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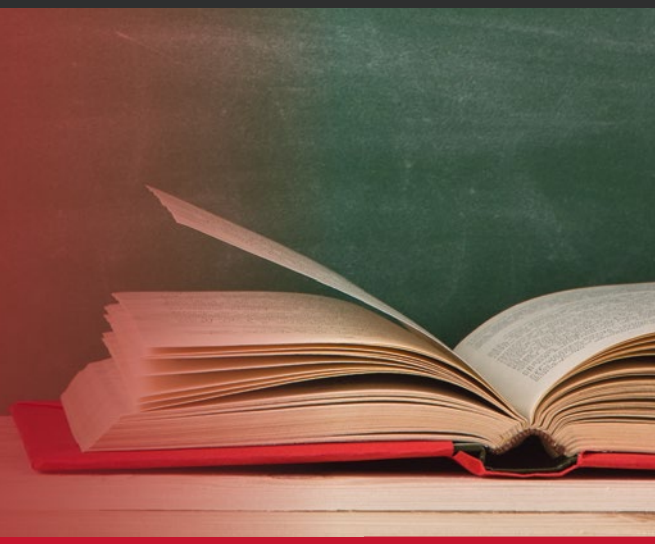

Godwell Nhamo
Vuyo Mjimba *Editors*

Sustainable Development Goals and Institutions of Higher Education

Springer

Sustainable Development Goals Series

World leaders adopted Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development. Providing in-depth knowledge, this series fosters comprehensive research on these global targets to end poverty, fight inequality and injustice, and tackle climate change.

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Contributions are welcome from scientists, policy makers and researchers working in fields related to any of the SDGs. If you are interested in contributing to the series, please contact the Publisher: Zachary Romano [Zachary.Romano@springer.com].

More information about this series at http://www.springer.com/series/15486

Godwell Nhamo • Vuyo Mjimba
Editors

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Springer

Editors
Godwell Nhamo
University of South Africa
Pretoria, South Africa

Vuyo Mjimba
African Institute of South Africa (AISA)
Human Sciences Research Council
Pretoria, South Africa

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Peer Review Process

The book underwent the rituals of academic blind peer review. The first part involved the screening of abstracts and the invitation to authors with accepted abstracts to submit the full draft manuscripts. The editors removed all author identifications from the manuscripts making them anonymous before forwarding them for the double-blind peer review process. Apart from being the international norm, this double-blind peer review process is mandatory for South African based authors in order to fulfil the requirements of the Department of Higher Education and Training's (DHET) policy for recognised research outputs for subsidy purposes. The editors presided over the incorporation of all peer review observations and comments to enhance the quality of the book product.

Acknowledgements

We, Prof. Godwell Nhamo (Editor-in-Chief) and Dr. Vuyo Mjimba (Editor), wish to thank all the authors and blind peer reviewers for their invaluable inputs during the writing and publishing process of this book. We thank Springer for taking on board this book project. We also wish to thank our families for their ongoing support of our work and we would like to express our sincere thanks to Springer for a quality product. The book project was coordinated through the Exxaro Chair in Business and Climate Change at the University of South Africa. The Exxaro Chair is a research Chair funded by the Exxaro Resources (Pty) Ltd Chairman's Fund. The Exxaro Chair, established in 2008, is now in its fourth term running (2018–2022). The vision of the Exxaro Chair is to 'create a Centre of Excellence in Business and Climate Change research, education, and advocacy-oriented community engagement'.

About the Book

This book emerged from the 6th International Conference on Sustainable Development (ICSD) that took place 26–28 September 2018 at Columbia University in New York, United States of America (USA). The conference was organised by the Center for Sustainable Development (CSD), The Earth Institute, The Global Master in Development Practice (MDP) and the Sustainable Development Solutions Network (SDSN). The conference theme was 'Breaking down Silos: Fostering Collaborative Action on the SDGs'. The ICSD brings together students, scholars, practitioners and other interested and affected stakeholders to evaluate sustainable development good practices and solutions in creating a society that can meet the needs of the present generations without compromising the needs of future generations. This way, the participants try to shape the future we want in the space of sustainable development. This was further triggered by several papers presented in the parallel session focusing on 'Breaking down Silos in Universities: Imaginative Interdisciplinary Approaches to Sustainable Development Research, Education, and Practice'. Following a meeting with a Springer representative during the conference, the Editor-in-Chief confirmed the book project resulting in a call for chapter contributions for an edited volume. In a world where many entities are looking at ways of addressing and implementing the Sustainable Development Goals (SDGs), this book remains a valuable contribution, not only from and for Institutions of Higher Education (IHE), but for society as a whole in as far as engaging the SDGs agenda is concerned. The authors and editors have tried their best to make the book an accessible read to several audiences.

Godwell Nhamo
Vuyo Mjimba

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About the Contributors

Javier Mazorra Aguiar is a research fellow at the Innovation and Technology for Development Centre at the Universidad Politécnica de Madrid (itdUPM). Javier has a PhD in Chemical Engineering from UPM, an MSc in Technology for Human Development from the UPM and BSc in Chemical Engineering from ULPGC. Javier has been a research fellow at itdUPM for the last 6 years, participating in more than 20 projects with special focus on access to energy and climate change in low- and middle-income countries. Currently, Javier is Coordinator of Alianza Shire (www.alianza-shire.org), a multi-stakeholder partnership for energy access in refugee camps with the participation of the Spanish Aid (AECID) and three Spanish leading companies on energy and lighting (Iberdrola, Acciona.org and Signify). Email: javier.mazorra@upm.es.

Manuel Alméstar is a researcher and project manager at the Innovation and Technology for Development Centre of the Technological University of Madrid (itdUPM). He graduated as an Architect from the National University of Engineering (Peru, 2010). He holds a Diploma in Project Management from the ESAN University (Peru, 2013) and has a Master in Strategies and Technologies for Development from the Complutense and Technological Universities of Madrid (Spain, 2018). He is a co-author of 8 scientific articles on sustainable development. Currently, he is responsible for the Platform-A Madrid. He has worked on projects such as the Collective Intelligence Platform CoLab.upm, a collaboration between UPM and MIT. He is also part of the Climate-KIC Promoter Group of the Technological University of Madrid. Email: manuel.almestar@upm.es.

Abiodun Olumide Ayeni is the current Head of Department of Educational Management in the Faculty of Education at the University of Ibadan in Nigeria. His fields of interest include economics of education and technical and vocational education and he has published over 45 journal articles in both local and international journals. He served as Co-Editor of more than six books. Prof. Ayeni has produced three PhDs. He was Editor-in-Chief of the *Nigerian Journal of Educational Administration & Planning* and is also currently Editor-in-Chief of the *African Journal of Educational Management*. He is a Registered Professional Member (Teacher), Teachers Registration Council of Nigeria; and Secretary, Kappa DeltaPi Education Society of Nigeria, whose headquarters is in Indianapolis, USA. Email: biodunmide@gmail.com.

Juan Azcarate has been working for the Madrid City Council in Energy and Air Quality projects for more than 25 years. He is responsible for the Air Quality and Climate Change Plan of Madrid (Plan A), low carbon strategies and clean vehicle initiatives. Currently, he is Deputy Director of Energy and Climate Change of the Area of Environment and Mobility of Madrid City Council. He has been leading the monitoring of several policies as Plan A, the energy balance of the city, emissions inventory, Madrid + Natural (Nature-Based Solutions to Climate Change Adaptation programme), public building energy improvement programme and diverse energy, climate change and mobility initiatives. Email: azcaratelj@madrid.es.

Annalyn Bachmann is the community manager at MIT's Center for Collective Intelligence. She has an MA in Sustainable International Development and an MA in Conflict Resolution and Coexistence from Brandeis University's Heller School for Social Policy and Management. She also has a BA in Political Science with a concentration in International Relations and Comparative Politics from Emmanuel College. During her time at the Center, she has worked on projects including managing a community of over 120,000 members working to solve climate change, helping facilitate expert-based scenario planning and co-creating a platform for civic participation in legislation in Chile. Email: annalyn@mit.edu.

Paul Bartlett teaches Environmental Justice and Climate Science at John Jay College and Fordham University. Prof. Bartlett is engaged in international collaborative research on environmental toxins and with co-author John Ruppert on qualitative and action research on civic engagement with ecosystem science and pedagogy. Prof. Bartlett began his environmental justice career serving contaminated communities as an environmental scientist and ecological economist working for noted pioneering ecologist and scientist-activist Barry Commoner, Founder and Director of the Center for the Biology of Natural Systems at Queens College. He worked on pollution prevention studies of the Great Lakes, the Arctic and public water supplies; intensive recycling; and public exposure to the WTC toxics. He participates in collaborative research and assessments with North American, Arctic and UN expert working groups. He was recently appointed to the scientific committee of a new Polar Academy at the Harbin Institute of Technology in Northeast China. Email: pbartlett@jjay.cuny.edu.

Kazeem Olajide Bello is Senior Research Fellow and Acting Programme Leader, Livestock Production Research Programme, Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR), Federal University of Agriculture, Abeokuta, Nigeria. His research work in the last 10 years spans mono-gastric (poultry and rabbitry) production and health management. He has supervised 33 undergraduates and 5 postgraduate (master's) students. He is a mentor to many students and academic colleagues as well as a representative of the University in both international and national feats. Dr. Bello has 31 journal articles in print, 7 refereed conference proceedings, 1 book, 3 technical reports and 2 awards to his credit. Email: belloko@funaab.edu.ng; kazeembello19@gmail.com.

Keene Boikhutso is Senior Lecturer in Social Studies, Department of Languages and Social Sciences Education at the University of Botswana. He teaches undergraduate and graduate students as well as supervises their research projects. Prior to joining the University of Botswana, Dr. Boikhutso taught at junior and senior secondary schools. His research interests are in the areas of citizenship education, nation-building, performance management, ethnic identity, assessment, and technical and vocational education. Dr. Boikhutso has published several book chapters and articles in peer-reviewed journals. He has participated in national consultancy studies on enhancing quality education and developing indicators and standards for the education sub-sector. He also serves as a reviewer for internal and external journals and is an external examiner for some universities. Dr Boikhutso is a member of the Council Research Committee for the Botswana Examinations Council and the Organization for Social Science Research in Eastern and Southern Africa. Email: boikhutso@mopipi.ub.bw.

Varaidzo Chinokwetu is Research Assistant in the Institute of Lifelong Learning and Development Studies at Chinhoyi University of Technology, Zimbabwe. Chinokwetu's research interests are in climate change adaptation, community development policies, livelihoods and environmental sustainability. She has undertaken several multi-country researches on climate change adaptation and disaster risk reduction and production of technical reports and book chapters. She is currently pursuing her doctoral studies in environmental management. Email: varaidzochm@gmail.com.

Gabriela Fernandez has PhD in Urban Planning, Design and Policy in the Department of Architecture and Urban Studies at Politecnico di Milano in Milan, Italy. In 2015, she was a PhD Visiting Student at the Massachusetts Institute of Technology in the Department of Architecture, Building Technology, Urban Metabolism Group. Fernandez's research focuses on urban metabolism ideologies and material flow analysis of metropolitan cities, identifying urban typologies and socio-economic indicators in the urban context while promoting urban metabolism public policy. Fernandez is Co-founder and Researcher at the Metabolism of Cities (www.metabolism of cities.org), a non-profit organisation registered in Brussels, Belgium with data, tools and publications related to urban metabolism studies. She received a Bachelor of Arts and Sciences in Public Administration with an emphasis in City Planning and a Master of City Planning from the School of Public Affairs at San Diego State University in San Diego, California, USA. Email: gabriela.fernandez@polimi.it.

Rosa Ferré is Director of the Centro de Creación Contemporánea Matadero Madrid. She has more than 20 years of experience in the conception and direction of the exhibition and cultural programming projects in the fields of plastic and visual arts, architecture, literature and contemporary thought. She has worked as a content consultant and manager of the exhibition and editorial projects for different national and international artistic and cultural institutions. Email: direccionartistica@mataderomadrid.org.

Pietro Fochi is a social entrepreneur at Eduactive. Pietro is currently serving as an official Youth Delegate of Italy to the United Nations (UNYD). While pursuing a master's degree in Law at the University of Bologna, he has built an extensive experience in national and international projects, working with both public and private sector entities. As a youth advocate, he is committed to the inclusion and the engagement of the new generations at all levels and works to strengthen bridges between them and the institutions. In his capacity of YD, he joined several international fora, including the 73rd United Nations General Assembly and the 57th Commission for Social Development, and connected with all sectors in order to spread the values of sustainability and to contribute to the implementation of the Agenda 2030 and its 17 SDGs. Besides, he is interested in the enforcement of international law and in the social impact of international soft law tools. Email: pietro.fochi@studio.unibo.it.

Will Hong is Assistant Professor in the Department of Digital Media and Journalism at the State University of New York at New Paltz. He holds graduate degrees from Princeton University and the Tisch School of the Arts at NYU and spent two decades in the film and television industry in New York City working in independent film production and creating award-winning persuasive media for network and corporate clients. He has taught filmmaking and digital media at The Lee Strasberg Theatre and Film Institute, the Dalton School and Marist College. Prof. Hong received a professional certificate in Campus Sustainability Leadership from the University of Vermont in 2015 and has led webinars and workshops on sustainability pedagogy innovation and mass communication at AASHE, ICSD and the Sustainability Curriculum Consortium Faculty Conference. Email: hongw@newpaltz.edu.

Oluwakemi Titilayo Irekhore (Senior Extension Fellow) is Programme Leader, Extension and Adaptive Research, at the Agricultural Media Resources and Extension Centre, Federal University of Agriculture, Abeokuta, Nigeria. As an animal nutritionist and extension personnel with over 17 years of field experience, her interest is in livestock nutrition and production for food security and economic development. She has to her credit two handbooks and 18 journal articles in local and international journals and she has supervised over 50 undergraduate students as well as two MSc projects. Dr. Irekhore also builds the interests and capacities of youths in agriculture and especially livestock production. She has equally led many locally and internationally funded projects on productivity and livelihood improvement for resource-constrained rural farmers. Email: raykemi@yahoo.com.

Kathleen D. Kennedy currently serves as Executive Director of the MIT Center for Collective Intelligence. In addition, she is a venture partner at Good Growth Capital and she serves on the board of *Hubweek*. From July 2016 to June 2017, Kathleen served as a lead organizer of The Engine (www.engine.xyz), a new MIT initiative created to advance innovation. This venture fund and accelerator programme opened in the Spring of 2017, was created to provide comprehensive support to transformative ideas from the formative stage to their most effective implementation. In her 16 years at MIT Technology

Review, most recently serving as its president, Kathleen helped to redefine the magazine brand and expand its global footprint, developing international programmes and producing world-class events. She also served six years as President of the MIT Enterprise Forum, a global network of chapters organized around entrepreneurship. Email: kdkenn@mit.edu.

Mphemelang Joseph (MJ) Ketlhoilwe received his PhD at Rhodes University, South Africa in 2007. He is Associate Professor of Environmental Education and Head of the Department of Languages and Social Sciences Education in the Faculty of Education at the University of Botswana. Prof. Ketlhoilwe researches and publishes on education policy, environmental education, and education for sustainable development, teacher education, evaluation, natural resources management for social change, project-based learning, and climate change and community resilience. Prof. Ketlhoilwe is the project leader of MESA (Mainstreaming of Environment and Sustainability Issues in African universities) and Re-Orienting Education and Training for Indigenous Youth in Botswana at the University of Botswana. Prof. Ketlhoilwe is also an Advisory Board member of the Global Environmental Education Partnership (GEEP). He is also the contact person for the Global Universities Partnership in Environment and Sustainability in Southern Africa (GUPES). His contacts are; Tel. 00267 3552337 Fax: 00267 3185096 Email: ketlhomj@mopipi.ub.bw.

