more depth so we lowered the amount of points it was worth from five points to four. Question R8 was removed which caused this question, R9, to be renamed to question R8.

R10: Does the institution provide financial incentives to support open access publishing, e.g., a publishing fund to support faculty members with article processing and other open access publication charges?

We discussed removing this question because it does not seem to relate directly to sustainability. However, open access publishing allows for more research, including sustainability-related research to be distributed throughout the world. Increasing knowledge in all topics is greatly important to sustainability. This question remained unchanged. We were unable to change this question to gather more depth so we lowered the amount of points it was worth from five points to four. Question R8 was removed which caused this question, R10, to be renamed to question R9.

Overall Scoring

With these changes to the Sustainability Benchmarking Tool (Appendix E) the total score for the Curriculum Benchmarking Tool is 55 points and the total score for the Research Benchmarking Tool is 45 points. The total score of the Sustainability Benchmarking Tool remains at 100 points but more points are allotted to the Curriculum Tool than the Research Tool to reflect the greater impact of sustainability in the curriculum on students than sustainability-related research.

Applying the Benchmarking Tool (Objective 2)

We applied the benchmarking tool primarily to the University of Worcester and in partial fashion to Kingston University. The tool was created for the University of Worcester which made it relatively easy to reapply in its modified form. We used our application of the benchmarking tool to Kingston University as a proof of concept for applying the benchmarking tool to other universities.

The University of Worcester

We began by running the benchmarking tool on the University of Worcester. The benchmarking tool consists of two parts: one part focusing on curriculum and what is being taught, the other part focusing on research. Both curriculum and research consist of two sub-sections. The formal curriculum section examines data on the courses and modules offered and taken. The formal research section examines data on the research being published year to year. Both formal sections use our analyzing software to examine large amounts of data in these areas. The informal sections examine opportunities to learn about or increase the amount of sustainability in the curriculum and

research at a university, outside of the classroom setting. The informal sections are answered by asking questions of pertinent staff members.

Formal Curriculum

We used the revised software in the benchmarking tool with the updated list of keywords and phrases to determine the sustainability content of the University of Worcester curriculum. The tool provides insights into how extensively the sustainable development goals are integrated in the university curriculum as well as how these resources are being utilized by students. A graphical representation of the results of the formal curriculum section (questions C1-C4) is presented in Figure 7.

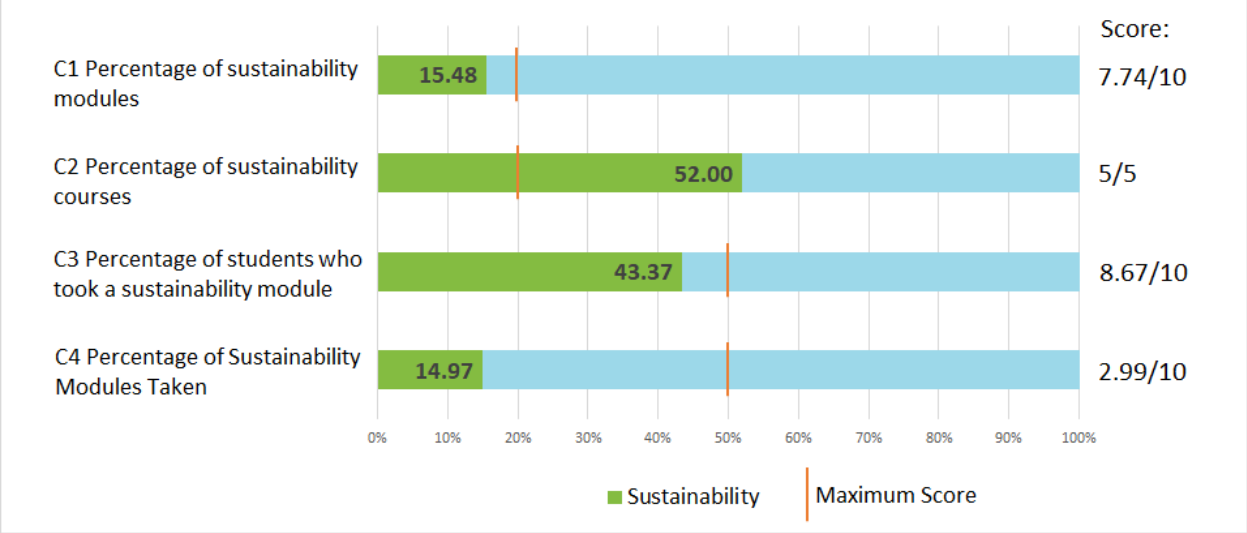

Figure 7: Sustainability Content of the Formal Curriculum at the University of Worcester, 2018-19

C1: Percentage of modules that include sustainability-related topics or themes, relative to the total number of modules offered at the institution.

Using the web app of the module directory for 2018/2019 provided by our sponsor, Dr. Barrett, we ran the curriculum module analyzing software. This question gathers a percentage of modules containing an SDG-related keyword. An example of a module and what the software does is included in Appendix C. The highest score attainable in this question is 10 points if more than 20% of modules address one of the SDGs. At the University of Worcester, 191 out of 1236 modules

or 15.48% of the modules address the SDGs giving the university a score of 7.74/10. Using the same software on the 2017/2018 module directory returned 15.55%. Overall, there is one more module this year that is not related to sustainability which caused a small percentage drop.

The software also identifies which modules associate with each SDG. For the University of Worcester, the largest proportion of sustainability modules relates to SDG 3, Good Health and Well-Being, followed by SDG 1, No Poverty. The relative proportion of each SDGs occurrence is shown in Figure 8.

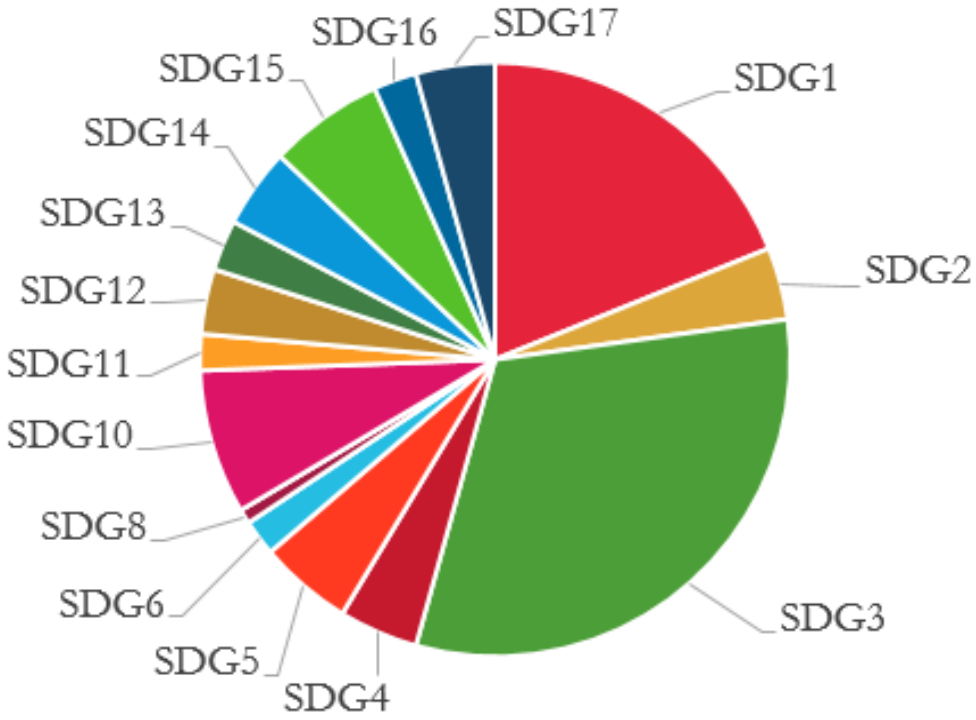

Figure 8: Proportion of SDGs in Modules at the University of Worcester, 2018-19

C2: Percentage of courses that include sustainability-related topics, themes, or modules, relative to the total number of undergraduate courses offered at the institution.

Having identified the modules that relate to one or more of the SDGs, the software determines which courses contain one or more of those modules. The highest score attainable in this question is 5 points which is awarded when the percentage of courses that address sustainability exceeds 20% of all university courses offered. At the University of Worcester, 47 courses out of 90 or 52.22% of the courses offered in 2018-19 included one or modules related to the SDGs, giving the university a score of 5/5. Using the same software on the 2017/2018 module directory returned

52.69%. Normally, the number of courses would not change year to year. Because the number of sustainability-related modules did not change significantly, the number of sustainability-related courses should not change significantly either.

C3: Percentage of undergraduate students who have taken a sustainability-related module in the current year in relation to total number of students enrolled at the institution.

Question C3 is designed to determine the number of students who have taken at least one sustainability-related module in the last year. A major goal of the benchmarking tool is to provide information so that universities can track and systematically increase the number of students learning about sustainability year-on-year. The highest score attainable for this question is 10 points when the percentage of students that have taken at least one sustainability module exceeds 50%. The module analyzing software produces the list of modules deemed to be sustainable which is formatted into an excel spreadsheet with modules codes and module names. We sent the spreadsheet to Greg Dobbins in the data management unit at the University of Worcester. In the academic year 2018-19, 4233 out of 9760 students or 43.37% of students had taken at least one sustainability-related module giving a score of 8.67/10.

