

Universities as Transformative Locations for Sustainable Approaches to Science: Network of Early-Career Sustainable Scientists and Engineers' Sustainable Universities Programme

Dr. Jennifer Dodson, Alexandra Hicken*, Luciana Miu, Natalie O'Neil, Tabitha Petchey, Daniel Pleissner, Norman Spencer & Dr Christiano Varrone

Network of Early-Career Sustainable Scientists and Engineers, @greenscientists

**alex.hicken@sustainableScientists.org, @ahichem07*

Introduction

Universities have a key role to play in sustainable development through their role in educating future leaders, fostering research to provide evidence-based solutions and acting as role models within society, (Fredman, 2012) with students increasingly expecting that universities will take a lead in embedding a culture for sustainable development (NUS, 2017).

Early university sustainability initiatives focused on estates management, however, with the recognition of the need to consider the role of universities more holistically, education and research for sustainable development has risen up the agenda. Current initiatives include the 'Green Guide for Universities', the International Sustainable Campus Network, the Association for the Advancement of Sustainability in Higher Education, Decade of Education for Sustainable Development and the Higher Education and Research for Sustainable Development (HESD) global portal. Analysis of these and other initiatives has highlighted the need to include all university stakeholders to embed a sustainable development culture (Lozano, 2006).

Early-career scientists are frequently a forgotten stakeholder in the development of university educational, research and management processes aimed at embedding a sustainable development culture (Hicken, 2017). Yet, early-career scientists are at an important formative time in their careers and frequently open and able to develop and implement new creative methodologies and research ideas. They also play an important role in engaging with the public and teaching undergraduate and graduate students. The Network of Early-career Sustainable Scientists & Engineers (NESSE) is utilising a bottom-up approach to enable early-career scientists to play a transformative role in supporting the development of a sustainable culture for education and research at universities and gain the skills to be leaders for sustainable development in their future careers. This type of bottom-up, 'grassroots' approach has been proposed as a key role for university's involvement in sustainable development (Ferrer-Balas et al, 2009).

This paper discusses NESSE's new Sustainable Universities initiative which aims to contribute to the development of universities as transformative locations for testing and embedding sustainable approaches to science and technology. We share two case studies of existing local NESSE groups which are changing the culture at their universities and in their careers.

NESSE's Sustainable Universities Programme

The Network of Early-Career Sustainable Scientists and Engineers (NESSE) is a global interdisciplinary network of early-career scientists who are using their knowledge and skills to build a sustainable and prosperous future for all. It was set-up to develop scientific cultures and early-career leaders that can integrate complex, interdisciplinary, collaborative and holistic research approaches and utilise their skills to tackle global sustainability challenges.

NESSE's Sustainable Universities Programme aims to provide members around the world with the skills to develop a sustainable science culture within their community. It contributes to the development of universities as transformative locations for testing and embedding sustainable approaches to science and technology by a) championing pioneering approaches by universities that are embedding sustainability throughout education and research, b) developing cultures for sustainable development at universities by creating a network of early-career interdisciplinary sustainable science networks at universities and c) support students and early-career scientists to identify career paths that meet their sustainable science objectives. These aims are achieved through four different activities:

1. Building an interdisciplinary early-career sustainable science groups network: we are rapidly growing our sustainable science groups network at universities which are transforming the culture, discussions and skills for early-career scientists for sustainable development.

2. Case studies of pioneer universities: we are developing case studies of universities that are pioneering innovative approaches to embed sustainable research and education throughout the curricula and developing a best practice guide to encourage other universities to

3. Mapping sustainable science career pathways: we are developing overviews of career pathways, postgraduate courses and training opportunities that enable early-career scientists to use their skills and knowledge to help tackle sustainable development challenges in research, policy, industry and beyond.

4. Sustainable research resource bank and communication platform: we are building a bank of information on sustainable research approaches and developing video

Sustainable University Case Studies

The NESSE Sustainable Science Groups network consists of autonomous, local networks at universities and in local communities that are changing the education and research culture at their universities through a bottom-up, 'grassroots' approach. Two case studies exemplify the unique and valuable role that early-career scientists can play in developing universities as transformative locations for sustainable approaches to science.