Riina Koivuranta (MSc, Agriculture and Forestry, Academic agronomist) is a project designer in the multidisciplinary master's programme Environmental Change and Global Sustainability (ECGS) at University of Helsinki. Koivuranta also works as an environmental consultant in the Visia Cooperative. She strives to contribute to sustainability education and deepen the science–policy–society interface. Koivuranta is interested in interdisciplinary dialogue and collaboration and the accessibility and impact of scientific knowledge, with a passion for sustainability transformation in general and sustainable food systems in particular. Email: riina.koivuranta@helsinki.fi.

Kaisa Korhonen-Kurki, PhD is Adjunct Professor in environmental policy. She works as a Programme Director of the Finnish Academy strategic research programmes 'Keys to Sustainable Growth', 'Changing Society and Active Citizenship' and 'Adaptation and Resilience for Sustainable Growth', and as a Research Coordinator at Helsinki Institute of Sustainability Science, HELSUS. She has over ten years of experience in working within science–policy interface with different kind of stakeholders from international to local levels. She is founder of a national science policy forum for environmental knowledge in Finland. She has been part of the evaluation team conducting the recent Evaluation of Finnish Sustainable Development Policy, commissioned by the Prime Minister's Office. She has over ten years of research experience on forest and climate policy governance particularly in tropical countries, as well as expertise in comparative policy analysis, on which she has published widely. Currently, her research focuses on science–policy

interaction, SDGs, sustainability transformations as well as innovative co-production research methods. Email: kaisa.korhonen@helsinki.fi.

Virpi Kuitto, MSc works as an environmental specialist in the University Facilities. She has decades of experience in developing new and innovative ways to improve campus sustainability, such as campus gardening and green campus principles. She is active in various international and national networks on campus sustainability. Email: Virpi.kuitto@helsinki.fi.

Olga Laiza Kupika is Senior Lecturer and Researcher at Chinhoyi University of Technology's School of Wildlife Ecology and Conservation, Zimbabwe. Dr. Kupika's research interests are in climate change adaptation, biodiversity conservation, green economy and sustainable development, ethnobiology, local communities and sustainable livelihoods, plant ecology and social ecology. Kupika has published 14 journal articles, some book chapters and technical reports. Dr. Kupika is currently supervising five Master's and three MPhil and is co–supervisor to two PhD students. Dr. Kupika is a member of several local, regional and international organisations focusing on biodiversity conservation, intangible cultural heritage, communities and sustainable livelihoods. Email: olgal.kupika@gmail.com.

Adebukunola Lala is Senior Research Fellow with the Federal University of Agriculture. She is specialized in Monogastric Animal Nutrition and has published both locally and internationally in her area of interest in improving poultry production and safe food. She is a member of various professional bodies both locally and internationally, as well as a fellow of Climate Impact Research and Capacity Enhancement in Sub-Saharan Africa (CIRCLE), an initiative of the Department of Development (DFID). Email: lalaao@funaab.edu.ng.

Ángeles Cristóbal López has worked in the Spanish Public Administration in different positions related to air quality, occupying the Head of the Air Quality Area of the Ministry of the Environment from 2003 to 2008. Since 2008, she has been working for Madrid City Council and currently she is the Deputy Director of Sustainability in the Area of Environment and Mobility of Madrid City Council, being responsible for the direction of the comprehensive monitoring, forecasting and air quality information system of the city of Madrid and the Department of Environmental Education. She has participated as a speaker in numerous courses, seminars and conferences. She graduated in Chemistry and Sociology. Email: cristoballma@madrid.es.

Julio Lumbreras holds a degree in Chemical and Environmental Engineering from the Technical University of Madrid (UPM) and a Master in Public Administration from the Harvard Kennedy School (HKS). Julio is passionate about increasing sustainability in higher education and transforming universities as change agents within cities. He received his PhD on Air Quality in 2003 from UPM. Currently, he is Associate Professor at UPM and Visiting Scholar at HKS. He is the UPM's Director for North America. He is a founding associate editor for the *Open Access Journal on Frontiers in*

Sustainable Cities. He is co-author of more than 60 papers and book chapters. He has participated in many international workshops and conferences on urban air quality, climate change and sustainable development. He has collaborated in more than 50 research works. Email: julio.lumbreras@upm.es.

Carol Maione received a Master of Science in Environment and Sustainability from the University of Michigan, Michigan. Her previous experience includes a Bachelor of Science and Master of Science obtained from Politecnico di Milano, Italy, where she focused on urban metabolism and waste generation. Her research interest centres on sustainable production and consumption of resources, with a specific focus on plastic materials. She is driven by her life-time commitment to reducing ocean plastic pollution by fostering awareness of the impacts of plastics on human and non-human communities and rethinking industrial processes based on circular economy and zero-waste models. Email: cmaione@umich.edu.

Carlos Mataix is Professor in the Department of Industrial Engineering at the Universidad Politécnica de Madrid. He directs the Innovation and Technology for Development Centre at the same university (itdUPM). The itdUPM is an interdisciplinary centre, with 15 research groups that develop technological and organisational measures to solve social and environmental problems innovations. His model is based on building partnerships for sustainability with technology companies, international agencies and NGOs. Carlos has a long history in the field of international cooperation for development. He co-founded the NGO Engineers without Borders (now ONGAWA), and was responsible for the Planning Unit and Quality Support of the Spanish Agency for International Development Cooperation (AECID). He has published several articles and books on management cooperation and, in particular, on building partnerships with the business sector. Email: carlos.matix@upm.es.

Alexio Mbereko is Lecturer in the Child Sensitive Social Policy Programme at the Women's University in Africa. He is an experienced social scientist who holds a PhD in Development Studies from the University of KwaZulu-Natal. He has 16 years' experience as a researcher and has served as a social scientist on two transdisciplinary ECOHEALTH (Environment, society and health) research projects: the Malaria and Bilharzia in Southern Africa (MABISA) and the Tackling Infections to Benefit Africa (TIBA) among other smaller studies. Dr. Mbereko has a sound background in humanities and social sciences where he has successfully utilized political ecology theory to understand social differentiation, marginalisation and inequalities, public health, natural resource utilisation, governance and policy. He has 15 publications in peer-reviewed media and more than 22 conferences attended. His research contributes to sustainable development through interrogating the environment, society and health nexus in a differentiated political economy; he fights for social justice through equity and equality. Email: ambereko@gmail.com.

Vuyo Mjimba, PhD (Editor of the book) is Chief Research Specialist in the Africa Institute of South Africa (AISA) hosted by the Human Sciences Research Council (HSRC). He is a development, policy and practice scholar with research interests in sustainable development. His focus is on industrialisation, global value chains, climate change and innovation. Dr. Mjimba brings more than 12 years of commercial enterprise experience and insights to his research and academic work. In this space, Dr. Mjimba interacts with both experienced and early career researchers and practitioners, as well as master's and doctoral students exploring a broad spectrum of sustainable development matters in Africa. Email: vmjimba@yahoo.com.

Annah Molosiwa is Senior Lecturer in language education, Department of Languages and Social Sciences Education at the University of Botswana. Her research interests are in the areas of curriculum development, language and literacy education, language policy, multicultural education, teacher education and teachers' professional development. Dr Molosiwa has published several book chapters and articles in peer-reviewed journals. She has vast experience in conducting large-scale studies, having participated in consultancies for the Ministry of Education and UNICEF such as the Review of the Botswana Secondary School Curriculum and Enhancing the quality of Education in Botswana. Dr. Molosiwa is a member of some professional organisations such as the Botswana Educational Research Association, International Literacy Association and Organization for Social Science Research in Eastern and Southern Africa (OSSSREA), Botswana chapter. Dr. Molosiwa serves as a reviewer for international journals and is an external examiner for some universities in the region. Email: molosiwaa@mopipi.ub.bw.

Jhonjali García Mosquera has a master's in Management of Technological Innovation, Cooperation, and Regional Development obtained from the Instituto Tecnológico Metropolitano ITM, Colombia and a Bachelor of Business Administration from the Universidad Tecnológica del Chocó 'Diego Luís Córdoba'. Currently, he is researching in a number of focus areas, such as Technological Surveillance and Competitive Intelligence, Technological Management and Innovation, Transformative Innovation Policies and Analysis of Collaboration Networks. With regard to the production and generation of new knowledge, he has contributed to the publication of six books in the areas of interest and has published two book chapters focused on the Sustainable Development Goals and Transformative Innovation Policies. He has also participated in several international conferences to share his research findings. Email: jhojalisk2@gmail.com.

Godwell Nhamo, PhD (Editor-in-Chief and Book Project Leader and Originator) is Chief Researcher and Chair for the Exxaro Chair in Business and Climate Change hosted by the Institute for Corporate Citizenship (ICC) at the University of South Africa (UNISA). Prof. Nhamo has interest in the fields of climate change and governance, the green economy and sustainable development, and he is a National Research Foundation C3 rated scholar.

Prof. Nhamo has published widely in his areas of interest and has over 20 years of work experience in the academic field. Among his offerings are six books (five edited) and over 70 journal articles. Since 2013, Prof. Nhamo has graduated 10 PhDs and hosted 10 postdoctoral fellows. Prof. Nhamo also sits on a number of international and national boards in his research space and has also received several awards and recognition for his outstanding work both locally and internationally. Email: nhamog@unisa.ac.za.

Olalekan Jacob Olaoye is currently a Principal Extension Fellow (PEF) at the Federal University of Agriculture, Abeokuta. He holds a Bachelor of Agriculture in Animal Breeding and Genetics, a Master of Fisheries Management and a PhD. Dr Olaoye has worked as Village Extension Agent (VEA) from 1996 to 2003 under the Ogun State Agricultural Development Programme (OGADEP). He has supervised 60 undergraduates, 5 master's and 3 PhD students. Dr. Olaoye has over 15 years' experience as an academic especially in Fisheries Extension and Production Management and has over 60 articles in reputed journals to his credit. Email: olaoyeoj@funaab.edu.ng.

Elizabeth Oluwalana is Associate Professor in the Department of Agricultural Economics and Farm Management, Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria. She obtained her bachelor's and master's degrees from the University of lbadan, Nigeria, and PhD in Forestry Economics and Management from the FUNAAB in 2011. Prof. Oluwalana, with a research focus on Agricultural and Resource Economics, has over 30 publications in learned journals and proceedings. She has co-patented 3 products, authored and co-authored 5 books and has had over 30 documented exhibitions with awards. Prof. Oluwalana is a member of many professional bodies including the Nigeria Institute of Management (NIM). Email: elizabetholuwalana@gmail.com.

Akinwumi Omotayo is Professor of Agricultural Extension and Rural Development with Doctor of Philosophy (PhD) degree from Ahmadu Bello University, Zaria, Nigeria, and Master's and Bachelor's degree in Agricultural Education from Virginia State University, Petersburg, Virginia, USA. He studied Geographic Information Systems (GIS) and Remote Sensing at the Natural Resources Institute, (NRI) University of Greenwich, United Kingdom. He has published over 60 scholarly articles in local and international journals, books and refereed conference proceedings in areas such as rural youth empowerment, agricultural extension, pastoralist cattle production system, farming system and rural health system studies. He served as a member of the Steering Committee of the Cassava Weed Management Project Supported by the Bill and Melinda Gates Foundation and hosted by the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Prof. Omotayo's current research interests are in eco-friendly and climate smart farming systems, rural development policy analysis and socio-economic impact of development interventions. Email: akinomotayo@gmail.com.

Elizabeth Omolola Oyedepo holds a Doctorate in Agricultural Economics (Development Economics option). She has nearly eight years' experience working with rural dwellers on asset ownership, poverty and gender issues. Email: lolaoyedepo1@gmail.com.

John Adebayo Oyedepo is Senior Lecturer at the Federal University of Agriculture, Abeokuta, Nigeria. He holds a PhD in Environmental Resources Management, a Master's in Environmental Management and Protection, a Master's in Science in Geographic Information System (GIS) and a Bachelor of Agriculture. He is a seasoned academic with up to 14 years' experience in the area of applied Geo-information Sciences Remote Sensing of the environment, Spatial Analysis and modelling of the environment. He is particularly interested in climate change adaptation and geographical targeting of interventions to the vulnerable. He served as the Monitoring and Evaluation Officer in the University-led interventions on the Agricultural Productivity Programme and has published over 35 articles in peer-reviewed journals. Email: johnoyedepo@gmail.com.

Angelo Paletta is Delegate on Finance, strategic planning and process innovation of the University of Bologna and Associate Professor at its Department of Management. Prof Paletta focuses his research and teaching activity on corporate governance, management control and strategic management of the economic performance; economics of enterprises and public services; and governance, accountability and management of universities, research institutions and schools. Paletta is Director of the Master course in Management of Educational Institutions of the University of Bologna and President of the Research Centre EGAM—International Studies in Educational Governance Accountability and Management. With over 110 publications, including 12 books, Prof Paletta has joined and coordinated numerous national and international projects dealing with methodological research, industrial research and pre-competitive development. Email: angelo.paletta@unibo.it.

Sanjana Paul (author of *University Environmental Hackathons to Further the Sustainable Development Goals*) is the co-founder and executive director of The Earth Hacks Foundation, an organisation dedicated to empowering hackers to generate innovative, actionable solutions to pressing environmental problems. She holds a bachelor's degree in electrical engineering and physics and is currently a postgraduate intern at the NASA Langley Research Center. Previously, Sanjana has worked at the National Science Foundation Research Experience for Undergraduates participant in extreme ultraviolet engineering in the Kapteyn-Murnane Lab in JILA, at the University of Colorado, Boulder, and as a Conservation Innovation Fellow with Conservation X Labs. Email: earthhacksorg@gmail.com.

Janna Pietikäinen, PhD is Vice-Dean in charge of educational and bilingualism affairs and Lecturer of Environmental Studies at the Faculty of Agriculture and Forestry, University of Helsinki. She received a PhD in forest sciences and has further specialized in interdisciplinary environmental

teaching. She is active as an educational developer in HELSUS Helsinki Institute of Sustainability Science and member of the distinguished Teachers' academy at the University of Helsinki. Her research is focused in environmental issues within forestry, food production and sustainability education. In addition, she is an active player in campus sustainability operations and has created student-driven environmental projects and campus activities. Email: janna.pietikainen@helsinki.fi.

Milena Popov is a multimedia artist and scholar with a PhD in Interdisciplinary Studies and an MFA and a BFA in Painting and Art Education. Popov teaches art and sustainability and environmental justice courses at the City University of New York, and she is a founding member of the Environmental Justice Minor at the John Jay College of Criminal Justice. She has published numerous texts on sustainability and culture, and is currently preparing her e-book, *Eco-Aesthetics and Biopolitics* for publication by the University of Arts Belgrade, while her essay Rethinking Fashion in the book *Eco Art Practicum* is forthcoming from New Village Press. Popov is a member of Eco Art Dialog, founder of Intellectual Salon, and a co-founder of the art group Aufwiedersehen. She has exhibited her artworks worldwide and some of her artworks have entered public collections, such as the Museum of the Contemporary Art of Vojvodina. Email: mpopov@jjay.cuny.edu.