C4: Percentage of modules taken by students that include sustainability-related topics or themes relative to the total number of modules taken by students.

Question C4 accounts for all sustainability-related modules taken during the academic year. Each student at the University of Worcester can takes up to 10 modules per year. The total number of modules taken by students in the last year was 47,264. After determining which modules at the University of Worcester were sustainability related, we were able to find how many of the total modules taken in the last year were sustainability related. This allows multiple counting of modules taken by one student to show up in the results. For example, if 30 students each take 2 sustainability modules, that is a count of 60.

The highest score attainable in this question is 10 points with a percentage of sustainability-related module taken instances greater than 50%. Using the spreadsheet we provided on sustainability related courses and modules, Greg Dobbins, in the data management unit, identified the number of sustainability modules taken by all students. In 2018-19, at University of Worcester,

7075 of the modules taken were sustainability-related out of the 47,264 modules taken resulting in 14.97%. This gives a score of 2.99/10.

Informal Curriculum

We then answered the informal section of the curriculum tool. The informal curriculum tool examines sustainability learning opportunities outside the classroom. This includes sustainability-related events held by the university and sustainability-related clubs or societies available for students to join. This part of the tool is less data intensive and many of the answers are subjective. The questions rely on the judgement of the individual interpreting and answering the questions. Results from the informal curriculum show how the institutions engages its students in thinking about sustainability and what extra opportunities are provided outside the classroom. Figure 9 summarizes the results of these analyses.

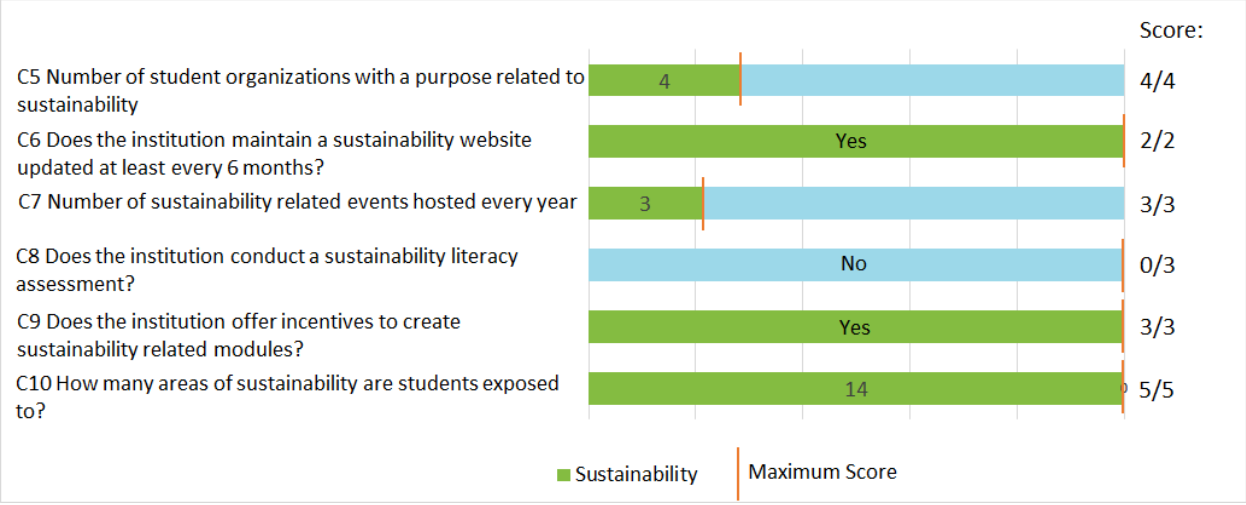

Figure 9: Sustainability Content of the Informal Curriculum at the University of Worcester, 2018-19

C5: Number of student organizations with a purpose directly related to sustainability.

Students can learn about sustainability outside the classroom. The assumption is that more students are likely to be more aware of and knowledgeable about sustainability when there are more clubs promoting sustainability at the university. The highest score attainable in this question is 4 points if the university has at least 4 sustainability-related student organizations. We found list of student organizations on the university website. In 2018-19, the University of Worcester had more than 4 student organizations (e.g. Education Enhancement, LGBTQ+, Nutrition, and Student Minds) resulting in a score of 4/4.

C6: Does the institution maintain a sustainability website updated at least every 6 months?

Research and policies on sustainable development are constantly changing, and universities need to update university faculty, staff, and students as well as the larger public on what they are doing to contribute to sustainability around the world. The university website is a valuable vehicle to communicate about these efforts with a variety of audiences on and off campus. The highest score attainable in this question is 2 points if the university regularly updates its sustainability website. The Director of Sustainability, Katy Boom, had updated the website recently. The University of Worcester does have an updated sustainability website giving a score of 2/2.

C7: Number of university wide sustainability-focused educational programs or events offered by the student union in the last year.

SDG-focused educational programs and events allow for students to learn about sustainability without necessarily committing to a module or student organization. Having more of these events provides more opportunities for students to learn about sustainability. The highest score attainable in this question is 3 points with at least 3 sustainability-focused educational programs or events in the last year. Katy Boom, the Director of Sustainability, provided a list of events. In 2018-19, the University of Worcester had more than four events (e.g. Go Green Week, Co-op Bottle Giveaway, Fairtrade Procurement Event, and Welcome Week) resulting in a score of 3/3.

C8: Does the institution conduct an assessment of the sustainability literacy and knowledge of its students?

A literacy test is a good way to measure how much students have learned about sustainability. The number of sustainability modules offered and taken only matter if students are learning from them. The highest score attainable is 3 points if the university conducts a sustainability literacy assessment. In 2018-19, the University of Worcester did not conduct a sustainability literacy assessment giving a score of 0/3.

C9: Does the institution have an ongoing program that offers incentives for academic staff in multiple disciplines or departments to develop new sustainability modules and/or incorporate sustainability into existing modules?

Increasing the sustainability content of existing modules or creating new modules that address different aspects of sustainability is vital to the promotion of sustainability in the future. Many universities provide incentives for staff to enhance the sustainability content of the curriculum. The highest score attainable in this question is 3 points if the university does offer incentives. Katy Boom, the Director of Sustainability, provided us with a description of sustainability programs at the University of Worcester. In 2018-19, the University of Worcester had the Learning for Responsible Futures Initiative earning in a score of 3/3 on this question.

C10: How many of these sustainability areas does the institution expose the students to outside of the classroom i.e. buildings, year-round events or programs?

This question is rather open-ended to allow universities to show the extent that they are using their campuses as living laboratories. The highest score attainable in this question is 5 points if the university exposes its students to all 14 of the categories. We determined the number of 'areas' represented at the University of Worcester by speaking with Katy Boom and Dr. Heather Barrett, reviewing the university website, and personal observations on the campus. The University of Worcester exposes its students to all 14 areas and scored 5/5 in 2018-19.

- Air & Climate - Car Share Program to reduce carbon emissions
- Buildings - The Hive, a sustainability-focused library
- Energy - Student Switch Off Program, incentivize turning off electronic devices when not in use
- Food & Dining - Caterer Aramark which works with sustainable, local suppliers
- Grounds - Ecocampus Platinum as well as university gardens and pizza oven
- Purchasing - Sustainable Procurement Strategy
- Transportation - WooBikes, a bikeshare program
- Waste - Recycling areas for food and reusables in student areas
- Water - Student run water saving project and water bottle program
- Coordination & Planning - Director of Sustainability works with estates to meet sustainability standards

- Diversity & Affordability - Admissions provides financial aid and scholarship for students in need
- Investment & Finance - Money Advice Program for students
- Public Engagement - Go Green Week, engaging the community in sustainable efforts
- Wellbeing & Work - Healthy for Life Program encouraging students to live healthy lives

Formal Research

In additional to the formal and informal curriculum at the University of Worcester, we also assessed the sustainability content of formal research activities at the university. The formal research tool examines research in progress and published. The formal research tool uses the research analyzing software to search the institution's research database for publications related to sustainability (R2). The tool uses an additional question (R1) of appropriate staff to supplement the results of the research analyzer software. Figure 10 summarizes the results of these analyses.