1. Green Chemistry Initiative, University of Toronto, Canada

The Green Chemistry Initiative (GCI) at the University of Toronto was founded in 2012 by a group of graduate students and post-doctoral researchers in the Department of Chemistry who were in search of a way to not only decrease the environmental impact of their own chemistry research but also educate others within the chemistry community on the principles and merits of green chemistry.

Many of the early-career scientists who set-up the group were working on solutions to pressing environmental problems, but felt that the experimental methods they used didn't integrate sustainability holistically. In addition, whilst the teaching of green chemistry principles was incorporated into the undergraduate curriculum, the principles was not embedded in the research laboratories and there was no formal process for graduate students and post-docs to learn how to apply green chemistry practices within their research.

The Green Chemistry Initiative was therefore set-up to raise awareness about green chemistry in order to promote more sustainable practices within the chemistry community at the University of Toronto. Activities have included:

- Developing simple and fun educational approaches across the department including a chemical waste disposal poster and a 'Just Shut it' fumehood campaign
- Surveying the sustainable chemistry content of undergraduate curricula courses
- Running an annual symposium for early-career scientists at the University of Toronto and beyond more in-depth study of particular aspects of green chemistry such as how to implement greener processes graduate research and assess their impact
- Running monthly seminars bringing in academics, industry and policy speakers to talk about the latest sustainable science and technology development

The Green Chemistry Initiative has been instrumental in changing the culture and approach to sustainability in both research and curricula within their department. A major accomplishment of the GCI was being a catalyst for the University of Toronto to become the first Canadian university to sign the Green Chemistry Commitment (GCC). Within the GCC, academic institutions collaborate to share resources and know-how in order to positively impact how the next generation of scientists are educated about sustainability issues. Participating departments commit to green chemistry instruction as a core teaching mandate. The aim is to provide undergraduates and graduates with the required understanding to make green chemistry become standard practice in laboratories around the world. This, in turn, ensures that when graduates of the university enter the workforce, they are armed with the knowledge of how to make molecules and processes more sustainable and less toxic by adhering to the twelve principles of green chemistry.

2. GreenSTEMS, University of York, United Kingdom

GreenSTEMS is an early-career sustainable science group at the University of York (United Kingdom) that aims to connect and support **STEM** (Science, Technology, Engineering and Mathematics) + **Social** scientists in developing cross-disciplinary thinking in their research by engaging them in a local network. The group started in July 2014 and brings together early-career researchers from varied backgrounds and from different departments across campus under the common interest of sustainable development.

Despite the University of York being rich in research groups and networks exploring different aspects of sustainability there was a lack of collaboration between them, particularly bringing together early-career scientists to exchange knowledge, develop skills and build their networks in order to embed sustainable science approaches in their work and future careers. GreenSTEMS has developed a number of activities to integrate sustainable approaches into education and research across the university.

A public dialogue project, GreenReactions, trained early-career scientists from a range of disciplines in science communication, and brought them together with the general public in a face-to-face two-way dialogue green technologies being developed at the University of York. The project aspired to build local public trust in scientists and sustainable technologies as well as to empower young researchers to effectively communicate and engage the public in their research.

GreenSTEMS runs a range of seminars on sustainable development topics including on architecture, fashion and consumerism, food and agriculture, transport and health. These seminars bring together PhD students, postdoctoral researchers and staff to talk about their research within these topics from across different departments and programmes.

GreenSTEMS has been recognised by the University of York as a valuable way for researchers to gain new skills and contributing to the university's aim to develop solutions to global challenges.

Conclusion

Early-career scientists are a key player in the development of sustainable approaches to science both now and in the future. NESSE's network of early-career Sustainable Science groups is already transforming the culture, networks and discussions at their universities. Building on this, NESSE aims to achieve more rapid and impactful change at universities to embed a sustainability culture within education and research through our 'grassroots' Sustainable Universities Programme.

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