Sara Romero is a researcher and coordinator for the team in the Innovation and Technology for Development Centre at the Technical University of Madrid (itdUPM). She is also the coordinator for the Sustainable Transformation in Cities Open Platform. Her academic profile combines anthropology, sustainable development and communication. Her current research focuses on the relationship between social innovation and social change that draws from an ethnographic approach. The previous professional background was performed on digital communication and marketing areas on transnational companies and the United Nations agency. Email: sara.romero@upm.es.

Norman Rudhumbu is Executive Dean in the Faculty of Science Education at Bindura University of Science Education in Zimbabwe. Prof. Rudhumbu has great interest in the fields of sustainable development, educational leadership and curriculum development and implementation. Prof. Rudhumbu has published widely in his areas of interest and has over 27 years of work experience. Among his offerings are 10 books and over 40 journal articles. Prof. Rudhumbu has supervised over 20 master's dissertations and is currently supervising 4 PhD students who are on the verge of completing. Prof. Rudhumbu sits on a number of local boards in his research space and has also received a number awards and recognitions for his outstanding work both locally and regionally. Email: nrudhumbu@buse.ac.zw.

John Ruppert earned his PhD in Ecology and Evolution from Rutgers University in 2015, with a focus in Science and Environmental Education; specifically, socio-scientific reasoning, ecosystem services for education, model-based inquiry and scientific literacy. He has published in *The Journal*

of Research in Science Teaching and Research in Science Education. A Professor of biology at Saint Peter's University in Jersey City, New Jersey, John Ruppert uses his research to inform his classroom practice. He is also an advisor to several undergraduate and graduate research students, a co-PI on a grant seeking a clearer understanding of scientific literacy for workplace readiness in STEM, an EHS Officer and a partner for a Noyce science teacher programme. Email: jruppert@saintpeters.edu.

Paula Schönach, PhD is a Research Coordinator at the Helsinki Institute of Sustainability Science (HELSUS), University of Helsinki, Finland. She received a PhD in 2008 in environmental policy. Her current research interests focus on northern environmental history with an emphasis on water-related issues, such as water governance and infrastructures; watershed management and the history of water pollution and protection. She has been a visiting scholar at the University of British Columbia and the University of Alberta in 2016 and 2018, respectively. She is the Regional Representative of the Nordic Countries in the European Society for Environmental History. In HELSUS she is responsible for enhancing and coordinating research in sustainability science at the University of Helsinki. She has among others participated in the recent Evaluation of Finnish Sustainable Development Policy, commissioned by the Prime Minister's Office. Email: paula.schonach@helsinki.fi.

Jaime Moreno Serna is Technical Director of the Innovation and Technology for Development Centre at Universidad Politécnica de Madrid (itdUPM). In his work at the itdUPM, he accompanies various teams and projects of education and applied research, with an interdisciplinary and multi-actor approach, to accelerate innovations in policies that facilitate the achievement of the SDGs. He also has a master's degree in Technology for Human Development from the Universidad Politécnica de Madrid, where he also obtained his Industrial Engineer diploma, in a double degree programme with the Ecole Nationale Supérieure de Techniques Avancées de Paris. He was previously a director of projects on sustainability in the Saharan region at the Spanish NGO Movimiento por la Paz (MPDL). Email: jaime.moreno@upm.es.

Jenny Shumba holds a PhD in Education, a Master of Education in Curriculum Studies and a Bachelor of Education in Curriculum Theory. A trained teacher by profession, she has taught at virtually all levels of the education system (from pre-primary to university). During her years of teaching, she won accolades and has been in positions of responsibility within and outside the school system. A prolific researcher and publisher in her own right, she now has 3 book chapters and 31 publications to her name in renowned journals. Her areas of passionate interest include early childhood education, bereavement counselling, programmes in higher education and curriculum development at all levels. She derives much satisfaction in assisting others in the area of research. Dr Shumba has also participated in consultancy work for various organisations. Email: Jshumba@ufh.ac.za.

Nthalivi Silo is Senior Lecturer in Environmental Education in the Department of Primary Education of the University of Botswana. She did her PhD in Environmental Education at Rhodes University, South Africa. Her areas of interest are curriculum issues in environmental education and development of children's civic agency and competences in environmental related and sustainability issues. She has published her research work in peer-reviewed journal articles, bulletins, manuals, book chapters, conferences, seminars and workshops papers at the national, regional and international levels. She has developed and reviewed courses in Environmental Education at the University of Botswana. Dr. Silo is an EEASA Council member. Email: SILON@mopipi.ub.bw.

Katriina Soini (PhD, Human Geography) is Adjunct Professor in Environmental Policy and Rural Studies. Currently, she is Senior Researcher at Natural Resources Institute Finland. She has long-term experience in sustainability research in the context of natural resources governance, in particular from the social and cultural points of view. Recently, her study has also concerned Sustainability Science and sustainability science education; she has also contributed to teaching Sustainability Science at the University of Helsinki. Besides her research activities she is a co-ordinator of the Finnish Expert Panel on Sustainable Development and Editor-in-Chief of Routledge Studies in Culture and Sustainable Development. Email: katriina.soini@luke.fi.

Karen Hormecheas Tapia is an Industrial Engineer from Universidad Nacional de Colombia at Medellín and is currently pursuing a master's degree in Administrative Engineering at the same institution. From 2017, Tapia has been an active member of the research group focusing on innovation and technology management. As part of this research group, Tapia has participated in several research projects focusing on the relationship between innovation and social and environmental challenges. Email: kchormecheat@unal.edu.co.

Tullia Gallina Toschi is a Full Professor at the University of Bologna, coordinator of the research group of instrumental and sensory analysis of food and of the food waste innovation centre. She focuses her research on methods for verifying food quality and authenticity, with interest in vegetable oils and fats, and food innovation, re-use of by-products and virtuous interactions in the R&D. She coordinates international (www.oleumproject.eu; www.plotina.eu) and national research projects, collaborates with several institutions at a global level and is a member of the olive oil chemists of the International Olive Council (UN, Madrid) and of the Italian Ministry of Food, Agriculture and Tourism (MIPAAFT). Co-author of more than 130 publications, she has graduated more than 50 degrees or doctorate thesis. After serving as President of the Guarantee Committee for Equal Opportunities, Employee Well-being and Non-Discrimination at Work—University of Bologna, she is Delegate for Wellness at Work at UNIBO and Member of the National Scientific Qualification Committee for Food Science and Technology. Email: tullia.gallinatoschi@unibo.it.

Francesco Ubertini is the University of Bologna Rector (2015–2021) and since 2007, he is Full Professor of Mechanics of Solids and Structures at the University of Bologna. He is a member of the Board of Rectors of UnaEuropa—University Alliance Europe, Board member of European University Association, president of Federico Zeri Foundation, Bologna Business School, Fibra—Fondazione culturale Italo Brasiliana and Bononia University Press. He is a Board member of the Italian University Rectors Conference and Council member of Magna Charta Universitatum Observatory. His research activity focuses on various aspects of mechanics of solids and structures, with theoretical and applied contributions in many fields of Engineering. These include in particular (a) numerical modelling and structural analysis; (b) smart structures and innovative materials; (c) historical structures and innovative materials; and (d) structural monitoring and diagnostics. Email: francesco.ubertini@unibo.it.

Daniel Cardona Valencia has a full-time teaching position at the Instituto Tecnológico Metropolitano in Medellín, Colombia. Prof. Cardona holds a master's degree in Finance and has a special interest in the fields of inclusive finance and financial education focused on achieving the Sustainable Development Goals. Prof. Cardona has written articles on ICT and Finance, Inclusive Innovation and Academic Trends in the teaching of finance. Prof. Cardona has participated in several international conferences and social project addressing his topics of interest. Email: danielcardona@itm.edu.co.

Alejandro Valencia-Arias has a PhD in Engineering, focusing on Industry and Organisations and a Master's in Systems Engineering. Prof. Valencia-Arias is a member of the institutional research group in Management Sciences at the Instituto Tecnologico Metropolitano. In addition, he is a researcher at Fundación Universitaria Católica del Norte. He has a great interest in the fields of entrepreneurship, technology adoption models and mobile learning. Prof. Valencia-Arias has published in his areas of interest and has over eight years of work experience in the academic field. Among his offerings are one book and over 30 journal articles. Prof. Valencia-Arias is also an Editor-in-Chief of the journal *Revista CEA*. He has received recognition for his work in Colombia. Email: javalenciar@gmail.com.

Kgosietsile Velempini is Lecturer in the Environmental Education unit in the Faculty of Education at the University of Botswana. He has a PhD in Curriculum and Instruction from The Patton College of Education at Ohio University, Ohio, USA. His research focuses on environmental and sustainability education, sustainable development, tourism, community-based natural resource management, climate change and local knowledge systems in Africa. He has published in various environmental and geography education related international journals. Dr. Velempini holds two Master degrees, one in International Affairs from Ohio University and the other in Environmental Sciences from the University of Botswana, respectively. He has a graduate certificate in Environmental Sustainability from Ohio University, a Bachelor of Arts (Environmental Sciences) and a Postgraduate Diploma in Education

from the University of Botswana. He has completed graduate courses as well in Wageningen University of Research (WUR) in the Netherlands and the University of Science and Technology, Beijing (USTB), in the People's Republic of China. Email: kgosi2015@gmail.com.

Eliana Villa is an Engineer with a master's degree in Administration and a PhD in Industry and Organisations obtained from the National University of Colombia. She is a Professor at the Instituto Tecnológico Metropolitano in Medellín, Colombia. Her current research is situated in the field of Transformative Innovation Policies (TIP), a framework for the construction of public policies in science, technology and innovation (STI) to support the changes needed to achieve the Sustainable Development Goals (SDGs). This new framework has been led by the SPRU of the University of Sussex and was included in the Green Book 2030 in 2018 and the Science and Innovation Policy of Colombia. Prof Villa has participated in several international conferences and social projects related to the same topics, specifically focusing on the role of universities in innovation processes that allow a positive impact on climate change, as well as in social inequality that exists in growing countries. Email: elianavilla@itm.edu.co.

Leocadia Zhou is Director of the Risk and Vulnerability Science Centre at the University of Fort Hare, South Africa. Dr. Zhou has built-up solid global reputational transdisciplinary research on climate change risks and vulnerability assessment on food and water security in rural communities of South Africa. Dr. Zhou has published two book chapters and 22 research articles in high impact journals. Dr. Zhou's strength in transdisciplinary approaches and rapport with government officials at Provincial and National levels has resulted in her heavy involvement in bridging the gap between science and policy interface. This has been achieved through conducting skills training and dissemination workshops for government officials, vulnerable rural small-scale farmers and to unemployed youths on climate change related adaptation strategies. Dr. Zhou has been awarded the Vice Chancellor Excellent Community Engagement Award in 2016 and has supervised over 15 master's and four PhD students to completion. Email: lzhou@ufh.ac.za.

1 The Context: SDGs and Institutions of Higher Education

Godwell Nhamo and Vuyo Mjimba

1.1 Introduction

The year 2015 was significant in many respects as it marked the conclusion of agreements defining a number of important global development agendas. Foremost among these agendas are the Addis Ababa Action Agenda on development finance and means of implementation (United Nations 2015a), the 2030 Agenda for Sustainable Development (AfSD) and its 17 indivisible Sustainable Development Goals (SDGs) (United Nations 2015b) and the Paris Agreement (United Nations Framework Convention on Climate Change—UNFCCC 2015). Complementing these important agendas are other global development agendas that came up just before and immediately after 2015 that have a huge bearing on the implementation of the SDGs in institutions of higher education (IHE). These development agendas are, notably: The Sendai Framework for Disaster Risk Reduction running from 2015 to 2030 (United Nations 2014), the United Nations Educational, Scientific and Cultural Organization (UNESCO), Global Action Programme on Education for Sustainable Development (UNESCO 2014) and the New Urban Agenda from the United Nations' Habitat III (United Nations 2016).

To the researchers and IHE in particular, these agenda avail an endless list of opportunities to contribute both academically and practically to the various converging objectives of these agendas. Against this background, there is certainly a case for reflection on the implementation of the 2030 AfSD and its SDGs, which is the focus of this publication. Across the globe, the challenge of localising the SDGs in terms of national development priorities requires a combination of technical, scientific as well as administrative and political input. It is clear that a collaborative approach is needed in order to stay true to the SDG's inclusive and bottom-up approach. Of particular interest is the notion that the SDGs represent a development agenda that should be realised by both developed and developing countries. This provides IHE with a novel opportunity to collect and share insights and good practices. Hence through the SDGs, the world hopes to conclude by 2030, the unfinished business of the Millennium Development Goals (MDGs). The SDGs are documented as a co-created plan of action for global citizens, the planet, and prosperity (United Nations 2015b).

The IHE have a crucial role to play in meeting the sustainable development challenges by going beyond advancing training and skills

G. Nhamo (✉)
Institute for Corporate Citizenship,
University of South Africa, Pretoria, South Africa
e-mail: nhamog@unisa.ac.za

V. Mjimba
African Institute of South Africa (AISA),
Human Sciences Research Council (HSRC),
Pretoria, South Africa

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development. The IHE must not only produce excellent teachers, but 'uncover ground-breaking research, and connect services to communities' (Owens 2017: 418). This is because IHE generally remain on neutral grounds in the eyes of several stakeholders and are one of the key drivers of economic, social, and other forms of progress of any given country (Utama et al. 2018). In this context, IHE are encouraged to develop management systems based on the principles embedded in the SDGs (Box 1.1).

Overall, Utama et al. (2018) presents five strategies that may facilitate a swift movement making IHE realise the localisation of SDGs quicker. These strategies include the improvement of IHE quality, equity, sanitation and environment, research and innovation, and partnerships both locally and globally. Notwithstanding the fact that apart from the broader SDGs agenda, there is a specific SDG (SDG 4) targeting IHE. This SDG has ten targets and a number of indicators. Some of the targets directed at IHE include the following (United Nations 2015b: 17):

- By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.
- By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.
- By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous people and children in vulnerable situations.
- By 2020, substantially expand globally the number of scholarships available to developing countries for enrolment in higher education.

The IHE are at the forefront of creating and co-creating knowledge, coming up with innovations and discoveries, yet in many cases the outcomes of the efforts of IHE such technological powers

Box 1.1: Abridged Version of the SDGs

- Goal 1: End poverty in all its forms everywhere.
- Goal 2: End hunger, achieve food security and improve nutrition and promote sustainable agriculture.
- Goal 3: Ensure healthy lives and promote well-being for all at all ages.
- Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Goal 5: Achieve gender equality and empower all women and girls.
- Goal 6: Ensure availability and sustainable management of water and sanitation for all.
- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all.
- Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.
- Goal 10: Reduce inequality within and among countries.
- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable.
- Goal 12: Ensure sustainable consumption and production patterns.
- Goal 13: Take urgent action to combat climate change and its impacts.[1]
- Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
- Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems,

(continued)

[1]Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.

sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

- Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
- Goal 17: Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development.

Source: United Nations (2015b: 14)

are hardly implemented within campuses. A broader understanding on the role of IHE in the SDGs space reinforces the notion of socially responsible IHE, moving away from conventional debates on quality, financing, and student mobility (Tandon 2017). Through conceptualising IHE as socially responsible institutions, the capacity deficits in achieving the SDGs that include lack of sustained political support from governments, inadequate resources, institutional and human capacity, and knowledge deficit can be addressed.