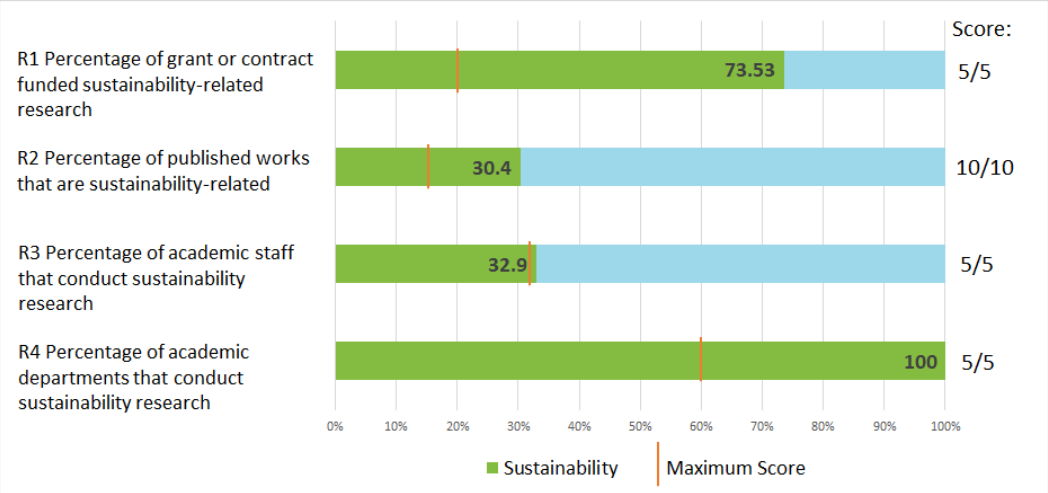

Figure 10: Sustainability Content of the Formal Research at the University of Worcester, 2018-19

R1: Percentage of grant or contract funded sustainability-related research projects, relative to the total number of grant or contract funded research at the institution.

To answer Question R1, the tool asks appropriate staff to determine the number of ongoing, funded research projects at the institution that address sustainability as a proportion of all funded research projects. The metric focuses on the number of discrete projects, not the amount of funding. If the proportion of sustainability-related projects exceeds 20% of the total, the university is

awarded the highest possible score of 5. We spoke with Karen Dobson in the Research Department at the University of Worcester to determine the answer to this question. We initially asked for the amount of funding that sustainability-related research projects received, however that data is not publicly available. Instead, we had to determine the number of sustainability-related research projects as a proportion of all research projects active in 2018-19 based on the titles of each project. This assessment therefore does not distinguish between the size of the project based on funding amounts or the numbers of staff and students involved. In 2018-19, 73.53% of the funded research projects at the University of Worcester related to sustainability giving it a score of 5/5.

R2: Percentage of published research articles with a focus on sustainability-related themes, relative to the total number of research publications in all areas.

Rather than asking staff to provide data, Question R2 uses the research analyzing software to scan the titles and abstracts of all research publications in the previous academic year according to the university research database. The software uses the same set of keywords used in the module analyzer to identify those projects related to sustainability. The highest score attainable in this question is 10 points with a percentage of sustainability-related published research articles greater than 15%. The University of Worcester returned 30.4% of published research related to sustainability giving a score of 10/10.

The software also identifies the distribution of SDGs in the University of Worcester's published research. SDG 3 (Good Health and Well-Being) and SDG 1 (No Poverty) figure most prominently as research topics (Figure 11), which is similar to the pattern found in the curriculum (Figure 8). SDGs 8 and 9 were not covered at all in the University of Worcester Research.

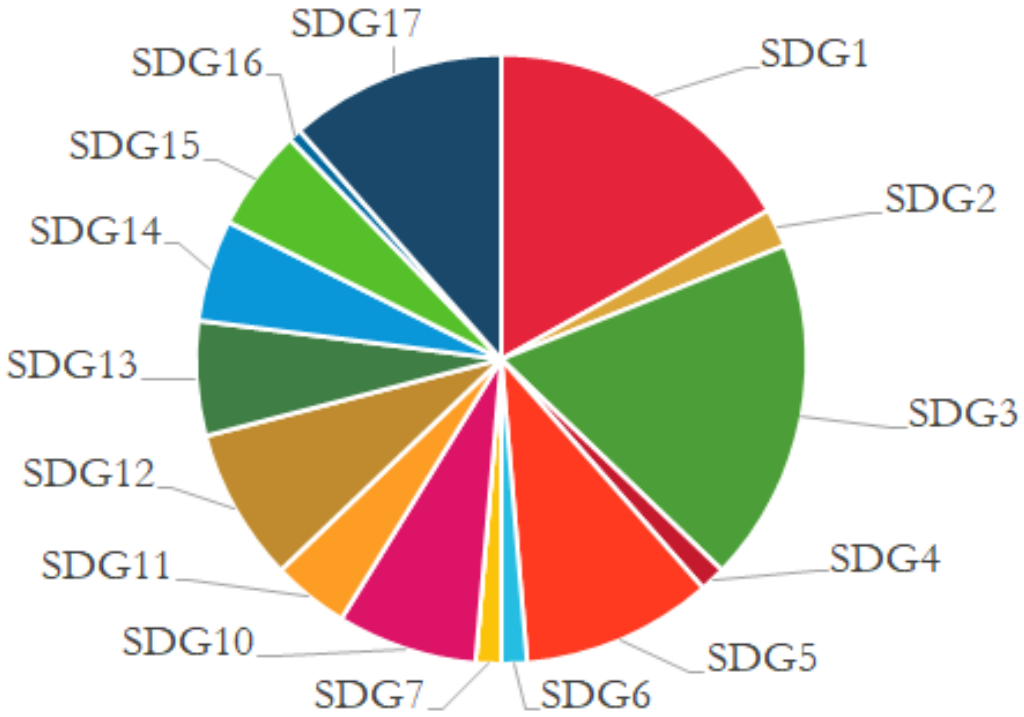

Figure 11: Proportion of SDGs in Published Articles, 2018-19

R3: Percentage of the institution's academic staff that are currently engaged in sustainability-related research, relative to the total amount of academic staff who conduct research.

This question gathers the number of staff that conduct sustainability-related research as a percentage of the total number of staff that conduct research. The research analyzing software returns the answer to this question. The highest score attainable in this question is 5 points with a percentage of staff greater than 32%. Almost 33% of faculty at the University of Worcester conducted sustainability-related research in 2018-19 giving a score of 5/5.

R4: Percentage of academic departments that include at least one academic staff member that conducts sustainability-related research, relative to the total number of academic departments.

This question determines which academic departments have one or more staff engaged in sustainability research as a percentage of departments that contribute to sustainability-related research. The highest score attainable in this question is 5 points with a percentage of departments greater than 60%. We cross referenced the list output from the research analyzing software with a list of academic staff found on the University of Worcester website. We found that 100% of the

academic departments at the university have at least one academic staff conducting research in sustainability giving a score of 5/5.

Informal Research

We moved on to the informal section of the research tool. The informal research tool examines how sustainability-related research is being encouraged at a higher education institution through resources and student/faculty engagement. The questions in the informal research tool are answered with yes or no. The informal research tool like the informal curriculum tool is less data intensive and relies on the judgement of the individual implementing the benchmarking tool and those answering the questions. Results from the informal research tool will show how an institution encourages sustainability-related research. Figure 12 summarizes the results of these analyses.

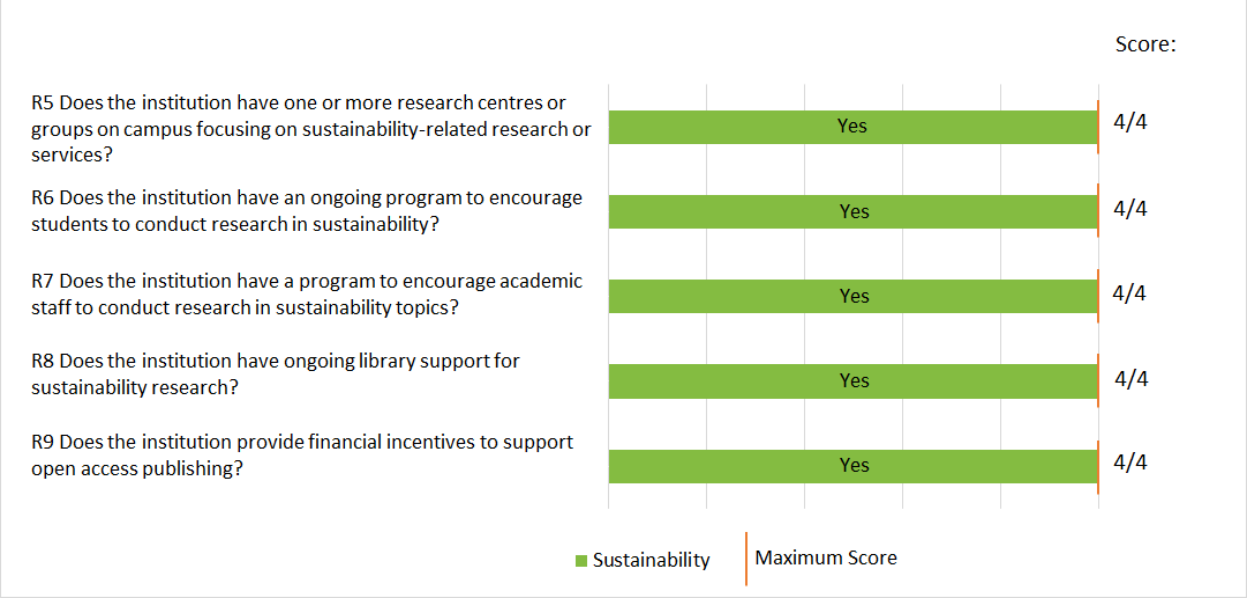

Figure 12: Sustainability Content of the Informal Curriculum at the University of Worcester, 2018-19

R5: Does the institution have one or more research centres or groups on campus focusing on sustainability-related research or services?

This question determines if there are services at the institution with the purpose of promoting sustainability. The highest score attainable in this question is 4 points if the institution has a research centre related to sustainability. We found a list of research centres on the University

of Worcester website. The University of Worcester has multiple sustainability-related research groups including Green Voices, Ecology and the Environment, and Social Psychology of Education which gives it a score of 4/4.

R6: Does the institution have an ongoing program to encourage students in multiple disciplines or academic programs to conduct research on sustainability-related topics?

Student involvement in research is important. Students can also provide a lot of help to researchers while learning more about sustainability. The highest score attainable for this question is 4 if the university has a program encouraging such student involvement. Katy Boom, the Director of Sustainability, provided us with a description of their sustainability programs. The University of Worcester has the Learning for Responsible Futures program which provides monetary rewards to research projects that focus on sustainability and include students as researchers giving it a score of 4/4.

R7: Does the institution have an ongoing program to encourage academic staff in multiple disciplines or academic programs to conduct research on sustainability-related topics?

It is important for researchers from all types of disciplines to conduct SDG research. This question is designed to determine whether the institution provides incentives for conducting this research as a way of showing its commitment to institution-wide sustainability. The highest score attainable for this question is 4 if the university has a program. Katy Boom, the Director of Sustainability, provided us with a description of their sustainability programs. The University of Worcester has the Learning for Responsible Futures program which provides monetary rewards to research projects that focus on sustainability and include academic staff as researchers giving it a score of 4/4.

R8: Does the institution have ongoing library support for sustainability-related research and learning in the form of research guides, materials selection policies and practices, curriculum development efforts, sustainability literacy promotion, and/or e-learning objects focused on sustainability?

Sustainability-related resources show that the university is interested in informing their students about sustainability. Sustainability resources allow students who are interested in sustainability projects or research to access the information they need for their work. The highest score attainable for this question is 5 if the university has library support for SDG-related topics. We

found a list of library guides on the University of Worcester website and spoke with librarians. The University of Worcester has multiple library guides in SDG topics such as Geography and Environmental Science giving it a score of 5/5.

R9: Does the institution provide financial incentives to support open access publishing, e.g., a publishing fund to support faculty members with article processing and other open access publication charges?

Open access publishing allows greater numbers of people to access research. Learning about sustainability through specific research interests would expand sustainability research into the world. The highest score attainable for this question is 4 points if the university provides such financial incentives. We found the University of Worcester publishing policies on the university's website. The University of Worcester has an open access policy for publishing research giving it a score of 4/4.

Kingston University

We looked at how well the sustainability benchmarking tool could be adapted to other universities and attempted to run the benchmarking tool on Kingston University. We ran into problems with the way that Kingston University held their data. For C1 through C4, the module analyzing software must be run on either a web app of the module directory or a csv of the module titles and descriptions. Kingston University uses the same SITS database for their directory as the University of Worcester, however, it does not include module descriptions. They were also unable to create a csv of the modules because they were in the middle of transferring their module listings to a different database. Therefore, we were unable to perform the formal part of the curriculum tool on Kingston University.

We asked Dr. Victoria Hands to perform the remaining questions of the benchmarking tool. This was mainly to see how easy the tool was to run and how understandable the questions were to answer. We were given several good suggestions to improve the benchmarking tool which we examine in the next section. Prior to sending the benchmarking tool, we ran the research analyzer on Kingston University's research database. It used keywords to scan a JSON file downloaded from EPrints, the same database software as the University of Worcester. The research software did not work originally and was difficult to update due to slight differences in naming conventions. We

discuss making the benchmarking tool universal in Section 4 of our findings. We made some corrections and found that 18% of published articles have some aspect of SDGs in them which would answer question R2. We also found that 23% of authors wrote those sustainability-related articles for R3.

Evaluating the Effectiveness of the Benchmarking Tool (Objective 3)

We evaluated the effectiveness of the benchmarking tool and the results produced by it and found enhancements for the tool according to the sponsors' input. We recorded when we started working on a question, when the question was finished, who was contacted, when that person was contacted, when that person responded with information, if that person had to defer the question to another, who that other person was, and the total time it took to answer that question for every question of the benchmarking tool. This information is stored in a University of Worcester benchmarking tool spreadsheet along with the scores for each question.

We found that question R1 on the research tool takes the longest time to receive an answer and does not provide much depth. However, it does not take much work to complete and only relies on the amount of work the Research Department has before focusing on the question. It also could not be answered in the manner that was asked. The question was answered as the percentage of sustainability-related ongoing funded research projects out of the total number of funded projects. The original question of amount of funding could not be answered as the information is considered private.

We also changed the location that questions C6, C7, C8, C9, R5, R6, and R7 are answered from. We initially attempted to use the website to answer these questions but were unable to answer them completely and they took a significant amount of time. We asked Katy Boom, the Director of Sustainability at the University of Worcester, these questions and received answers to all of them very quickly. This helped solidify the idea that a university could quickly apply the benchmarking tool themselves without our help.

Question Updating

We discussed with our sponsors to get their input on questions in the sustainability benchmarking tool. Often this input would come from meetings during the application of the tool. Feedback from both our sponsors was very constructive and provided an outside view of the benchmarking tool and where it can be improved.

The first major input from our sponsors was to change question C10 from exposing students to 10 seemingly arbitrary areas of sustainability to exposing students to the 17 sustainable development goals. This input challenged how we defined sustainability at the time and how confusing it may be to others who seek to use this tool and have different definitions of sustainability. The Sustainability Benchmarking Tool was developed to measure how well a Higher Education Institution was accomplishing certain areas of the Sustainable Development Goals. Therefore, when a question mentions sustainable or sustainability-related it meant the definition of sustainability defined by the United Nations in the 17 Sustainable Development Goals. To fix this problem we changed every instance of sustainable to or sustainability-related in the benchmarking tool questions to SDG or SDG-related (Appendix F).

Question C6 received input for further explanation and possible expansion of the question. This question was changed first as part of objective one which intended to clear up confusion on what constitutes regular updates to a website. When our sponsors attempted to use the tool themselves there were still problems of interpretation in the question. Such as what counts as an update to a website, why the six months, and is this the most effective question to ask? We found that it is difficult to create a criterion that contains every possible update to a website. The question was changed again to put more focus on the user and ask if they or any faculty had updated the sustainability website. In the assumption that users of the sustainability benchmarking tool are members of a university's sustainability department. The time limit of 6 months to update the website was kept the same. The reason to update the website was to insure all information stayed up to date but some pages would stay up to date for years depending on the information. There was no need for frequent updates, as long as the sustainability website was being reviewed and changed twice a year it would still be relevant. The last input to C6 was to measure how effective the sustainability website was. The suggestion was to record how many people visited the website. There is no current way for the sustainability benchmarking tool to record website visitation. It would have to be a changed implemented by the university such as google analytics or a short questionnaire before accessing the sustainability website. It is important to find how many students visit the

website and not just total visits because the benchmarking tool measures the learning of sustainability in students.

Question C7 received a wording change after a recommendation from our sponsor. The focus of question C7 was originally on "university wide" events which diminished the importance of engaging the community if the event was confined to the campus of the university. The reworded question now puts focus on "education programs or events" that "engaged the students". This new form of the question opens up to more events that can be scored and allows for events that are not hosted by a university as long as it is sponsored and engages students.

Sponsor Recommendations

Not all input or recommendations from our sponsors could be acted upon in the time available for this project. We did however explore each recommendation to see how it could be used in a future iteration of this project. One such recommendation was to change question R8 to measure how many sustainability-related works are being accessed at the university library each year. We explored if it was possible to record how many times sustainability-related works were accessed through the Hive databases. The Hive is the joint University of Worcester and City of Worcester library. In a meeting with IT staff at the Hive we found that the library used Google analytics to track use of its databases. Google analytics is designed to easily sort various data points gathered from a website including search queries. It is possible to find this information at the University of Worcester. Further questioning of other universities is needed, but collecting and analyzing such data would appear to be a viable option in a future version of the benchmarking tool.

In question C8 we had discussed how a better version of the question could ask for average student score on a sustainability literacy test or how many students take a sustainability literacy test instead of whether one was available at the institution. A solution to this issue came up in a discussion with our sponsors we learned of the SULItest. The SULItest was established in 2013 as a sustainability literacy test of the SDGs. This test is currently in trial runs and is beta testing the questions and features of the test. It is still unavailable for universities to use and give to their students, which is why we were unable to act on this information. When the SULItest is released, question C8 could use the sustainability literacy assessment, expanding on the depth of the question.

Our sponsors also emphasized the need to include examples in each benchmarking tool question to clarify the type of information being sought. Accordingly, we have included examples in

each question on the website version of the benchmarking tool. Unfortunately, since most of the results from the benchmarking tool are from the University of Worcester there is not enough data to provide effective examples. If the tool is used by more universities, it will gather more data on what universities provide as answers for each question. From these answers more effective examples can be developed and incorporated in future versions of the tool.