The involvement of IHE in SDGs localisation from a social responsibility view point can be addressed through the three co-mandates of IHE namely: teaching and learning; research and development; and engaged scholarship (sometimes referred to as community engagement or service to the community) (Nhamo 2012). The interaction between these mandates is complex both conceptually and practically. Since there remains contestation as to whether engaged scholarship should be a separate or integral pillar to the other two pillars (Nhamo 2013a), this book takes the view that engaged scholarship remains an integral element of the other two pillars. Agbedahin (2019) and Boni et al. (2016) add to the complexity and highlights that a focus on SDGs localisation in IHE will be incomplete without considering the intertwining between education, sustainable development, human development, and education for sustainable development. English and Carlsen (2019) add the lifelong learning dimension from SDG 4 seen as pivotal in the attainment of many other SDGs. The authors highlight five other SDGs with a strong link to lifelong learning, namely SDGs 3, 5, 12 and 13.

This book seeks to present case studies related to how the IHE have been involved in localising the SDGs. Seeking to accelerate the localisation of the SDGs in IHE, the book brings together both theoretical and case study-based contributions to the implementation of SDGs. The next three sections are dedicated to documenting how IHE can localise the SDGs within the twin pillars of teaching and learning; and research and development as well as general SDGs localisation outside the highlighted pillars.

1.2 SDGs Localisation in the Teaching and Learning Space

Tandon (2017) advises on a number of practical steps could be undertaken by IHE to embed SDGs in the teaching and learning space. The author identifies three such pathways as curriculum revisions, the introduction of new courses and engaged pedagogy. Regarding curriculum revisions, the argument is that existing syllabus and curriculum may be adjusted and updated enhancing new perspectives from the SDGs not considered in the old curriculum. From the engaged pedagogy perspectives, teaching of many of the SDGs could take place out of the lecture rooms and practically demonstrated within community set-ups. For example, agricultural faculties may wish to get into the communities when teaching about organic farming and traditional food conservation habits that address SDG 2.

One key area of interest forms the IHE perspectives is the United Nations' Principles for Responsible Management Education (UN PRME). Weybrecht (2017) explores the crucial role of UN PRME in sustainability and SDGs localisation. In the author's view, business schools globally should take responsibility in translating the global development trajectory

from the SDGs into tangible solutions that resonate with communities in which they operate. This implies integrating the SDGs agenda into business schools' curriculum. This is important for a future where it is possible to reach a common global view that addressing the SDGs may be an unwritten license to operate. The SDGs may also be used as a platform for business schools to engage their external stakeholders, assisting them to further localise the SDGs in their own operations. Weybrecht (2017), however, contends that management education has not fully embraced the SDGs and proposes a four-step sustainability engagement framework. The framework looks at: (1) setting the scene, (2) integrating (embedding, collaborating and contributing), (3) identification of unique engagement points and (4) providing an enabling environment. Storey et al. (2017) concur with the view of a limited response of PRME with regard to the SDGs. The authors are of the opinion that PRME remains cluttered and fluid. In contrast, the SDGs agenda is enhancing a collective direction. This is evident in the SDG-centred mission statement posted by the UN PRME in 2016. This change in posture from UN PRME resulted from the 2015 Global Forum for PRME that took place on the side-lines of the United Nations SDGs Summit in New York. Participants to the Global Forum for PRME requested key stakeholders, among them governments, business leaders and the United Nations agencies to give support to PRME in developing future leaders that would assist in attaining the SDGs (Parkes et al. 2017).

Table 1.1 Ways IHE are engaging the SDGs in the teaching and learning space

Organisation	SDGs initiative
Curtin University	Doctorate in Sustainable Development for the SDGs
The University of Sydney	Teaching SDG 1 (End poverty in all its forms everywhere)
Victoria University of Wellington	Mapping curriculum through the SDGs
University of South Africa	Sustainable Development Goals for Society (SDGs4S) Research Stream Inauguration of the localisation of SDGs in institutions of higher education public lecture series through the Exxaro Research Chair in Business and Climate Change
University of Pretoria, South Africa	South Africa's SDGs hub offering Africa's first multidisciplinary postgraduate degree on the SDGs

Source: Modified after SDSN Australia/Pacific (2017: 47–52)

Several examples of ways in which IHE are engaging with the SDGs in the teaching and learning space are emerging. Some of these examples are presented in Table 1.1.

Table 1.1 shows the diversity of approaches. What is important is that despite this diversity, there is a common goal and capacity as well resources availability determines the trajectory and its form.

1.3 SDGs Localisation in the Research and Development Space

Tandon (2017) suggests what needs to be done in IHE regarding SDGs localisation in research and development spaces. The author identifies the first port of call as the contribution of new knowledge on how the world may achieve the set objectives of the SDGs. However, the emerging work on SDGs baselines (Nhamo et al. 2018, 2019) reflect that many countries lack appropriate baselines to measure, report and verify (MRV) progress on SDGs. Additional insights from this work is on huge data gaps for the indicators spelt out for MRV that require Big Data.

Tandon (2017) proposes three practical ways by which IHE can make research and development contribute meaningfully to understanding SDGs namely: (1) framing locally usable research; (2) co-production of knowledge through partnerships and (3) learning new competencies. Both the students and staff (teachers and mentors) are encouraged to frame policy and context research questions. Given the different forms of governance between countries, SDGs-related research questions ought to define and address challenges from the global, regional, national, state or provincial, local and company-specific context(s). For example, a number of questions may arise. How can IHE research address matters of extreme weather events resulting from climate

change that negatively affects human settlements and ecosystems? How can the research show the linkages between the SDGs? Floods and droughts, for example, bring suffering in municipalities and households, affecting vulnerable individuals. Hence, research contributing to building climate resilient cities, communities and households remains paramount in this generation, thereby addressing both SDG 11 that focus on building sustainable human settlements and cities and SDG 13 that demand proactive climate action.

The co-creation of research agendas on SDGs by IHE cannot be over emphasised. The key actors at any given time in a society include government, business, development and donor community as well as civil society. Stakeholders have different interests and views of societal challenges. In addition, the intensity of their views and willingness to participate in agenda-setting discourses that seek to address the challenges also differ. Nevertheless, whenever there is a need for developing a societal challenge-solving and/or understanding research agenda for IHE, these key stakeholders should be consulted to enhance buy in and acceptance of emerging solutions and approaches to solve defined challenges. In addition, such consultations have the added advantage of unlocking financial and other resources that IHE may not have. This research approach may also contribute in refining data generation protocols for Big Data that is central to MRV in SDGs. Partnering with municipalities or any other entities in assisting them to build model SDGs localisation entities remains a huge research and development agenda. From such partnerships, multidisciplinary research teams can be assembled and deployed in fulfilling several requirements in scaling up SDGs implementation. This is important, as Tandon (2017) has identified gaps showing that the SDGs could have brought in new areas of research that demand researchers to learn and build new areas of competencies. A case in point once more is the language of Big Data propelled under the SDGs era. Learning new competencies may require students and staff to collaborate with other IHE, building lasting partnerships for SDGs and personal competences. In this context, the development of Massive Open Online Courses (MOOCs) (Nhamo 2013b) remains a platform for research and development as well as teaching and learning for SDGs. Several examples of ways in which academics are engaging the SDGs have emerged (Table 1.2).

Once more, Table 1.2 shows a diversity of approach emphasising the established fact of many approaches to meeting a common goal. More of such approaches are encouraged now and into the future.

Table 1.2 Ways IHE are engaging the SDGs in the research space

Organisation	SDGs initiative
Academy of Science, South Africa (ASSAf)	Including SDGs in academy's Annual Performance Plan, Annual Report and Strategic Plan
Science Council of Japan (SCJ)	Setting up expert committee on SDGs
Swiss Academy of Sciences (SCNAT)	Incentivising universities through SDG focused programmes
The World Academy of Sciences (TWAS)	Aligning prizes and/or awards to SDGs
Global Young Academy (GYA)	Using SDG-referenced Working Groups
Academy of Sciences, Malaysia (ASM)	Running flagship studies in sustainable development research and developing a national Science, Technology and Innovation plan for the SDGs
Thai Academy of Science and Technology (TAST)	Holding (bi) annual members' meetings on SDG-relevant themes
Chinese Academy of Sciences (CAS)	Commissioning national sustainability reports
Zambian Academy of Sciences (ZaAS)	Organising live television phone-ins on SDG-relevant issues
The University of Queensland	Achieving SDG 6 discussion paper series
The University of Technology, Sydney	The UTS Development Network
Victoria University of Wellington	SDG Ideation Forum
The University of Western Australia	SDG research website
Monash University	Safe Families Research Study
Institute for Sustainable Futures, University of Technology, Sydney	Mapping research to the SDGs

(continued)

Table 1.2 (continued)

Organisation	SDGs initiative
Curtin University Sustainability Policy Institute	Western Australia's SDG Network
Sustainable Development Solutions Network Australia/Pacific	Leading SDG localisation in Australia
University of South Africa	Inauguration of the Cyclones, Floods and SDGs Research Group in southern Africa Proposal development, coordination and ultimate publication of this book on SDGs and Institutions of Higher Education in partnership with Springer Proposal development, coordination and ultimate publication of another book in the series titled Scaling up SDGs Implementation in partnership with Springer

Source: Modified after InterAcademy Partnership (2017: 12–13) and SDSN Australia/Pacific (2017: 47–52)

1.4 SDGs Localisation in IHE: Focus on Governance and Management

In addition to the twin pillars and mandate of IHE discussed earlier to which SDGs localisation takes place, De Vall and Pubill (2018) bring additional concepts of governance and management. Governance looks at incorporating the principles of SDGs into institutional culture and the way in which IHE are regulated through policies, protocols and procedures. This should be complemented by the management, which looks at fostering a sustainable campus management and operations. In fact, the authors go further challenging IHE to acknowledge their unsustainable pathways that result in environmental degradation through their huge carbon footprints. This makes the actions for good environmental stewardship in IHE campuses regarding water, energy, transport and waste management paramount.

The Sustainable Development Solutions Network (SDSN) Australia/Pacific (2017) presents a guide on getting started with the SDGs in IHE. In this guide, the authors propose a five-stage approach to localising SDGs. The first stage is to map what IHE will already be doing. This is followed by building capacity and ownership of the SDGs, then the identification of priorities, opportunities and gaps. The fourth stage involves the integration, implementation and embedding the SDGs in all practice, with the last and fifth stage focusing on monitoring, evaluation and communication. These stages and/or parts of the stages are further discussed in some chapters of this book.

As matters of SDGs localisation in IHE continue to grow, questions are also emerging on how the IHE themselves are addressing some of the SDGs. SDG 5 (gender) quickly comes to the fore. Oludayo et al. (2019) focus on gender disparity in admissions into IHE in Nigeria using empirical data for the period (2010–2015). The authors are convinced that gender equality in accessing IHE is a crucial factor to building a sustainable world and future. The authors further acknowledge that although a number of countries across the globe have attained gender parity in primary education, this has not been the case for IHE. An analysis of data on enrolments across IHE in Nigeria confirms that indeed, females are still disadvantaged. In 2010, females comprised 41% of total enrolments in IHE and this figure improved slightly to 43% in 2015. The 2015 figure becomes a good baseline for localising SDG 5 in IHE in Nigeria and it remains to be witnessed if the 2030 target on gender parity will be achieved. Another study on gender and IHE implores the institutions to look at themselves as platforms for capacity development to address violence against women and promote gender quality. In Sweden, twin measures are now in place to realise: (1) the inclusion of gender equality as a measurable outcome in IHE quality assurance and (2) the amendment of the Swedish Higher Education Ordinance to embed mandatory knowledge of violence against women in the degree programme of seven selected relevant professional groups.

The localisation of SDGs in IHE should not take place haphazardly. For greater efficacy, a systemic approach will always work better. Given

this background, a number of IHE have started this journey. Among such are the University of the West of England (UWE), Bristol in the United Kingdom. In coming up with its roadmap to localise the SDGs, the UWE (2016) started from its structure that is organised around four faculties namely: Arts, Creative Industries and Education; Business and Law; Environment and Technology; and Health and Applied Sciences. In this journey, the UWE further draws from its already existing 2020 Sustainability Plan that sets out the UWE's ambition to become a sustainable university and a roadmap spelt out and approved by the university's Sustainability Board on 19 April 2016. The roadmap is code-named 'Meeting the UN Sustainable Development Goals: the contribution of the University of the West of England, Bristol'. The Sustainability Plan comes in three main categories focusing on Enhancing the Staff and Student Experience, Education for Sustainable Development and Resource Effectiveness. Each of the categories is further subdivided into 11 themes with high-level aims, key performance indicators (KPIs) and targets. The UWE management then audited and parcelled out what each of the faculties was doing and should do in order to contribute to the SDGs and plans for the university to make a significant contribution to each of the 17 SDGs.

Elsewhere, Okayama University (2017) is now deliberately using the SDGs as a common language for communicating the university's activities to the world. The communication permits the university to visualise its effort and press towards building new partnerships with both its local and international stakeholders. Among some of the case studies profiled are: the developing of plants adapting to climate change, supporting town development, and the promotion of science and technology innovation. The matter of partnerships with government and communities is also raised by El-Jardali et al. (2018), who acknowledge the changing role of universities in the SDGs era. However, for this changing role of universities to be fully realised and be of benefit to other stakeholders, there is a need to change the mind-sets and culture by all key actors, among them, governments and the private sector. A sustained dialogue remains the lubricant for the success.

In as much as there is excitement over the localisation of SDGs by IHE, El-Jardali et al. (2018) offer some advice. The authors believe there is a risk of SDGs 'fatigue' that may result in IHE going back to the silo approaches to development. Despite the fact that this extreme case or retrogression could be true, a number of IHE, particularly those from developing countries are still embracing the SDGs agenda and support its objectives (Albareda-Tiana et al. 2018). The next and last section in this chapter presents the book outline.

1.5 Book Outline

This book comes in 16 chapters inclusive of this introduction and conclusion chapters. Chapter 2 looks at how the University of Helsinki is moving towards realising the SDGs. The authors indicate that Universities such as Helsinki are facing a growing trend to redefine their strategies and organisation to align to sustainability requirements. However, the process of building the structures for sustainability research and education requires the breaking down of existing disciplinary silos. The chapter then analyses the new initiatives in research, education and governance, and management operations to which the University committed during 2015–2018 through the SDGs lens. The results show that SDG 4 (Quality Education) is an overarching goal represented in all new initiatives within research, education and university management. SDG 17 (Partnerships) and SDG 3 (Health and Wellbeing) are also equally strongly emphasised. However, SDGs 1 (No Poverty), SDG 6 (Clean Water and Sanitation) and SDG 5 (Gender Equality) are not considered, or if so, given little emphasis. The analysis further revealed that small niche innovations, tactical and operational activities at the grassroots level like networks, science activism and student awareness pushed for regime-level changes. However, the financial incentives and policy changes initiated on the regime level enabled the niche-level innovations to develop

and lead to strategic decisions providing a window of opportunity to initiate structural changes.