Assessing the Universality of the Benchmarking Tool (Objective 4)

Our final objective was to assess how the tool could be modified and packaged for use at other universities. We found this to be much more convoluted than our initial observations. Adapting the module and research analyzing software to work for any university regardless of how they stored their module directory and research database posed substantial challenges.

When we first met with our sponsors, we were under the impression that both the University of Worcester and Kingston University stored their module directory in the same format since they both used the same service for maintaining their modules, SITS. SITS is a product of the Tribal Group that is used for storing module directories at universities across the United Kingdom. This initial impression, however turned out not to be the case even though both universities use SITS. Although, the University of Worcester does store their module descriptions in SITS, Kingston University does not, but rather in individual Word documents. Due to the key difference of how the module descriptions are stored, we were not able to use the module analyzing software at both universities.

We determined a more standard way universities would have to present their module data in order to successfully run module analyzing software at multiple universities. For applying the benchmarking tool, we decided to test a Comma Separated Values (CSV) file format to hold the module codes, module titles and module descriptions for undergraduate students. We contacted the data management staff at the University of Worcester, and Kingston University, as well as the data management staff at a selection of other Universities (University of Leicester, Coventry University, Keele University, and Newman University) to see if they could create the CSV file with their modules.

When the University of Worcester's Data Management Team responded with the CSV, we found a couple underlying problems with this file type. Since a CSV, works with comma separated values, if the module description had a comma in it, the CSV would recognize the punctuation

incorrectly and separate the description. This would cause the keyword searching to break as some keywords in descriptions could get cut off and not be recognized. Another issue we found was there would be an excess number of blank lines in the file that would appear to the software as blank modules. Although, we were able to use the CSV provided to develop new module analyzing software, we were unable to compare the results produced by this CSV to the previous module analyzing software because the CSV was too faulty.

Kingston University was unable to produce the CSV file as they are currently in the process of moving the descriptions from Word documents to a website. However, Keele University was able to produce the CSV, although they use their own manual process for benchmarking the sustainability in the module descriptions. The CSV they provided did not include the module descriptions, but was produced by their student database, SCIMs, which is where they store their module descriptions as well. Since the information in the CSV and the module descriptions are both stored in SCIMs, Keele University could export the necessary information to a CSV file for the module analyzing software. Also, the CSV provided to us by Keele University included the course routes each module belonged to which would help answer C2, as well as the number of students taking the modules which would help answer C3 and C4.

For the research analyzing software, we decided to keep the same file type as the previous year, a JSON file format. We found both the University of Worcester and Kingston University use the same publication service for their research, EPrints. With EPrints we were able to export all the research of a specific year into a single JSON file. We also found that Keele University uses the same service and we could export their research as a JSON file as well. A JSON file can compile a year of research into a single file that can be parsed. The biggest challenge we found in analyzing the research data is that not all projects include abstracts in the database. This means the software will under-report the number of sustainability related projects. Improving the accuracy of the software would require that all research projects listed in a database also include an abstract.

Finally, we needed a platform that would maintain the tool and analyzing software that any university could use. We decided a website would be the best platform to develop, as websites are the most easily accessible platform to anyone with an internet connection. We explored options such as Wix and WordPress for drop and drag web development, however, found that we needed more access to the software that included the analyzing software. Instead, we decided to use Bootstrap 4, which is a library framework for front-end development that allows for the website to be customized and functional to what we require. The website was created using HTML5, CSS 3, and

JS. We decided to host it on GitHub due to GitHub's capabilities for code repositories and version control.

The website consists of six pages and a link to the United Nations SDGs (Appendix G). These pages consist of the Home, About, Curriculum Tool, Research Tool, Disclaimer, and Keywords. The About page is where all information regarding the tool questions and software can be found, as well as the justifications of the keywords used for the module and research analyzing. The Curriculum Tool and Research Tool pages both host their respective parts of the tool. This includes the module and research analyzing software, respectively, the benchmarking questions, and a brief user manual for how to answer the questions and where to get the information to input. At this time the information is stored locally and is deleted every time the pages are refreshed. Since entered information is being stored briefly, a pop-up of a disclaimer explaining the privacy protection pops up when either of these pages are entered. The Disclaimer page also reiterates the privacy protection that the user can read through. Finally, the Keywords page lists out all the currently used keywords that are a part of the module and research analyzing software.

The module and research analyzing software had to be updated to work in JS. This was an easy conversion from the previous IQP as most of the base code remained the same. The key differences between the new version and previous version is the language is now entirely in JS. Also, both analyzing software now keep track of modules and research with respect to each of the 17 SDGs. This includes modules and research that double count because they reflect multiple SDGs.

Conclusions & Recommendations

We found there are a number of different ways to benchmark sustainability at a university. Several sustainability benchmarking tools are currently in use but each has strengths and limitations. Simpler tools use quasi-automated assessments of publicly accessible data (e.g. People and Planet). Universities do not need to spend any time inputting data but the results are limited primarily because publicly accessible university websites have only limited information about their sustainability activities. More comprehensive benchmarking tools (e.g. STARS and THE) provide a wider spectrum of information about university activities related to sustainability, but require considerable effort from participating institutions to gather and submit data in appropriate forms.

Other universities have taken a different approach to tracking their progress promoting sustainability. For example, in 2014-15 Keele University devoted substantial time and resources through Green Keele, its Office of Sustainability, to manually establish a baseline assessment of all its efforts regarding sustainability, including all aspects of their curriculum and research. With somewhat less additional effort each year, the university can now update the baseline information and assess year-to-year progress on sustainability across university courses and modules. This is arguably the most accurate way to assess progress on sustainability at a university but many universities do not have the resources to conduct manual sustainability assessments annually. Such a customized approach also limits the ability to compare progress across the higher education sector.

The sustainability benchmarking tool developed at the University of Worcester was intended to address two limitations of previous benchmarking tools. Namely, it was designed to (1) explicitly assess the sustainability content of the research and curriculum at universities and (2) to do so in a manner that was semi-automated and required relatively little staff time and resources. The two limitations require a fine balance between achieving the desired richness of analysis without making the data gathering unnecessarily burdensome.

The module and research analyzing software was easy to update to the newest academic year for the University of Worcester and did not require any major modifications. It only required the newest list of research publications from the University website and the web app to the module directory, both of which were easy to gather. The software makes the tool very efficient and valuable to the University of Worcester.

The University of Worcester scores highly in the benchmarking tool, with a perfect 45/45 on the research tool and a 41.4/55 on the curriculum tool. The university only lost points in some

parts of the formal curriculum and for not having a sustainability literacy assessment. The University of Worcester's scores are not surprising since the university has focused on sustainable development for many years and has scored highly on other independent assessments, such as THE and People and Planet. The sustainability benchmarking tool provides a good way to measure the University of Worcester's current efforts and future progress in promoting sustainability. We recommend that the University of Worcester continue to use the modified tool to track their progress.

Making the tool more universally applicable, however, will require a substantial effort primarily because universities store data on their curriculum, research, and other activities in many different forms. Kingston University uses the same database tools (SITS) for modules as the University of Worcester but they enter their data for their modules without the descriptions. This made the module analyzing software unusable and would require major software changes to fix. We were able to run the research analyzing software on Kingston University's research publications. Their research publications are available in a JSON file format, which is similar to the University of Worcester's, which made the software usable. However, many publications did not include the abstract, an important piece that is analyzed. Without it, only titles are examined which would lead to less accurate percentages. We recommend that Kingston University examines their policies regarding how research publications are listed. We also recommend that Kingston University use the benchmarking tool when module descriptors are included in a file type (CSV) usable with our software and abstracts are included with published articles.

Universities throughout the United Kingdom use a number of different databases for each of their module directories and research publications, and adapting software to accommodate all the different formats would be very challenging. JSON was a common file type used for research publications that the University of Worcester, Kingston University, and Keele University all used. Other universities used different file types to store information about their research. Within this file type, universities can name descriptors differently or leave them out entirely. This problem is exacerbated with module directories. We posed the solution to instead use a more common file type, a CSV file. However, many universities are unable to provide it and using commas in a module description would break the file. It is unlikely that the universities will adopt a uniform approach to storing such data, so any comprehensive tool will need to be designed to accommodate a variety of data formats, or it will require university staff to output existing data into a standard format that the tool can process. We recommend that future teams explore other universal file types and converse with other universities in the United Kingdom to determine which file types are possible to create.

Keywords also pose problems. Each university emphasizes different aspects of sustainability that reflect their particular curriculum and research activities. As a result, the keywords that might accurately detect all the sustainability activities at one university may not be as valid at another university. On the other hand, making the list of keywords too general will result in a large number of false positives and an inflated assessment of the sustainability content of the curriculum or research activities. We recommend that future versions of the module and research analyzing software explore the use of machine learning and artificial intelligence to scan for SDG-related modules and publications. This would increase the accuracy of the tool and remove the need to continuously enhance the keywords for every institution. The tool would be able to learn text patterns that pertain to sustainability and use them to determine which modules or articles were related to sustainability, greatly reducing the errors associated with specific keywords and phrases.