In Chap. 3, emphasis is placed on how IHE are dealing with SDG 7 with a focus on polices and projects from the University of South Africa (UNISA). The chapter highlights that as the world continues moving along sustainability pathways, higher education cannot be left behind. The chapter emerges from a lived experience by a staff member whom, together with colleagues embarked on a roadmap for addressing energy efficiency, alternative energy and carbon management within UNISA. Through Participatory Action Research (PAR), the chapter documents processes leading to the finalisation and subsequent implementation of UNISA's Energy and Carbon Policy. Three cycles informed by PAR emerged namely: the development and approval by management of a Unisa roadmap entitled the Green Economy and Sustainability Engagement Model (Cycle 1: 2012–2013); seeking outside partnerships and funding to develop the Unisa Energy Master Plan alongside the Unisa Energy and Carbon Policy (Cycle 2: 2014–16) and ongoing projects implementation and scaling up in energy efficiency and solar technologies (Cycle 3: 2017–2019). Based on the positives coming up, one would recommend the Unisa model to other higher education institutions in South Africa and beyond as this model is functioning well.

'Build It and They Will Come: The Faculty Learning Community Approach to Infusing the Curriculum with Sustainability Content' is the subject matter in Chap. 4. For those working towards infusing higher education curricula with sustainability content, the sustainability-based faculty learning community (SFLC) model structured around the United Nations (UN) Sustainable Development Goals (SDGs) is said to provide an effective non-prescriptive platform to promote both understanding of systems thinking and the SDGs. The SFLC also encourage course revision and development that include class content relevant to the SDGs. Designed for a small cohort of faculty fellows each year, the SFLC is a low-cost opportunity for institutions to encourage faculty to learn about the SDGs and apply them to their teaching, provide them with institutional support and the freedom to venture outside of their particular academic disciplines, formally connect with community partners, and to aid professional development by helping instructors reimagine their teaching and research as place-based and regionally relevant. The aim of this chapter is to provide an overview and brief history of the SFLC specifically the Ponderosa/Piedmont model, and then present in more detail a case study of the creation and development of the SFLC at SUNY New Paltz in New York. The write-up starts from the inception of the idea, to the most recent assessment of results and plans for the future in the Hudson Valley.

Chapter 5 addresses 'Urban Metabolism and Minority Pulse: An Education and Awareness Campaign Targeting Minority Groups'. The chapter uses the SDGs as a common language to educate vulnerable members of society through tailored method solutions, educational criteria and interdisciplinary approaches. The chapter provides a replicable policy toolkit to target underrepresented populations. The case study covered the cities of Mantova and Milan, Italy. Seven identified target groups: children, elderly, people with disabilities, students and academics, women, LGBTI+, and homeless and refugees. This study designs methodology toolkits to develop awareness of urban metabolism, climate change, and resource consumption behaviours with reference to SDG 4, SDG 12 and SDG 13. Phase I consists of a campus-wide awareness initiative to create interdepartmental networks of students, researchers, and professionals studying sustainability issues. Phase II implements community-based workshops, training courses, and educational programmes targeting minority. Phase III includes guidelines to inform institutions on the importance of developing synergies between citizens, public and private entities, and minorities in strategy design.

The integration of core sustainability meta-competencies and SDGs across the silos in curriculum and professional development are the subject matter in Chap. 6. The chapter presents examples using guided inquiry with peer-to-peer learning with team wiki projects, case studies,

SDGs and reflection essays using Digication ePortfolio, Blackboard and self-assessment exercises and instruments. The authors present interesting comparisons of the New Ecological Paradigm—Revised instrument metrics and the Sulitest Sustainability Literacy self-assessment before and after the course for classes and individuals. Limitations of these instruments and alternative quantitative and qualitative instruments are discussed. A faculty development workshop template for sustainability across the curriculum with the sustainability meta-competencies and SDGs has been developed from this experience and an Association for the Advancement of Sustainability and Higher Education (AASHE) inter- and multidisciplinary bioregion faculty development workshop template.

Chapter 7 narrows down to assessing the role of IHE in the implementation and/or support of SDGs. The IHE play an important, multi-faceted role in this new global development agenda, which strives to eradicate poverty, while addressing social needs such as education, health, social protection, job opportunities, climate change, food security and environmental protection. All these areas, and more, are reflected in the 17 SDGs. This chapter provides an assessment of good practices, actors and activities in the implementation of the SDGs in IHE in South Africa, Zimbabwe and Nigeria. The output of this assessment is the generation of an understanding of the extent to which IHE curricula and their implementation satisfy students' sustainability-related knowledge and skills to be able to successfully deal with the current and future global socio-economic and environmental sustainability challenges. The study identifies the types of institutional arrangements that appear to be particularly conducive to mainstream SDGs as well as challenges in the implementation of the SDGs and recommends how IHE may advance. This qualitative study uses a content analysis of documents to look deeply into institutional characteristics of the case studies, as well as interviews with key informants in the sector.

Chapter 8 focuses on the role of universities towards achieving climate change-related SDGs and draws from a case study of Chinhoyi University of Technology (CUT) in Zimbabwe. The authors see universities as uniquely placed to broker links between different development sectors and policy domains through fostering cross-cutting approaches to achieving the climate change-related SDGs. As such, the chapter documents the extent to which CUT has been contributing towards achieving the climate change-related SDGs, specifically SDG 13 through research, community engagement and teaching. The chapter relied on desktop reviews of grey literature produced by the university in the form of reports, research records and the CUT database. The data was interpreted using content analysis. Findings indicate that the university offers modules with components on climate change, especially in the School of Agricultural Sciences and Technology as well as School of Wildlife Ecology and Conservation. The study also found that apart from taught degree programmes, some academics collaborate internally and with external stakeholders towards research activities and community programmes, which contribute towards climate change science, adaptation, mitigation and resilience in Zimbabwe and Africa. CUT can be used as a model on how universities can translate climate-related research into policy and action through fostering linkages between academics and other stakeholders towards climate smart development initiatives.

The opportunity to foster urban innovation through universities and a focus on the city of Madrid is documented in Chap. 9. Literature shows that not only disciplinary expertise is needed, but also the ability to deal with systemic problems involving a diversity of stakeholders, with varying levels of power to design and implement solutions. It is imperative for the higher education institutions to interact with a range of actors, inside and outside the academic community, and to take into account diverse mental frameworks, languages, cultures and interests. The Innovation and Technology for Development Centre at the Technical University of Madrid (itdUPM) has successfully created a multidisciplinary collaborative network of internal and external professionals to promote action research

and education for sustainable development. One of the ongoing interdisciplinary projects is a living lab (PlatformA) designed in collaboration with the Massachusetts Institute of Technology (MIT) Center for Collective Intelligence (CCI) and MIT Climate CoLab to foster sustainable innovation in the city of Madrid. Through the fostering and sharing of processes between public and private stakeholders, PlatformA takes an innovative approach with the ultimate hope that it will boost a novel multi-actor partnership towards sustainable transformations and the Global 2030 Agenda for sustainable development and its accompanying 17 SDGs.

Chapter 10 deliberates on the enhancement of roles and responsibilities of IHE in implementing the Sustainable Development Goals (SDGs). The SDGs represent a shift to ensure that sustainable development becomes the prevailing paradigm in transforming society and protecting the natural environment. The 2030 Agenda reaffirms the notion of working together in partnerships. The IHE in southern Africa can therefore inspire future leaders to have innovative skills and mindsets of transforming societies by engaging in impactful research and embodying sustainability practices. The institutions can achieve this through promoting interdisciplinary work and problem-based learning experiences. A conceptual orientation to problems that confront IHE is required to help clarify practices that characterise these institutions in achieving the desired sustainability. This chapter explores IHE processes, aimed at escalating their roles and responsibilities in effectively implementing SDGs. The chapter is guided by three questions: (1) what are the implied roles and responsibilities of IHE in SDGs implementation? (2) How can IHE demonstrate participatory approaches towards effective sustainability processes and (3) How can IHE strengthen existing partnerships to enhance the implementation of SDGs? In addressing these questions, the chapter articulates underlying problems and existing gaps in IHE processes with a view of initiating reforms that have an effect on enabling SDGs implementation. This may help identify knowledge gaps on sustainability, hence enabling IHE to initiate forums that bring together relevant stakeholders to co-engage on best practices.

Chapter 11 looks at University Environmental Hackathons and how these can further the SDGs. Even as hackathons expand in scope and scale, participants and problems still remain primarily those within or entering the field of software engineering. To apply the hackathon innovation model, incorporating rapid prototyping and development, to environmental problems, Earth Hacks was created. This chapter discusses the creation of Earth Hacks, a purpose-driven interdisciplinary hackathon focused on generating innovative, actionable solutions to pressing environmental problems. The authors detail the multidisciplinary approach they integrated into Earth Hacks events from the onset of the planning and ideation processes, as well as how they structure judging criteria to be able to take into account the multidisciplinary nature of the projects. They discuss the ideation process and organisational structure of Earth Hacks events, as well as strategies to make hackathon follow up successful. The authors believe that hackathons can be a powerful tool to advance the SDGs and hope to be able to create a global community of student leaders dedicated to breaking down barriers in tech and applying their skills to solving environmental problems.

'Learning and Teaching Practices promoting Education for Sustainable Development: Case studies from Social Studies and Language Education from the University of Botswana' makes up Chap. 12. The successful achievement of the goals of education for sustainable development (ESD) primarily depend on the nature of the curriculum, teaching and learning approaches, assessment practices and teacher commitment. Research shows that, although secondary school teachers are expected to infuse global issues in their respective teaching subjects at secondary school level, in Botswana, many of them are unable to do so. Teacher education programmes are blamed for not equipping them with the knowledge and skills needed to integrate such issues into their disciplines. The aim of this chapter is to share attempts made by two teacher education instructors in incorporating ESD in their

courses at the University of Botswana. The key questions addressed are: (1) which pedagogical approaches can be employed in humanities disciplines to embrace ESD? (2) How can students be assessed to measure the extent to which they have acquired the knowledge, skills and attributes needed to participate in sustainable development? Data for this chapter are based on document analysis and examples of practices from the authors' courses. The research adopted narrative inquiry approach gathering data whose analysis demonstrates that it is possible for instructors, to transform their pedagogical and assessment practices to embrace ESD principles.

Chapter 13 deliberates on 'Livelihood Support Programmes for Sustainable Development Goals in Rural Nigeria' with a focus on the Federal University of Agriculture, Abeokuta (FUNAAB). Nigeria extended a livelihood support programme to neighbouring villages it adopted for its Agricultural Productivity Programme (APP). The APP included training, advisory services and dissemination of some agricultural technologies. The targets of APP were to effectively tackle development challenges by increasing agricultural productivity and to reduce poverty and hunger (malnutrition) as entrenched in the first two SDGs. Four technologies were disseminated and demonstrated to the rural dwellers. The project beneficiaries were guided into personal investment using practical knowledge acquired from the demonstration. At the end of 2 years, an early impact assessment was conducted. Results revealed that the income of farmers improved from $1.81 to $3.76 a day from just two enterprises. Nutritious food such as vitamin A-fortified cassava, quality protein maize, fish, eggs and chicken were made available to people in the rural areas. The University-led APP intervention is an empirical way of actualising the SDG at the village level.

'Transformative Innovation Policy, SDGs and the Colombian University' are matters discussed in Chap. 14. The Transformative Innovation Policy (TIP) views the university as part of the national systems of innovation. Furthermore, higher education institutions are at the core of such policy. This chapter presents the contribution the Colombian university is making to selected SDGs. The SDGs include: SDG 4—Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; SDG 16—Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and effective, accountable and inclusive institutions at all levels and SDG 17—Strengthen the means of implementation and revitalise the global partnership for sustainable development. The chapter describes the manner in which Colombia University was involved in drafting the National Science and Innovation Policy and document the importance of the University as a fundamental axis for a transformative structure. This is evident in the manner in which the University became a centre for the generation and dissemination of knowledge, basic and applied research, and technology transfer. Such academic activities can be aligned with the TIP by following a series of recommendations to develop a public innovation policy that contributes to the country's achievement of the 2030 Sustainable Development Agenda and its 17 interlinked SDGs.

Chapter 15 documents the adoption of the SDGs as a reporting framework at the Alma Mater Studiorum (University of Bologna) in Italy. Since 2016 the University of Bologna has been implementing an innovative strategy of measuring its performance through the Agenda 2030 for Sustainable Development and its convoying 17 SDGs and related targets. As a large sized multi-campus system with over 86,000 students, the University has the need and the duty to harmonise the relationship between the environment and people. The SDGs have been therefore adopted as standards to measure the university's sustainability through the publishing of an annual report, included within the broader frame of its Strategic Plan. This has provided an effective push to reshape institutional and management strategies, to better plan, monitor, and strengthen accountability to stakeholders. After investigating the context, the approach has been developed, the contribution will point out the identified challenges mainly connected to the availability of data. As findings, the reports on the United

Nation's SDGs exposed the value of identifying indicators able to provide comparable results for setting IHE as central actors of change in the achievement of the SDGs. The emerging pattern shows a shift from a process of basic literacy on sustainability to a political action of inner dissemination of the culture of sustainability transitioning from a subsidiary report to a comprehensive 'AlmaGoals' initiative.

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2 Towards Realising SDGs in the University of Helsinki

Kaisa Korhonen-Kurki, Riina Koivuranta, Virpi Kuitto, Janna Pietikäinen, Paula Schönach, and Katriina Soini

2.1 Introduction

Our aim in this chapter is to explore the transition to sustainability in the University of Helsinki. In particular, we assess how far the university's new initiatives in research, education and operational management correspond with the Sustainable Development Goals (SDGs) agenda. We take a multi-level perspective on the socio-technological transition framework (Geels 2002; Geels and Schot 2007) and examine niche-level activities in the University of Helsinki so as to enhance understanding of how regime-level processes, particularly at the university, but also in the wider context of Finnish science policy, have enabled or disabled their emergence. We demonstrate that the transition was supported by several internal and external factors and processes related to the evolution of sustainability science, research profiling and educational reforms. These ongoing and partly overlapping processes created windows of opportunity that facilitated the onset of a transition that was based on the emergent science of sustainability. We show that all these processes are interconnected, and we conclude that both the positive push of external funding and strong internal support contributed to the transition to cross-disciplinary sustainability in the university.

Institutes of higher education are experiencing a growing need to redefine their activities, strategies and organisations along the lines of sustainability (Beynaghi et al. 2016). Indeed, sustainability is among the key topics in education, research, outreach and campus operations within universities (Barth and Michelsen 2013; Ferrer-Balas et al. 2009). Hundreds of them have joined networks related to sustainability, such as the Sustainable Development Solutions Network supported by the United Nations (UN) and the International Sustainable Campus Network (ISCN). A number of university-based centres or institutes focusing on sustainability research and education have been established (Lozano et al. 2015). Universities have started to implement SDGs in their internal operations, as well as in cross-sectoral partnerships with governments and communities to promote and support their adoption in society at large (Findler et al. 2019). All these activities could be seen as a response to the 'sustainability call' put out in recent international (e.g. the SDGs and Paris Agreement of 2015) and national conventions, as well as to real global environmental and social

K. Korhonen-Kurki (✉) · R. Koivuranta · V. Kuitto
J. Pietikäinen · P. Schönach
University of Helsinki, Helsinki, Finland
e-mail: kaisa.korhonen@helsinki.fi; riina.koivuranta@alumni.helsinki.fi; Virpi.kuitto@helsinki.fi; janna.pietikainen@helsinki.fi; paula.schonach@helsinki.fi

K. Soini
Natural Resources Institute Finland (Luke), Helsinki, Finland
e-mail: katriina.soini@luke.fi

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challenges (e.g. climate change, biodiversity loss and immigration). They are further reflected in the growing body of research that is documenting and monitoring progress.

However, despite the advances and successful practices, many studies also highlight various internal and external challenges and constraints in the transition to sustainability in universities (see for example, Beringer and Adomßent 2008; Beynaghi et al. 2016; Dedeurwaerdere 2013; Ferrer-Balas et al. 2008, 2009; Trencher et al. 2014; Albareda-Tiana et al. 2018). The nature and relative importance of these challenges and constraints may vary between countries and institutions, but there are some common characteristics, which we summarise as scientific, organisational, supportive, conceptual and ideological (Soini et al. 2018). First, sustainability research and education are distinct from mono-disciplinary research and education, requiring a paradigm shift on both the individual and the collective level towards systems thinking and interdisciplinary collaboration in research and education. Second, the organisational structure of universities has tended to support disciplinary-based research and education; hence, new structures and practices are required to cross-disciplinary boundaries and to increase the feasibility of research collaboration with non-academic partners. Third, current reward and funding systems within academia do not necessarily support inter- or trans-disciplinary sustainability research and education. Fourth, the conceptual vagueness of sustainability, along with the varying and conflicting aims and goals related to it, may cause problems in collaboration and communication across sectors and disciplines. Finally, although most parties agree on the need for sustainability in broad terms, there may well be differing views on how to achieve it.

Despite these challenges, research has also revealed many drivers that could enable the transition (Holmberg and Samuelsson 2006; Ferrer-Balas et al. 2008). These include visionary leadership, combined with arrangements that promote co-operation and collaborative efforts among existing networks of people (e.g. interdisciplinary research groups) that operate across the university. These 'connectors', as well as units and practices that facilitate communication and the coordination of activities and responsibilities between disciplines and sectors may support the transition, and external pressure (from society or peer institutes) and funding may push it further.

There are numerous ways of analysing the barriers to sustainability in universities, as well as the enabling factors and the pathways of transition or transformation. Ferrer-Balas et al. (2008) introduced the Framework-Level-Actors framework when comparing the transition to sustainability in seven universities. The multi-level perspective on transition (MLP) and the transition-management (TM) framework that draws on organisational and management studies have also been found useful for analysing the transition process (Stephen and Graham 2010). Transitions are understood in the latter as long-term and fundamental transformation processes through which established socio-technical systems shift to new and more sustainable modes.

First, we briefly describe our approach and our method. Second, we analyse some of the key documents reflecting the transition to sustainability in light of the SDGs. Third, we explore the hindering and enabling factors and fourth, we summarise the key issues that emerged from the analysis.

2.2 The Transition to Sustainability

In line with Stephen and Graham (2010), who applied frameworks concerning socio-technical transition and transition management in the context of the transition to sustainability in universities, we suggest that there are initiatives (such as sustainability centres and interdisciplinary Master's programmes on sustainability) that could be considered niche-level innovations in attempts to create amenable scientific and organisational conditions for inter- and trans-disciplinary sustainability research and education. Most of these innovations are

developed on the niche level by small networks of dedicated actors, driven by internal momentum in the form of learning, performance improvement and support from powerful groups, and often constrained by time, space and scope (Bulkeley and Castán Broto 2012). Experimentation on this level is triggered by the intentional destabilisation of existing institutions and routines as the actors seek novel opportunities and outcomes through informed deliberation.

The evolution of innovations is influenced by the socio-technical landscape, in other words the wider socio-political context from market to national and international policy, and from demography to technology. Destabilisation of the regime due to pressure in the landscape (for example, and in the case of universities new societal requests for science or funding availability) may create windows of opportunity for niche innovations.

The transition-management framework adds four types of activity within the evolution of a transition: strategic, tactical, operational and reflexive (Loorbach 2007, see also Stephen and Graham (2010). Strategic activity focuses on high-level engagement in visioning, laying out long-term system-level goals and objectives and establishing a structure and context for social change. The emphasis in tactical activity is on agenda and coalition building on the sub-system level and on negotiations among stakeholders and actors. The focus on the operational level is on experimentation, project building and implementation, and more specifically on learning and the co-production of knowledge in the short term. Reflexive activity involves evaluating and assessing the current situation on various levels.

The theory of multi-level socio-technical transition has been successfully applied in many cases across various sectors, but it has also attracted criticism. Berkhout et al. (2004) criticise the emphasis on bottom-up at the cost of top-down activities: although experiments are crucial in the process, there is no less urgency in transitioning the whole system. It must also be acknowledged that not all emerging experiments are viable or prove to be sustainable. Therefore, careful analysis of practical examples and experiments constitutes a good basis on which to design and adapt policy frameworks in line with the recognised barriers and opportunities.

2.3 Methods

This study is based on a close monitoring of the transition to sustainability in the University of Helsinki. The authors were involved in the meetings and in the planning of new sustainability activities between 2014 and 2018. The material for the study consists of planning documents, research-profiling applications, descriptions of Bachelor's and Master's degree programmes, and annual review documents (Table 2.1).

The first part of the analysis comprises the SDG mapping of key documents depicting the processes of sustainability transition in the university during years 2015–2018. The choice of documents for the analysis reflected the aim to shed light on current developments in the main tasks of the university: research, education and societal activities and its internal operations.

We analysed research-profiling applications because they represent new initiatives that cross current faculty borders and existing administrative structures or strengthen existing research foci. The Ministry of Education and Culture and the Ministry of Economic Affairs and Employment in Finland drafted a policy action programme for research and innovation in 2012, following which the Finnish Government agreed on a crucial strategic decision. This resulted in the creation of a new, targeted funding instrument to strengthen the research profiles of Finnish universities. The Government's public finances plan for the years 2015–2018 earmarked 50 million euros of central government finances for universities to be allocated through the Academy of Finland over the time period 2015–2019. These funds were dedicated in their entirety to strengthening the research profiles of universities (Academy of Finland 2018).

Similarly, we analysed the newly established Bachelor's and Master's degree programmes that cross traditional current and rigid disciplinary

Table 2.1 A summary of the research material

Type of material	Description	Years covered	Remarks	Sources
Research-profiling applications of the University of Helsinki submitted to the Academy of Finland	Four application documents, a total of 129 pages, with 14 distinct research-profiling areas described. All the documents describe how the respective profiling aligns with the University's strategy, and what division of foci among other national institutions of higher education are included	2015–2017	The applications vary in extent and the depth at which the different profiling actions are described	Profiling applications are not public documents
Descriptions: an overview of the curricula of the novel Bachelor's and Master's programmes at the University of Helsinki that cross faculty boarders	Fifteen programme descriptions, in total 72 pages when converted to a Word document All the descriptions include the following subsections: Study objectives, Study contents, Choosing a main subject or field of specialisation, Tuition fees, Structure of studies, Final project, Career opportunities, Internationalisation, Co-operation with other parties, Research focus, Post-graduate study opportunities	2017–2019 Programmes were established in the university-wide reform of educational degree programmes and the curricula approved for the period 2017–2020	The descriptions vary in extent and depth, the word count of each programme ranging from around 1000 to well over 3000. Only the UH degree programmes that cross faculty borders were included in the analysis	Information was retrieved from Studyinfo.fi in January 2019. Studyinfo.fi provides official and up-to-date information about study programmes leading to a degree in Finland. Programme descriptions can be retrieved by inserting keywords "University of Helsinki" and the programme name in the search engine at Studyinfo.fi. The descriptions are given in the language of tuition (English (ENG)/Finnish (FI). The studied programmes are (3) Bachelor's Programme in Environmental Sciences (FI: "Ympäristötieteiden kandiohjelma"); Molecular biosciences (FI: "Molekyylibiotieteiden kandiohjelma"); Philosophy (FI: "Filosofian kandiohjelma") and (12) Master's programme in Atmospheric Sciences (ENG); Environmental Change and Global Sustainability (ENG); European and Nordic Studies (ENG); Human Nutrition and Food-Related Behaviour (ENG); Intercultural Encounters (ENG); Life Science Informatics (ENG); Mathematics and Statistics (ENG); Microbiology and microbial biotechnology (ENG); Philosophy (FI: "Filosofian maisteriohjelma"); Plant Biology (ENG); Social and Health Research and Management (FI: "Sosiaali- ja terveystutkimuksen ja johtamisen maisteriohjelma"); Urban Studies and Planning (ENG).

University of Helsinki Annual Review documents	Annual Reviews comprise the topics: introduction by the rector, research, teaching, public engagement, staff, finances, services and facilities. The average length is 70 pages We omitted the sections Research and Teaching from our analysis because these topics are covered separately in the more detailed analysis of research applications and novel degree programmes (see above)	2016–2018	In analysing the years 2016 and 2017, we used the annual reviews published on 29 March 2017 and 28 March 2018, respectively. We were provided with the final draft for the year 2018 because the report was not publicly available at the time	Annual Review documents 2016 and 2017 are available at: https://www.helsinki.fi/sites/default/files/atoms/files/the_university_of_helsinki_annual_review_2017.pdf https://www.helsinki.fi/sites/default/files/atoms/files/the_university_of_helsinki_annual_review_2016_and_strategy_review_2013-2016.pdf

and faculty borders. These new cross-faculty programmes were established in connection with the educational reform at the University of Helsinki that was initiated in 2015 and have been operational since August 2017. The traditional current educational structure based on separate and independent disciplines offering major subjects in the university curriculum was replaced with broader degree programmes incorporating several disciplines. In total, 15 programmes were classified as crossing faculty boarders and were therefore included in the SDG mapping analysis.

We analysed the actions and operations of the university using the annual review reports for the years 2016–2018. These reports highlight the main attainments, developments and novel initiatives of the reporting year. We excluded the sections dealing with research and education, having analysed new developments in these areas using the more focused and relevant material described above and used the remaining sections in our analysis of actions and operations. The titles of the sections varied from year to year, but the contents comprised an introduction by the rector, a review of changes in the operating environment (including achievements in university rankings) and sections on social responsibility and public engagement, staff and HR, finances, services and facilities.

All the documents were analysed in line with the SDG framework as follows. The new developments within the university were not planned and designed from the perspective of implementing SDGs, which are not explicitly mentioned in them. Thus, the quantitative analysis is based on a qualitative interpretation of the materials using the SDGs and their descriptions and sub-targets as a framework. When we read the documents we collected and organised direct quotations referring to distinct SDGs. On the level of individual profiling areas, degree programmes and annual review reports, we determined the occurrence of each SDG and formed a quantitative aggregate by a grouping them in four-tier categories. We followed this with a further qualitative analysis. We added a qualitative weighting to stress the relative differences in importance of the respective SDGs in these categories by raising its category level by one. For example, SDG 10 is included in four profiling areas, but given that one of them is entirely devoted to inequalities (INEQ), we stressed its qualitative weight. Differences in the number of mentions as well as in the qualitative weighing are indicated in Fig. 2.1 by the relative size of the white circles. We used the framework presented in Getting started with SDGs in Universities—guide (SDSN—Australia/Pacific 2017) to identify and group management operations and activities, as well as organisational policies linked to sustainability and presented in the annual review reports.

In addition to SDG mapping, we identified factors enabling and restricting the transition through a qualitative analysis of the planning documents supplemented with our notes from the observations in the planning processes and the changes happening in the policy landscape of Finnish science and education. We used this information to interpret the transition initiatives.

2.4 Realising SDGs in the University of Helsinki

2.4.1 SDG Mapping

We conducted SDG mapping of the selected University initiatives that represent new openings in the field of research and education, as well as in the university's operations and activities. A summary of the SDG mapping of selected documents depicting the transition to sustainability in research (2015–2017), teaching and education (2017–2019), and activities and operations (2016–2018) at the University of Helsinki is presented in Fig. 2.1. The size of the circles indicates the frequency of the hits on the particular SDG under consideration: no circle = no hits or only one hit, the smallest circle = a few hits, a medium-sized circle = an intermediate number of hits, and a large circle = several hits.

The analysis of research-profiling activities reveals both obvious and surprising aspects. The fact that SDGs 8, 9, 17 and 3 are the most

Fig. 2.1 SDG mapping of the selected university initiatives

frequently mapped with regard to new research initiatives reflects the principles of profiling rather than the dominant foci. Given that the application form for profiling funding includes a question about the significance of the profiling and deselections for competence-based growth or other societal benefit, it is obvious that almost all the applications mention this as one of the core elements of success. Additionally, in that the profiling of research is based on the principle of strong national and international collaboration with relevant partners, SDG 17 is inherently included in all the applications. Quality Education (SDG 4) is mentioned in 10 of the 14 applications, which is hardly surprising given that the analysis concerns an institution of higher education.

We also found that the profiling of research in the University of Helsinki stresses Good Health and Wellbeing (SDG 3) and Industry, Innovation and Infrastructure (SDG 9). Both of these goals are broadly connected to many kinds of research initiatives. 'Well-being' as a very general goal in particular is easy to incorporate into various kinds of research. However, the particularly strong emphasis on Health and Wellbeing is evident in the fact that apart from being mentioned in 10 of the 14 applications, one of the profiling areas (OneHealth) is devoted entirely to health-related research. The strong emphasis on Industry, Innovation and Infrastructure could be an indication of the pressure exerted on public universities in light of diminishing funding. A focus on industry and innovation could be perceived as a strategy aimed at securing and increasing research funding. Developing and more effectively utilising diverse research infrastructures are general aims that apply to many kinds of research foci, and thus are rather naturally emphasised along many research paths.

However, four Sustainable Development Goals were rarely, if ever, targeted in the documents: No Poverty (SDG 1), Zero Hunger (SDG 2), Gender Equality (SDG 5) and Clean Water and Sanitation (SDG 6). These are goals that Finland as a country has succeeded in achieving (see Sachs et al. 2018). However, the fact that gender equality is not mentioned in any of the new research initiatives is also surprising. It might be that it is implicitly included in the more general mentions of inequality, which in the analysis is included in SDG 10 (Reduced Inequalities).

Of the remaining intermediate categories, the largest one comprises SDGs that are included in between two and five profiling applications of the total 14. This is not surprising, in that the very idea of profiling is to choose different, distinct and complementary core areas of research. Similarly, the inclusion of Clean and Affordable Energy in only two profiling areas stems from the profiling principle of decreasing national overlap in research foci: the area is largely covered by two other Finnish universities (Aalto University and LUT University) and is thus not as prevalent in the UH agenda. One profiling area, namely sustainability science and the related establishment of the Helsinki Institute of Sustainability Science (HELSUS), is a significant and recent transition towards a focus on SDG-relevant research at the University of Helsinki. Inherent in this profiling is an emphasis on various SDGs, but the overall range that will be

covered within the related research remains to be analysed in the longer term.

Contrary to the analysis of research-profiling areas, mapping related to SDGs in degree programmes fell within the upper-intermediate level of hits. This means that several SDGs could be identified from multiple descriptions of degree programmes. This is quite understandable: UH profiling areas are meant to target rather than to span, whereas degree programmes crossing faculty borders may include elements related to various SDGs. However, the inventory also identified a large variation among the programmes: some were linked to only one or two goals, and even then quite vaguely, whereas others spanned most of the 17 goals. Although not developed with the SDG framework, courses of study such as the MSc in Environmental Change and Global Sustainability and the Bachelor's programme in the Environmental Sciences were, according to the descriptions, aimed at tackling sustainability challenges within a wide spectrum encompassing almost all the SDGs. In addition, some programmes focused on one or two SDGs in particular. By way of an example, the MSc in Urban Studies and Planning (USP) highlights Goal 11 (Sustainable Cities and Communities), whereas the Master's programme in Human Nutrition and Food-Related Behaviour (HNFB) specifically targets SDG 3 (Good Health and Wellbeing).