We recommend that the benchmarking tool be continuously updated. Sustainability is ever-changing and the questions need to maintain relevance to global policy. The Sustainable Development Goals are currently the driving force behind sustainability and each of the questions should be related to them in some way. For example, we changed question C10 to incorporate each of the 17 SDGs instead of miscellaneous areas of sustainability and we believe this greatly improves the specificity and clarity of the benchmarking tool. As the benchmarking tool is used at other universities in the United Kingdom, the scoring (i.e., weighting factors) needs to be updated as well. The scores were largely based on universities in the United States reporting on sustainability with STARS. The scoring of the benchmarking tool will need to be changed based on the data collected from other UK universities to provide a score weighting that will continuously encourage universities to improve but not make it so hard to achieve a reasonable score that it discourages them from using the tool.

References

AASHE. (n.d.). About STARS. Retrieved February 19, 2019, from https://stars.aashe.org/about-stars/

AASHE. (2019, February 16). STARS Participants & Reports [Digital image]. Retrieved February 17, 2019.

Asif, M. (2015). *Determining improvement needs in higher education benchmarking*. Benchmarking, 22(1), 56-74. doi://dx.doi.org/10.1108/BIJ-02-2013-0025

EAUC. (2018). Sustainability Leadership Scorecard. Retrieved February 15, 2019, from https://www.eauc.org.uk/sustainability_leadership_scorecard

Filho, W. L., Wu, Y. J., Brandli, L. L., Avila L. V., Azeiteiro, U. M., Caeiro, S., & da Rosa Gama Madruga, L. R. (2017). *Identifying and overcoming obstacles to the implementation of sustainable development at universities,* Journal of Integrative Environmental Sciences, 14:1, 93-108, DOI: 10.1080/1943815X.2017.1362007

Glover, A., Peters, C., & Haslett, S. K. (2011). *Education for sustainable development and global citizenship: An evaluation of the validity of the STAUNCH auditing tool*. Int J of Sus in Higher Ed, 12(2), 125-144. doi:10.1108/14676371111118192

Hands, V., & Anderson, R. (2017a). *Benchmarking sustainability research: A methodology for reviewing sustainable development research in universities*. In W. Leal Filho (Ed.), Sustainable development research at universities in the United Kingdom: Approaches, methods and projects (pp. 27-43). Cham: Springer International Publishing. doi:10.1007/978-3-319-47883-8_3

Hands, V., & Anderson, R. (2017b). *Local Sustainability Indicators and Their Role in the Implementation of the Sustainable Development Goals in the HE Sector*. In W. Leal Filho (Ed.), Sustainable development research at universities in the United Kingdom: Approaches, methods and projects (pp. 267-283). Cham: Springer International Publishing. doi:10.1007/978-3-319-47883-8_3

Kingston University. (a). Our history. Retrieved from https://www.kingston.ac.uk/aboutkingstonuniversity/factsandfigures/ourhistory/

Kingston University. (b). Student profiles. Retrieved from https://www.kingston.ac.uk/aboutkingstonuniversity/factsandfigures/studentprofiles/

Kingston University. (c). Sustainability at Kingston University. Retrieved from https://www.kingston.ac.uk/sustainability/

Kingston University. (d). Sustainability Governance. Retrieved from https://www.kingston.ac.uk/sustainability/governance/

Berman-Jolton, J. L., Kuros, A., Madhurkar, K. S., & Rockcress, A. D.. (2017). *Critiquing and Developing Benchmarking Tools for Sustainability*. (Undergraduate Interactive Qualifying Project No. E-project-121617-105759). Retrieved from Worcester Polytechnic Institute Electronic Projects Collection: https://web.wpi.edu/Pubs/E-project/Available/E-project-121617-105759/unrestricted/Benchmarking_Sustainability_Final_Report.pdf

McCowan, T. (2016). *Universities and the post-2015 development agenda: An analytical framework*. Higher Education, 72(4), 505-523. doi:10.1007/s10734-016-0035-7

National Union of Students (NUS). (2017). About Responsible Futures. Retrieved January 15, 2019, from https://sustainability.unioncloud.org/responsible-futures/about

People & Planet. (2018, November 09). People & Planet University League. Retrieved February 8, 2019, from https://peopleandplanet.org/university-league

SDSN Australia/Pacific (2017): Getting started with the SDGs in universities: A guide for universities, higher education institutions, and the academic sector. Australia, New Zealand and Pacific Edition. Sustainable Development Solutions Network – Australia/Pacific, Melbourne.

Times Higher Education. About us. Retrieved from https://www.timeshighereducation.com/about-us

Times Higher Education. (2018, November 08). University Impact Rankings: FAQs. Retrieved February 15, 2019, from https://www.timeshighereducation.com/world-university-rankings/university-impact-rankings-faqs

United Nations. *Millennium Summit (6-8 September 2000).* Paper presented at The Millennium Summit, United Nations. (2015). SDGs: Sustainable development knowledge platform. Retrieved from https://sustainabledevelopment.un.org/sdgs

United Nations. (December 1994). *Agenda 21*. Paper presented at the United Nations Conference on Environment and Development, United Nations. (2016, October 31).

United Nations. (a). MDGs [Digital image]. Retrieved February 24, 2019, from http://www.un.org/en/africa/osaa/images/mdgs2.gif

United Nations. (b). SDGs [Digital image]. Retrieved February 24, 2019, from https://en.unesco.org/sites/default/files/sdgs_poster_936_en.png

University of Worcester. (n.d.). University of Worcester strategic action plan 2013-2018. Retrieved from https://www.worcester.ac.uk/documents/university-worcester-strat-plan-2013-18.pdf

University of Worcester. (2017). University history. Retrieved from https://www.worcester.ac.uk/discover/university-history.html

University of Worcester. (2018a). Sustainability. Retrieved from https://www.worcester.ac.uk/discover/sustainability.html

University of Worcester. (2018b). Research impact. Retrieved from https://www.worcester.ac.uk/discover/science-research-impact.html

University of Worcester. (2019). Facts and figures. Retrieved from https://www.worcester.ac.uk/discover/facts-and-figures.html

Velazquez, L., Munguia, N., & Sanchez, M. (2005). *Deterring sustainability in higher education institutions: An appraisal of the factors which influence sustainability in higher education institutions*. International Journal of Sustainability in Higher Education, 6(4), 383-391. Retrieved from https://www.emeraldinsight.com/doi/full/10.1108/14676370510623865

Woods, I. W., Fennick, J. H., Morgan, J. M., & Kornacki, T. J. (2018*). Implementing and Critiquing the Higher-Ed. Sustainability Evaluation Tool* (Undergraduate Interactive Qualifying Project). Retrieved from Worcester Polytechnic Institute Electronic Projects Collection: https://digitalcommons.wpi.edu/iqp-all/5204

World Commission on Environment and Development. (1987). *Report of the world commission on environment and development: Our common future*. Retrieved from http://www.un-documents.net/our-common-future.pdf

Yarime, M., & Tanaka, Y. (2012). *The Issues and Methodologies in Sustainability Assessment Tools for Higher Education Institutions: A Review of Recent Trends and Future Challenges*. Journal of Education for Sustainable Development, 6(1), 63–77. https://doi.org/10.1177/097340821100600113

Appendices

Appendix A: Original Benchmarking Tool

Curriculum Tool

Questions	0	1	2	3	4	5
C1. Number of courses that include sustainability related topics, themes, or modules, relative to the total number of undergraduate courses offered at the institution, as a percentage	0%	1-5%	6-10%	11-15%	16-20%	>20 %
C2. Number of modules that include sustainability-related topics or themes, relative to the total number of modules offered at the institution, as a percentage	0%	1-5%	6-10%	11-15%	16-20%	>20 %
C3. Number of undergraduate students who have taken a sustainability-related module in relation to total number of students enrolled at the institution, as a percentage.	0%	1-20%	21-40%	41-60%	61-80%	>80 %
C4. Number of departments at the university that include sustainability in their curricula in relation to the total number of departments/colleges at the university, as a percentage.	0%	1-20%	21-40%	41-60%	61-80%	>80 %
C5. Does the institution contain one or more student organizations with a purpose directly related to sustainability?	No					Yes
C6. Does the institution maintain a regularly updated sustainability website?	No					Yes
C7. Does the institution's student union offer at least one university wide sustainability-focused educational program or event at least once a year?	No					Yes
C8. Does the institution conduct an assessment of the sustainability literacy and knowledge of its students?	No					Yes
C9. Does the institution have an ongoing program that offers incentives for academic staff in multiple disciplines or departments to develop new sustainability modules and/or incorporate sustainability into existing departments?	No					Yes
C10. Is the institution utilizing its campus by having physical locations which specialize in the following areas of	0	1-3	4-6	7-8	9-11	12-14

sustainability? ● Air & Climate ● Buildings ● Energy ● Food & Dining ● Grounds ● Purchasing ● Transportation ● Waste ● Water ● Coordination & Planning ● Diversity & Affordability ● Investment & Finance ● Public Engagement ● Wellbeing & Work						