Our analysis of SDGs in university education reveals a generally strong emphasis on SDG 3 (Good Health and Wellbeing). Three individual degree programmes targeted these themes in particular, but related themes could also be identified in other BSc and MSc programmes. This could be attributable to the university's long tradition in focusing on health and medicine, as well as to the ideals of the Finnish welfare society emphasising well-being as such. A similar emphasis on health and well-being has also been identified in some Sustainability Course Inventories (SCIs) (see e.g. Brugmann et al. 2019). The minimal emphasis on SDG 1 (No Poverty) was in accord with the results of a similar study conducted in Spain (Albareda-Tiana et al. 2018).

Of the 17 goals, SDG 17 (Partnerships for the Goals) and SDG 4 (Quality Education) were also among those with the most hits related to the educational programmes. This could be considered unsurprising for various reasons. First, given that the description used in the Study.info-platform includes a mandatory section on Co-operation with other parties, almost all the programmes (13/15) met the criteria for SDG 17 (Partnerships for the Goals). Second, all the BSc and MSc programmes included in the inventory were deemed naturally to target SDG4 (Quality Education), having their origins and aims in providing high-quality university teaching. Thus, it could be claimed that this finding reflects both the principles of this particular mapping and the used data set, as well as the emphasis on these SDGs in UH degrees. This is further highlighted when the degree programmes are considered in the wider context of university transformation. One of the big changes that occurred simultaneously with the degree reform was the introduction of tuition fees in Finnish universities. Implemented on 1 August 2017, the reform introduced mandatory tuition fees for non-EU/EEA nationals taking international Master's programmes. Given the emphasis in SDG 4 on equal opportunities in education, this change could be seen as counteracting it in spirit and aims.

A similar difference in spirit would seem to affect the fulfilment of SDG 17 (Partnerships for the Goals). Many of the MSc and BSc programme descriptions emphasise co-operation within the University of Helsinki, regionally or within Finland. International possibilities were often generally mentioned in another mandatory section, 'Internationalisation', which includes information on internships and exchange studies. Thus, one might ask if emphasising national strategic partnerships is in line with the spirit of SDG 17, which highlights international co-operation, and especially North-South or triangular partnerships, which as such are non-existent in the descriptions. These questions support the choice of some HEIs to leave SDG 17 out of the inventories on account of its ambivalent nature (see e.g. Brugmann et al. 2019).

As with research, SDG 5 (Gender Equality) was not mentioned in any of Helsinki University's degree programmes in the mapping of education. This could be attributable in part to the general nature of the analysed texts: paragraphs and sentences highlighting lower levels of inequality in general (linked to SGD 10, Reduced Inequalities) included mentions that also quite likely referred to the study of inequalities related to gender. This also highlights the interconnectedness of the 17 goals.

The mapping does not consider the curriculum in detail, nor its implementation, and therefore does not take into account how the identified themes are acted upon. The general nature of this mapping highlights the need for further research into course content, which could be carried out with existing sustainability-assessment tools such as AASHE's Sustainability Tracking, Assessment and Rating System (STARS) (see e.g. Maragakis and Dobbelsteen 2015). This would not only better enable comparison between the University of Helsinki and other HEIs, but it would also facilitate temporal monitoring within the university, which in turn would foster further discussion on the direction and time-span of desired changes. Although it might be hard to point out the desired high point or culmination of sustainability transition, monitoring and further target setting would help to guarantee continuation in the desired direction.

In terms of the University's own operations and actions, the strongest contributions are directed to advancing quality education (SDG 4), good health and well-being (SDG 3), reducing inequalities (SDG 10) as well as partnerships (SDG 17).

The upper cluster of SDGs implemented in university societal actions and campus operations include those aimed at reducing inequalities. The University of Helsinki has an established committee for promoting and assessing equality and regularly runs several campaigns. Measures focused on promoting good health and well-being (SDG 3) and providing decent work (SDG 8) include improving workplace well-being and healthcare services and providing re-location services for newly recruited staff members and their families. Improvements targeted at advancing quality education include retrofitting equipment for digital online teaching, ensuring Open University teaching and science events for the general public and strategic measures to improve degree programmes, student selection and pedagogical competences of teachers. The university also reports strong progress in strengthening and establishing new partnerships (SDG 17) such as with national research institutes, which operate in university premises and collaborate closely with the university both in the research projects and in using joint research infrastructures. New partnerships are also being established with industries and decision-makers to promote knowledge transfer and co-creation.

Achievements in improving energy and water efficiency, as well as sustainable production and consumption, mainly concern reducing the consumption of energy, electricity and water, which is also connected to the target of reducing the net floor area in use. Several actions have been taken to increase the output of renewable energy, including its production at the solar power plant on the Viikki campus and the wood chip power plant at Lammi biological station. Solar energy production is expected to represent between 5 and 6% of overall annual consumption on the Viikki campus, which has an energy-intensive research infrastructure. Other measures aimed at implementing SDGs 7, 12 and 13, which have an environmental and climate action focus include reducing energy and water consumption in buildings by developing energy-efficient solutions and technical systems, supporting sustainable construction projects such as the LEED-certified Kaisa Library Building and the Green Office environmental programme on the Viikki campus, and the launching of a programme to advance healthy and sustainable forms of commuting. In addition, UH has a fair-trade certification and is committed to considering aspects of fair trade in its operations.

However, we found only a few new initiatives targeted at eradicating poverty and hunger, or safeguarding life on land and below water on the level of societal actions or university operations. One explanation for this could be the strong focus

on and expertise in technical development, such as the creation of technical solutions for energy, electricity and water supply.

In sum, there is a strong focus on quality education in all the analysed areas, such as in research proposals, new degree programmes, societal activities and university operations. This indicates the existence of well-established links to top educators active in research, active and consistent pedagogical curriculum development, and high standards in teaching and learning facilities, including up-to-date information and communication technologies. The paucity of hits on SDGs 1 (No Poverty), 6 (Clean Water and Sanitation) and 5 (Gender Inequality) was surprising given the university's goal to address global challenges.

The aim in the following analysis is to identify the factors that either enabled or hindered the transition to sustainability in the University of Helsinki.

2.4.2 The Internal Push for Sustainability: Active Grassroots Actors and Networks

A large volume of research linked to sustainability has been conducted at the University of Helsinki in recent decades. Some of it has been carried out within established interdisciplinary networks and centres operating across faculty borderlines. Indeed, there is a long tradition of interdisciplinary co-operation in the field of environmental research. The Helsinki University Environmental Research Unit (HERU) was established in 2002, for example. The name was changed to HERC—Helsinki University Center for Environmental Research, and until 2008 the centre was active in initiating interdisciplinary environmental research in six faculties. Eventually, the multidisciplinary environmental teaching initiative was incorporated into it and together they formed the Helsinki University Centre for Environment, HENVI, which was responsible for carrying out and coordinating environmental research and teaching. All HU faculties contributed to the activities of HENVI, which was successful in creating networks of researchers from different disciplinary backgrounds. The experience gained in HENVI regarding the challenges and opportunities of interdisciplinary collaboration, and the academic networks created, played a crucial role in the later development of the Helsinki Institute of Sustainability Science. The Institute promotes sustainability research and supports the development of new degree programmes in environmental studies and sustainability science as well as other activities promoting the transition to sustainability in the university.

Helsinki University has also hosted several thematic networks of sustainability research: The University of Helsinki Global South Network (HUGS) concentrates on research and teaching on the Global South, whereas interdisciplinary urban research and teaching are tackled within the Urban Academy and the Helsinki Metropolitan Region Urban Research Programme.

Complementing these formal interdisciplinary networks are several informal networks established among researchers in areas such as environmental archaeology, sustainability and business, as well as the pharmacists' going-green initiative the Generation Green Team. The active role played by a few individual researchers within these networks in creating spaces for interdisciplinary collaboration was also crucial in enabling the later reforms.

In the field of education, Helsinki University's decision to re-structure both Bachelor's and Master's educational programmes facilitated the creation of novel sustainability approaches. The reform was initiated in 2015 and the new degree programmes were operational from August 2017. The current educational structure based on separate and independent disciplines organised as major university subjects in the curriculum was transformed into broader degree programmes involving several disciplines. The reform was conducted under the supervision of the Academic Affairs Council, which defined the general principles of the degree programmes in a meeting

held in October 2015. Primarily, the educational overhaul should facilitate the provision of high-quality degree programmes that would appeal to applicants and have a broad disciplinary scope enabling students to choose their specialisation later on in their studies. Second, the curriculum should be competence-based, highlighting career-relevant competences, and third, the focus should be on collaboration among teachers and academic disciplines implemented in the form of multi- and interdisciplinary teaching. In contrast to the current curriculum comprising a major subject and one of several minor subjects, the re-structured Bachelor's and Master's programmes were intended to encompass one or several fields of science, disciplines or thematic modules, and accordingly the faculties were asked to involve a large group of relevant parties from various disciplines, faculties and units in setting them up.

We claim that the educational reform created a window of opportunity for the planning of new degree programmes. Strong and functional teachers' networks in environmental studies, urban studies, sustainability science and several other trans-disciplinary areas were activated and embarked on the negotiation and planning of degree programmes and curricula that incorporated current disciplinary approaches into interdisciplinary and novel degree structures.

The strong pressure from environmentally aware students has also led to improvements in university operations and the development of environmentally- and sustainability-oriented courses and degree programmes. The sustainability science-oriented MSc programme has attracted the most applications since the reforms were introduced.

Furthermore, grassroots-level actors have played a key role in pushing for sustainability-focused reforms: for example, one person with a mission to think green and promote renewables and environmental awareness came up with the idea and initiated the process of establishing a solar power plant on the Viikki campus. Such grassroots efforts could be considered *tactical and operational-level* activities (Stephen and Graham 2010) in the transition to sustainability in the university—building an agenda and coalitions to push for reforms as well as initiating sustainability projects.

2.4.3 External Pushing for Sustainability: Policies and Funding

Complementing the internal activism, the reforms in Finnish science and research policy created a window of opportunity on the regime level.

The funding scheme described above forced universities to strengthen their research profiles and to identify the areas in which they wanted to focus and profile themselves. As Finland's largest and oldest university, the University of Helsinki has a unique position in the country. It covers almost all research fields with the exceptions of technology and business. Defining its future profiling areas and, on the other hand, deciding which areas to deselect to safeguard resources, was a hard exercise for the old, multidisciplinary university. Profiling areas include existing high-quality areas, emerging areas with top-level potential and new areas with high potential (Academy of Finland 2018).

The University of Helsinki made the strategic decision to add sustainability science as a new emergent area with high potential to its established and strong research fields such as health, atmospherics and data sciences.

This decision, as well as the successful funding application submitted jointly to the Academy of Finland by six faculties, formed the financial and organisational basis for the Helsinki Institute of Sustainability Science. The funding allowed the establishment of ten new tenure-track professorships, among other positions. Given the size of the country, and of its academia, this is a remarkable number of new research posts. The Academy of Finland will help to fund these professorships for a 4-year period, after which time they will be funded by the participating faculties. In other words, the faculties will have to redirect existing resources to these newly established

positions, having made the strategic decision to participate in the sustainability science initiative. This directly reflects the *strategic-level activities* in the transition to sustainability mentioned by Stephen and Graham (2010). Furthermore, this initiative will change the structures—new interdisciplinary professorships will replace the old faculty Chairs. A similar procedure applies in the other profiling areas, but the focus on sustainability science is specific to the transition to sustainability.

Reform in the field of education was initiated by the university, but there was strong external pressure to renew the degree programmes and structures in light of the increasing competition in educational markets—namely attracting the best international students.

In terms of sustainable operations and actions, the increasing pressure to provide environmentally friendly and energy-efficient premises to tenants in university-owned properties has fuelled investments in new technical solutions. In addition, the national strategy was reformed in 2013 and Society's Commitment to Sustainable Development was established as the key instrument for implementing the UN Agenda for Sustainable Development. Soon after this, in April 2014, the Ministry of Education and Culture sent all Finnish universities a letter of instruction dealing with performance management and annual reporting, with a section on how to submit their strategies for advancing sustainable development in their tasks and actions. This prompted the University of Helsinki to establish a committee for corporate social responsibility. The group prepared the ground and the university made its sustainability pledge in 2015. It undertook to promote the more efficient use of water and energy, healthy and sustainable forms of workplace travel and the development of renewable energy. PhD education would also be tailored more to society's needs, which committed the university to connect its doctoral graduates with the working world. These commitments reflect the established and strong focus on SDGs 3, 6, 7, 8 and 11, which is reflected in our analysis.

2.4.4 External Pushing for Sustainability: Timing

One of the major factors that enabled the faculty deans to make the crucial strategic decision to focus on sustainability science as well as other initiatives was the obvious urgency (or the lack of it) of sustainability as a real-world challenge to which Helsinki University needed to respond. It had defined sustainability as among the grand challenges of the era, as was stated in its strategy. Furthermore, Sustainable Development Goals (SDGs) were set in 2015, and it became clear that countries such as Finland also needed to meet them.

2.4.5 Hindering the Transition to Sustainability: Resistance from Current Disciplines and the Faculty Structure

Counteracting the various enabling factors that pushed for the transition to sustainability were several hindering factors that, in the main, related to existing university structures. Sustainability was viewed not as a *science* as such, but rather as an activity of social interaction with its strong emphasis on trans-disciplinary knowledge co-production. Furthermore, the sustainability transformation as an aim and an approach for a new institute of sustainability science was considered too radical and political. This could be referred to as ideological resistance. Reciprocal prejudices concerning the essence of sustainability science were also evident among representatives of different scientific traditions: some social scientists saw it purely as a natural and environmental question, whereas some natural scientists claimed that it was social science devoid of strict scientific methodology. However, these views could be seen as reactions to the perceived risks involved in the profiling activities and the anticipated result of ultimately eliminating some of the established Faculty Chairs.

Experiences from earlier interdisciplinary activities also show that not all scientists are

comfortable with inter- and trans-disciplinary activities. This is something that has to be accepted.

It was not only the ideological and epistemological differences and emotional resistance that complicated the organisation of interdisciplinary cross-faculty activities in both research and education: the faculty structure also proved to be a hurdle. The University of Helsinki has a very strong vertical structure—a rectorate and faculties organised according to disciplines, with a few independent units responsible for specific activities or research areas (such as biotechnology). However, these units have a very minor role in teaching activities. A new 'joint action unit' linking the faculties was therefore created for the sustainability science centre. The benefit of this kind of structure is that, as formally attached to them, it engages the faculties in the activities of the sustainability science institute.

Cross-faculty degree programmes also face the same difficulties in the field of education in that they operate in an undetermined space from the administrative and financial perspective. Although each degree programme is administratively assigned to one faculty, there are some unclear and undetermined decision processes and allocations of financial resources. As with the hindering factors distinguished in the transition to sustainability, ideological and epistemological differences as well as emotional resistance also play a role in the educational arenas. Cross-faculty degree programmes encounter resistance from teachers who value mono-disciplinary structures and research. The same pattern was observed in university operations and activities as problems with working across administrative lines arose in the planning and implementation of new sustainability initiatives.