Research Tool

Questions	0	1	2	3	4	5
R1. Amount of funding from grants and contracts specifying sustainability-related research, relative to the total funding from grants and contracts at the institution, as a percentage.	0%	<1 %	1-3%	4-7%	8-10%	>10 %
R2. Number of published research articles with a focus on sustainability-related issues, relative to the total number of research publications in all areas, as a percentage.	0%	<1 %	1-3%	4-7%	8-10%	>10 %
R3. Number of the institution's academic staff that are currently engaged in sustainability research, relative to the total amount of academic staff who conduct research, as a percentage.	0%	1-8%	9-16%	17-24%	25-31%	>31 %
R4. Number of academic departments that include at least one academic staff member that conducts sustainability research compared to other areas of research, relative to the total number of academic departments, as a percentage.	0%	1-15%	16-30%	31-45%	46-60%	>60 %
R5. Does there exist one or more resource centres on campus providing sustainability-related research or services?	No					Yes
R6. Does the institution have an ongoing program to encourage students in multiple disciplines or academic programs to conduct research in sustainability?	No					Yes
R7. Does the institution have a program to encourage academic staff from multiple disciplines or academic programs to conduct research in sustainability topics? (To count, the program must provide faculty with incentives to research sustainability and specifically aim to increase faculty sustainability research)	No					Yes
R8. Has the institution published written policies and procedures that give positive recognition to interdisciplinary,	No					Yes

transdisciplinary, and multidisciplinary research during faculty promotion and/or tenure decisions?						
R9. Does the institution have ongoing library support for sustainability research and learning in the form of research guides, materials selection policies and practices, curriculum development efforts, sustainability literacy promotion, and/or e-learning objects focused on sustainability?	No					Yes
R10. Does the institution provide financial incentives to support open access publishing, e.g., a publishing fund to support faculty members with article processing and other open access publication charges?	No					Yes

Appendix B: Original Keywords

Goal 1- Poverty Poverty	**Goal 10- Inequality** Reduce Inequality Inequality
Goal 2- Food Hunger Food Security Nutrition Sustainable Agriculture	**Goal 11- Habitation** Inclusive Human Settlements Inclusive Cities Cities Human Settlements
Goal 3- Health Healthy Lives Well-Being All ages-elderly	**Goal 12- Consumption** Sustainable Consumption Consumption Productive Patterns
Goal 4- Education Equitable Education Inclusive Education Opportunities for all	**Goal 13- Climate** Climate Change
Goal 5- Women Gender Equality Empower Women Women Girls	**Goal 14- Maine-ecosystem** Conserve Oceans Sustainable Oceans Oceans' Marine Seas
Goal 6- Water Water Sanitation	**Goal 15- Ecosystems** Terrestrial Ecosystems Ecosystems Manage Forests Desertification Land Degradation Land Biodiversity
Goal 7- Energy Affordable Energy Reliable Energy Sustainable Energy Energy	**Goal 16- Institutions** Peaceful Societies Inclusive Societies Access to Justice Justice Inclusive Institutions Accountable Institutions
Goal 8- Economy Sustainable Economic Growth Sustainable Growth Economic Growth Productive Employment Employment Decent Work	**Goal 17- Sustainability** Global Partnership for Sustainable Development Sustainability Sustainable
Goal 9- Infrastructure Resilient Infrastructure Infrastructure Sustainable Industrialization	

Industrialization Foster Innovation Innovation	

Appendix C: Example Module

This module would be determined as related to sustainability based on the keywords within (e.g. 'natural ecosystems' and 'pollution'). The course Environmental Science, ENVS, containing this module would then be considered as a sustainability-related course.

Module Code	Module Title	Module Description
ENVS1200	Introduction to Environmental Science	This module is designed for students seeking a broad overview of *ecological systems* and the effect of humans on the ecosystems. It provides an introduction to *natural ecosystems*, population growth, and the interaction between human populations and our environment. The major goal of this module is to help students become more informed *environmental* citizens, skeptical when presented with data in the media, and knowledgeable enough to question and make informed decisions about the environment. It will primarily focus on current topics but areas of discussion likely to be covered include *ecosystems*, populations, *biodiversity*, *pollution*, environmental economics and *climate change*.

Appendix D: Updated Keywords

SDG 1:

Developing Countries	Quality Of Life	Impoverished
Economic Resources	Resource Efficiency	Poverty Reduction
Equality	Resource Overuse	Overuse Of Resource
Financial Inclusion	Third World	Poverty
Income Equality	Vulnerable	Wealth Distribution
Inequality		

SDG 2:

Consumption of Resources	Malnutrition	Rural Infrastructure
Food Gap	Nutrition	Sustainable Agriculture
Food Reserves	Quality Of Life	Hunger
Food Security	Resource Consumption	Hungry People

SDG 3:

Air Contamination	Well Being	Child Development
Air Pollution	Wellbeing	Human Well-being
Child Deaths	Well-Being	Mental Health
Clean Water	Soil Contamination	Sustainable Livelihood
Disability	Active Lifestyle	International Health Regulations
Healthy Living	Adolescent Development	Reducing Malaria
International Health Policy	Baby Development	Reducing Mortality
Soil Pollution	Well Being	

SDG 4:

Access To Education	Gender Sensitive	Education Sector
Basic Literacy	Inclusive Education	Special Education
Equal Education	Opportunities For All	Sustainable Education
Equitable Education	Refugees And Learning	Gender Equality
Gender Disparities In Education	Universal Education	Gender Equity
Gender Disparity		

SDG 5:

Disadvantaged	Humanitarian	Women Empowerment
Discrimination	Marginalised	Women's Rights
Empower women	Reproductive Health	Workplace Equality
Empowering Girls	Reproductive Rights	Women Equality
Empowering Women	Sexual Health	Women Rights
Empowerment Of Girls	Sexual Violence	Human Trafficking
Empowerment Of Women	Social Inclusion	Forced Marriage
Equal Access	Unemployment	Gender Discrimination
Equality	Universal Health Coverage	Gender equality
Exploitation	Violence Against Girls	Human Rights
Female Empowerment	Violence Against Women	Feminism
Female Genital Mutilation		

SDG 6:

Accessible Water	Sanitation	Water Resources Management
Affordable Drinking Water	Water Access	Water Scarcity
Contaminated	Water Disasters	Water Supply
Contamination	Water Ecosystems	Water-related Ecosystems
Ecosystem Protection	Water Efficiency	Water-use Efficiency
Ecosystem Restoration	Water Harvesting	Inadequate Water
Equitable Sanitation	Water Quality	Pollution
Hydropower	Safe Drinking Water	Recycle
Improving Water		

SDG 7:

Affordable Energy	Hydroelectric	Wave Energy
Alternative Energy	Low Carbon	Wave Power
Fossil Fuel	Reliable Energy	Wind Energy
Fossil-fuel	Renewable	Wind Power
Green Economy	Solar Energy	Energy Efficiency
Greenhouse Gas	Solar Power	Sustainable Energy
Greenhouse Gas Emissions		

SDG 8:

Decent Work	Human Trafficking	Economic Instability
Economic growth	Productive employment	Economic Sustainability
Equal Pay	Sustainable Economic Growth	Equal Rights To Economic Resources
Global Resource Efficiency	Sustainable Growth	

SDG 9:

Developing Countries	Resilient Infrastructure	Sustainable Industrialization
Foster innovation	Resource Use Efficiency	Water Resources
Infrastructure		

SDG 10:

Ageism	Inequality	Human Rights
Discrimination	Racism	Inclusion
Discriminatory	Reduce Inequality	Marginalization
Equal Opportunity	Sexism	Segregation
Equality	Classism	Social Inclusion

SDG 11:

Air Pollution	Human settlements	Resource Needs
Air Quality	Inadequate Housing	Smart Cities
Climate Change	Inclusive Cities	Waste Generation
Disaster Management	Inclusive human Settlements	Waste Management
Disaster Risk Reduction	Land Consumption	Habitat Quality

SDG 12:

Decarbonisation	Greenhouse Gasses	Sustainable Consumption
Efficient Use Of Resources	Natural Resources	Water Pollution
Energy Consumption	Productive Patterns	Alternative Energy
Energy Efficiency	Recycle	Consumption of Fossil Fuel
Energy Use	Recycling	Consumption Of Natural Resource
Food Losses	Reduce Waste Generation	Consumption Of Resource
Food Supply	Reduction	Recycling
Food Waste	Renewable	Resource Management
Future Proof	Resource Efficiency	

SDG 13:

Climate Action	Global Mean Temperature	Ocean Systems
Climate Change	Global Temperature	Paris Agreement
Climate Change Planning	Global Warming	Rising Sea
Climate Change Policy	Greenhouse Gas	Sea Level Rise
Cop 21	Greenhouse Gas Emissions	Natural Hazards
Cop 22	Greenhouse Gases	Pollution
Emissions	Ice Loss	Low-carbon Economy
Extreme Weather		

SDG 14:

Conservation	Marine	Seas
Conserve	Ocean Acidification	Sustainable Oceans
Conserve Oceans	Ocean Temperature	Vulnerable Species
Ecosystem Management	Oceans	
Global Warming	Protected Areas	

SDG 15:

Biodiversity	Land Loss	Ecological System
Deforestation	Land Use And Sustainability	Enabling Environments
Desertification	Manage Forests	Environmental Assessment
Desertifications	Protected Fauna	Environmental Degradation
Ecosystem Restoration	Protected Flora	Environmental Issue
Ecosystems	Protected Species	Environmental Sustainability
Illegal Wildlife Products	Reforestation	Environmentally Sensitive
Land Conservation	Soil Degradation	Environmentally-sensitive
Land Degradation	Terrestrial Ecosystems	Land Use
Biodiversity	Threatened Species	Natural Environment

SDG 16:

Access to Justice	Human Rights	Justice Legislation
Accountable Institutions	Inclusive Institutions	Justice Sector
Equal Access	Inclusive Societies	Safe Communities
Exploitation	Peace	Supporting Families
Hate Crime	Peaceful Societies	

Doha Development Agenda	International Support	Future Policy
Environmentally Sound Technologies	Poverty Eradication	SDG
Global Partnership	Sustainability	Social Sustainability
Global Partnerships For Sustainable Development	Sustainable	Sustainable Development
International Cooperation	Women Entrepreneurs	Environmental Policy

Appendix E: Revised Benchmarking Tool Used at the University of Worcester, 2018-19

Curriculum Tool

Questions	0	1	2	3	4	5
C1. Percentage of modules that include sustainability-related topics or themes, relative to the total number of modules offered at the institution. **Score out of 10**	0%	1-5%	6-10%	11-15%	16-20%	>20 %
C2. Percentage of courses that include sustainability related topics, themes, or modules, relative to the total number of undergraduate courses offered at the institution.	0%	1-5%	6-10%	11-15%	16-20%	>20 %
C3. Percentage of undergraduate students who have taken a sustainability-related module in the current year in relation to total number of students enrolled at the institution. **Score out of 10**	0%	1-20%	21-40%	41-60%	61-80%	>80 %
C4. Percentage of modules taken by students that include sustainability-related topics or themes relative to the total number of modules taken by students. **Score out of 10**	0%	1-20%	21-40%	41-60%	61-80%	>80 %
C5. Number of student organizations with a purpose directly related to sustainability.	0	1	2	3	4+	
C6. Does the institution maintain a sustainability website updated at least every 6 months?	No		Yes			
C7. Number of university wide sustainability-focused educational programs or events offered by the student union in the last year.	0	1	2	3+		
C8. Does the institution conduct an assessment of the sustainability literacy and knowledge of its students?	No			Yes		
C9. Does the institution have an ongoing program that offers incentives for academic staff in multiple disciplines or departments to develop new sustainability modules and/or incorporate sustainability into existing modules?	No			Yes		

C10. How many of these sustainability areas does the institution expose the students to outside of the classroom i.e. buildings, year-round events or programs? : ● Air & Climate ● Buildings ● Energy ● Food & Dining ● Grounds ● Purchasing ● Transportation ● Waste ● Water ● Coordination & Planning ● Diversity & Affordability ● Investment & Finance ● Public Engagement ● Wellbeing & Work	0	1-3	4-6	7-8	9-11	12-14

Research Tool:

Questions	0	1	2	3	4	5
R1. Percentage of grant or contract funded sustainability-related research, relative to the total number of grant or contract funded research at the institution.	0%	1-5%	6-10%	11-15%	16-20%	>20 %
R2. Percentage of published research articles with a focus on sustainability-related issues, relative to the total number of research publications in all areas. **Score out of 10**	0%	1-3%	4-7%	8-11%	12-15%	>15 %
R3. Percentage of the institution's academic staff that are currently engaged in sustainability research, relative to the total amount of academic staff who conduct research.	0%	1-8%	9-16%	17-24%	25-32%	>32 %
R4. Percentage of academic departments that include at least one academic staff member that conducts sustainability research compared to other areas of research, relative to the total number of academic departments.	0%	1-15%	16-30%	31-45%	46-60%	>60 %
R5. Does the institution have one or more research centres or groups on campus focusing on sustainability-related research or services?	No				Yes	
R6. Does the institution have an ongoing program to encourage students in multiple disciplines or academic programs to conduct research in sustainability?	No				Yes	
R7. Does the institution have a program to encourage academic staff from multiple disciplines or academic programs to conduct research in sustainability topics? (To count, the program must provide faculty with incentives to research sustainability and specifically aim to increase faculty sustainability research)	No				Yes	

R8. Does the institution have ongoing library support for (sustainability research and learning in the form of research guides, materials selection policies and practices, curriculum development efforts, sustainability literacy promotion, and/or e-learning objects focused on sustainability?	No				Yes	
R9. Does the institution provide financial incentives to support open access publishing, e.g., a publishing fund to support faculty members with article processing and other open access publication charges?	No				Yes	

Appendix F: Question Recommendations

This is our final recommended questions for the Sustainability Benchmarking Tool. The benchmarking tool has 10 questions under the Curriculum Tool and 9 questions under the Research Tool. These are not the questions that were implemented at the University of Worcester or Kingston University. Instead these are questions made with input and recommendations from our sponsors post implementation.

Curriculum Tool:

C1 Scoring	0	to				10
C1. Percentage of modules that include SDG-related topics or themes, relative to the total number of modules offered at the institution. **Score out of 10**	0%					20%
C2 Scoring	0	to				5
C2. Percentage of courses that include SDG-related modules relative to the total number of undergraduate courses offered at the institution.	0%					20%
C3 Scoring	0	to				10
C3. Percentage of undergraduate students who have taken an SDG-related module in the current year in relation to total number of students enrolled at the institution. **Score out of 10**	0%					50%
C4 Scoring	0	to				10
C4. Percentage of modules taken by students that include SDG-related topics or themes relative to the total number of modules taken by students. **Score out of 10**	0%					50%
C5 Scoring	0	1	2	3	4	
C5. How many student organizations exist with a purpose related to one of the SDGs?	0	1	2	3	4+	
C6 Scoring	0		2			
C6. Have you or other sustainability-related faculty updated the sustainability website in the last 6 months?	No		Yes			

C7 Scoring	0	1	2	3		
C7. How many SDG-focused educational programs or events engaged the students in the last year?	0	1	2	3+		
C8 Scoring	0			3		
C8. Does the university conduct a formal assessment of the sustainability literacy and knowledge of its students?	No			Yes		
C9 Scoring	0			3		
C9. Does the university have an ongoing program that offers incentives for academic staff to develop new SDG-related modules and/or incorporate the SDGs into existing modules?	No			Yes		
C10 Scoring	0	1	2	3	4	5
C10. How many of the Sustainable Development Goals does the institution expose the students to outside of the classroom i.e. buildings, year-round events, or programs? GOAL 1: No Poverty GOAL 2: Zero Hunger GOAL 3: Good Health and Well-being GOAL 4: Quality Education GOAL 5: Gender Equality GOAL 6: Clean Water and Sanitation GOAL 7: Affordable and Clean Energy GOAL 8: Decent Work and Economic Growth GOAL 9: Industry, Innovation and Infrastructure GOAL 10: Reduced Inequality GOAL 11: Sustainable Cities and Communities GOAL 12: Responsible Consumption and Production GOAL 13: Climate Action GOAL 14: Life Below Water GOAL 15: Life on Land GOAL 16: Peace and Justice Strong Institutions GOAL 17: Partnerships to achieve the Goal	0	1-3	4-6	7-9	10-12	13+
Total Score:	/55					

Research Tool:

R1 Scoring	0	to	5
R1. Percentage of grant or contract funded SDG-related research, relative to the total number of grant or contract funded research at the institution.	0%		20%
R2 Scoring	0	to	10
R2. Percentage of published research articles with a focus on SDG themes, relative to the total number of research publications in all areas. **Score out of 10**	0%		15%
R3 Scoring	0	to	5
R3. Percentage of the institution's academic staff that are currently engaged in sustainability research, relative to the total amount of academic staff who conduct research.	0%		32%
R4 Scoring	0	to	5
R4. Percentage of academic departments that include at least one academic staff member that conducts sustainability research, relative to the total number of academic departments.	0%		60%
R5 Scoring	0		4
R5. Does the institution have one or more research centres or groups on campus focusing on SDG-related research?	No		Yes
R6 Scoring	0		4
R6. Does the institution have an ongoing program to encourage students to conduct research on SDG topics?	No		Yes
R7 Scoring	0		4
R7. Does the institution have a program to encourage academic staff to conduct research on SDG topics?	No		Yes
R8 Scoring	0		4
R8. Does the institution have ongoing library support for sustainability research and learning in the form of research	No		Yes

guides, materials selection policies and practices, curriculum development efforts, sustainability literacy promotion, and/or e-learning objects focused on sustainability?						
R9 Scoring	0				4	
R9. Does the institution provide financial incentives to support open access publishing, e.g., a publishing fund to support faculty members with article processing and other open access publication charges?	No				Yes	
Total score:	/45					

Appendix G: Website

The website is currently hosted on GitHub. You can access it from here.

The code repository can also be accessed here.