In short, our analysis supports the results of previous studies on implementing SDGs in universities implying that whole-institution approaches are essential in the transition to sustainability (Müller-Christ et al. 2014; Albareda-Tiana et al. 2018). Mori Junior et al. (2019) further conclude that universities are at the forefront in implementing SDGs, particularly in terms of educating leaders of the next generation. They also point out that the transition to sustainability requires the commitment of the leadership—which was also confirmed in our study.

2.5 Conclusions

The results of the SDG mapping in the University of Helsinki show that Quality Education (SDG 4) is the goal that is clearly important for all the new initiatives in research, teaching and in its own operations. In addition, SDG 17 (Partnerships) and SDG 3 (Health and Wellbeing) are also strongly emphasised in all the initiatives. On the other hand, SDG 1 (No Poverty), SDG 6 (Clean Water and Sanitation) and SDG 5 (Gender Equality) are not considered, or are given little emphasis. This raises questions about the university's commitment to global development on the strategic level: surely these aspects should be covered in its new strategic planning if the aim is to have a global impact.

The Times Higher Education (THE) University Impact Ranking focuses on 11 SDGs, *excluding* SDG 1 (No Poverty) SDG 2 (Zero Hunger), SDG 7 (Clean Energy), SDG 6 (Clean Water and Sanitation), SDG 15 (Life on Land) and SDG 14 (Life Below Water). This focus was decided following consultation with HEIs (THE 2019). However, our analysis shows that universities could play a significant role in making use of new energy solutions (such as solar panels).

To conclude, the transition to sustainability is a complex process involving various actors and interests. If one considers the renewal processes that enabled such transition in the University of Helsinki in light of transition theory (Geels and Schot 2007), one could indeed conclude that small niche innovations, tactical and operational activities on the grassroots level, networks, science activism and student awareness pushed for regime-level changes. However, the financial incentives and policy changes initiated on the regime level facilitated niche-level innovations and led to the making of strategic decisions providing a window of opportunity for the

initiation of structural changes. This transition enabled the university to take an active role in solving sustainability problems and implementing Sustainable Development Goals (SGDs) on the societal level.

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3 Higher Education and the Energy Sustainable Development Goal: Policies and Projects from University of South Africa

Godwell Nhamo

3.1 Introduction and Background

The University of South Africa (Unisa) is a dedicated and comprehensive Open Distance e-Learning (ODeL) institution that has fully committed itself to the green economy and environmental sustainability agenda. The university, with its head offices in Pretoria, South Africa, registers in excess of 350,000 students annually (Unisa 2018) and being a responsible environmental steward may have a lasting impact on these students. Energy utilisation in South Africa is characterised by high dependence on cheap and abundant available coal. Coal is used to generate more than 90% of the country's electricity supplies and an estimated 30% of liquid fuel (Department of Energy 2016). However, reliance on coal is not sustainable because coal is a finite resource and its consumption emits harmful greenhouse gases (GHGs) that cause global warming, which in turn leads to climate change. Therefore, the little bit that Unisa can do in terms of moving towards cleaner and renewable energy will be a significant contribution in addressing the national challenge of dependency on dirty electricity from coal. To this end, Unisa's Environmental Sustainability Policy (Unisa 2012) commits the institution to consider and adopt "technologies and ways that enhance energy efficiency and the use of appropriate renewable and low carbon energy" in addition to putting in place interventions "to measure, report and verify the utilization of total energy consumption for all existing and new buildings on an annual basis".

Apart from Unisa's Environmental Sustainability Policy, the development of both the Unisa Energy and Carbon Policy and the Unisa Energy Master Plan draws insights from international, national and municipal policies, regulations and standards. Among the international policies and standards could be listed the following: The Greenhouse Gas Protocol (World Resources Institute 2004), 2030 Agenda for Sustainable Development (AfSD) with its 17 Sustainable Development Goals (SDGs) (United Nations 2015) and the United Nations Paris Agreement (United Nations Framework Convention on Climate Change [UNFCCC] 2015). Box 3.1 presents details on the energy SDG as documented in the 2030 AfSD. Although all the targets highlighted can be linked to Unisa's initiatives, targets 7.2 and 7.3 have a direct link and are more relevant to this current publication.

G. Nhamo (✉)
Institute for Corporate Citizenship, University of South Africa, Pretoria, South Africa
e-mail: nhamog@unisa.ac.za

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Box 3.1: Goal 7—Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All

Targets

- 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
- 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix
- 7.3 By 2030, double the global rate of improvement in energy efficiency
- 7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology
- 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries

Source: United Nations 2015

At the national level, Unisa's policies under consideration were informed by several policies including the National Development Plan (NDP) Vision 2030. Chapter 5 of the NDP states that "by 2030, South Africa's transition to an environmentally sustainable, climate change resilient, low-carbon economy and just society will be well under way" (National Planning Commission 2012: 199). Other policies of interest were the Green Economy Accord of 2011 (Economic Development Department 2011) and the commitment to reduce carbon emissions by the country in 2009 following the conclusion of the Copenhagen climate summit—COP15. During Copenhagen, South Africa pledged to undertake climate mitigation actions resulting in a 34% carbon reduction by 2020 and 42% by 2025 below the 2009 emissions baseline (Department of Environmental Affairs 2011). The government is also working on a GHG trajectory that will see if carbon emissions "peak, plateau and decline". The GHG emissions will peak between 2020 and 2025, plateau for about a decade thereafter, and start to decline in absolute terms thereafter (Ibid.). The work also draws insights from the local municipality—City of Tshwane's Green Building Development Policy and By-law (City of Tshwane 2009) and the Framework for a Green Economy Transition (City of Tshwane 2013).

This chapter emerges from a lived experience of embarking on a roadmap for addressing energy efficiency, alternative energy and carbon management within Unisa in response to the United Nations 2030 Agenda for Sustainable Development (AfSD). The work focuses on Sustainable Development Goal (SDG) 7 that deals with ensuring access to affordable, reliable, sustainable and modern energy for all.

3.2 A Literature Survey and Conceptual Setting

Bhowmik et al. (2017) postulate that the SDGs explicitly recognise research and education. As such, SDG 4 exclusively focuses on ensuring "inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations 2015: 14). Higher education institutions therefore are privileged as they are deemed neutral and trusted by many key stakeholders in communities. To this end, higher education institutions are expected to assist in raising awareness and educating the public on SDGs and other sustainable development-related agendas, including where we are coming from regarding the unfinished business of the Millennium Development Goals (MDGs). Through their established research and innovation capacities as well as linkages to industries hosting financial resources, higher education institutions (mainly universities) are expected to bring up evidence-based solutions to quicken the implementation of SDGs all over the world (Bhowmik et al. 2017).

The Sustainable Development Solutions Network (SDSN) Australia/Pacific (2017) is of the view that none of the 17 SDGs will be attained without the active engagement and involvement of universities and associated higher education institutions. To localise the SDGs within universities and other higher education institutions, several steps need to be undertaken as proposed by a

number of authors that include Owens (2017), Bhowmik et al. (2017) and the SDSN Australia/Pacific (2017). The identified steps include the following:

- Step 1: Map the existing state of knowledge on SDGs and targets in a country and within the concerned university.
- Step 2: Build internal capacity and buy-in on the SDGs.
- Step 3: Identify priorities, challenges, opportunities and gaps.
- Step 4: Integration, embedding and implementing SDGs within a university's policies, strategies and plans.
- Step 5: Monitoring, reporting and verification of actions on SDGs.

The steps identified herein, closely align to those identified in the SDG Campus developed for large businesses and other entities and organisations by the Global Reporting Initiative (GRI), the United Nations Global Compact (UNGC) and the World Business Council for Sustainable Development (WBCSD). The SDG Campus outlines five interlinked steps for mainstreaming and localising the SDGs within a company set-up namely: (1) understanding the SDGs, (2) Defining Priorities, (3) Setting Goals, (4) Integrating and (5) Reporting and Communicating (GRI, UNGC and WBCSD 2015).

From the whole-of-university approach embedded in the first set of steps 1–5 highlighted earlier, the universities' engagement with the SDGs agenda is likely to be a win-win adventure between the university and society (SDSN Australia/Pacific 2017). A win for the university as it gains access to new sources of funding and spread its sphere in terms of student catchment as well as harnessing benefits on localising the SDGs within its operations, and a win for the society as the communities get informed of the new global agenda and have some of their community problems resolved through new innovations and patents coming out of university research work. For example, climate change remains the greatest challenge ever faced by humankind. Hence, research and innovation addressing climate change action (SDG 13) and the need for sustainable energy (SDG 7) will be a welcome development.

The SDGs agenda can also be conceptualised around the typical higher education core mandates namely: teaching and learning, research and innovation, capacity development and community engagement (engaged scholarship). Further details on this framing are presented in Fig. 3.1. The focus of this chapter is on community engagement with an internal (in-reach) focus on localising SDG 7 into Unisa operations and reporting systems.

Although the whole-of-university approach remains useful, different universities are free to approach this framework differently (SDSN Australia/Pacific 2017). This implies that the one-size fits all approach will not work. Different universities were at different levels when the SDGs were proclaimed in September 2015 (United Nations 2015) and the same remains true today. To this end, mapping what a university will be already doing becomes inevitable. This mapping helps university management and its stakeholders to gauge the nature of work needed. Typically, this mapping should result in a university-wide call for a day or two of dialogue initiated and lead from the top management. Both the academic and administrative arms of the university should be at the same level of understanding as the resources required for SDGs implementation, be it human, financial, time or otherwise are usually released by the administrative arm of the university. The dialogue further helps in the allocation of roles and responsibilities based on the SDGs. For example, there are SDGs that can be allocated to certain academic faculties and schools, whereas there may be others that are cross-cutting calling for a closer cooperation between faculties and staff members. In as much as the SDGs are all in one and one in all (Nhamo 2017), implementation of these SDGs may require that certain functionaries be allocated specific SDGs.

Regarding energy matters in universities, work has been progressing in this front coupled with the desire to address climate change and reduce carbon emissions. The UK remains a

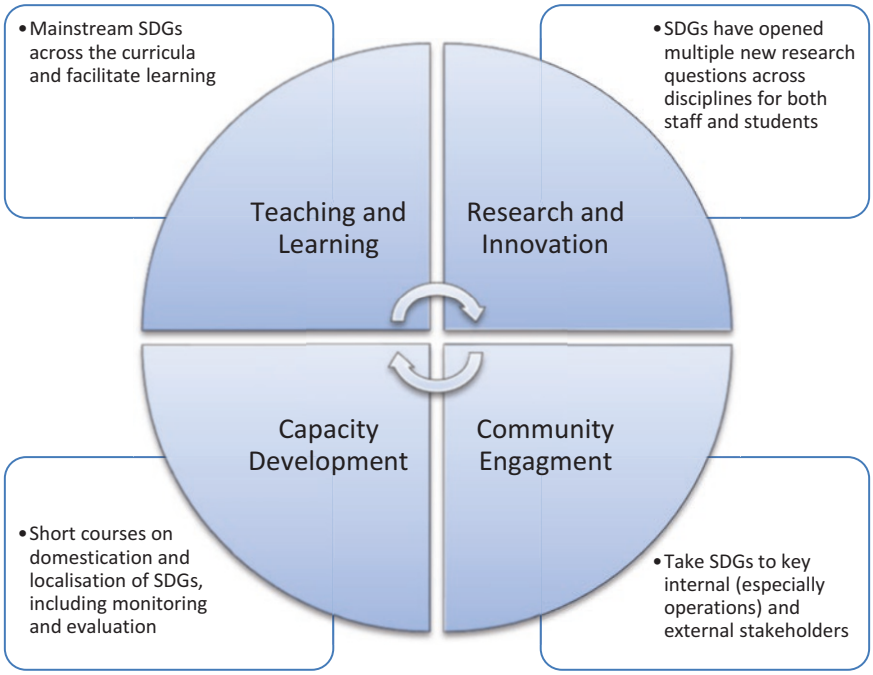

Fig. 3.1 SDGs framing in higher education institutions (Source: Author)

leader in terms of how its universities have been addressing energy and carbon management issues following the proclamation of its Climate Act in 2008. Given the space limitation for this chapter, a few cases will be considered to reflect the planning and commitment undertaken. Several universities in the UK have developed their energy and carbon management plans, which they have been implementing over the years and most of them have the life spans to 2020 (Brite Green 2016). From such energy and carbon management plans, a range of initiatives have emerged, among such rooftop solar, mini grids, running of green weeks etc. Table 3.1 provides a summary of the initiatives from selected UK universities. Energy efficiency remains one of the commonly utilised instrument in energy and carbon management. Although not common in the UK, solar rooftop has been gaining traction as a renewable and clean source of energy. Given that countries like South Africa remain favourable for solar installations, universities are expected to utilise this form of renewable and sustainable energy. The Living Laboratory for Sustainability (Living Labs) are also common and such labs bring together students, academic staff and estates teams working towards improving the sustainability performance on campuses (Brite Green 2016). The Living Labs have additional advantages in bringing hands-on activities to students, aiding in their gaining of industry experience.

The next section focuses on the methodology applied that draws from Participatory Action Research (PAR), followed by the presentation of data and discussion of findings, before concluding the chapter.

3.3 Methodology

The objective of the research is to profile, through the PAR methodology, how Unisa worked its way into addressing some elements of the energy SDG as highlighted earlier through its commitment to address environmental and sustainability matters like a progressive private entity. The PAR methodology was selected given the nature of the work that involved cycles of planning, implementation, evaluation, reflection and the repeat of

Table 3.1 Selected highlights on energy and carbon management initiatives in UK universities

University	Activity achievement		
	Solar installation	Curriculum, research and awareness	Energy efficiency (EE) and carbon reduction
De Montfort's University	–	Developed Greenview App, Living Lab	–
Edinburgh	–	Living Lab	–
Lancaster University	–	–	Presence sensors for the heating in student
London Metro	221 rooftops panels	Exploring New Curriculum, Hosting of the Green Week	–
London School Of Hygiene And Tropical Medicine	–	–	Reduced demand for freezer space and replaced old equipment with EE models
London South Bank University	–	–	Plant start/stop timings and heating/cooling optimisation
Manchester University	–	Living Lab	–
Royal Agricultural University	–	–	Use of Chartered Institution of Building Services Engineers (CIBSE) lighting guides as a benchmark
Strathclyde	–	Living Lab	–
University of Cambridge	–	Living Lab	–
SOAS University of London	–	–	55% carbon reduction 2005–2015, Heating Zone Controls, LED Lighting and Controls, Double glazed windows, etc.

Source: Author, based on Brite Green (2016: 1–29)

such (Nhamo 2012, 2013). The focus was on processes I led leading to the development of both the Unisa Energy Master Plan and the Unisa Energy and Carbon Policy. The twin policy documents enshrine eight focus areas, among them: energy management system requirements, energy planning, energy efficiency, renewable energy, carbon management, green procurement and capacity building. In drawing up the Energy Master Plan, two campuses were used for pilot studies namely: the Unisa Science Campus in Florida, Johannesburg and Muckleneuk, the main campus in Pretoria. The layout of the Science and that for Muckleneuk Campuses are shown in Figs. 3.2 and 3.3.

Through PAR, systematic cycles of inquiry emerged involving the planning, asking questions, taking action, observing, evaluating and critically reflecting (Nhamo 2012). The lead question remained "how best could Unisa address environmental and sustainability concerns in a manner similar to progressive entities in the private sector?" Given that I remained a key player, much of the data informing this write up was gathered from meetings, workshops, preparation of Memorandum of Agreement, inception meetings with outsourced service providers, direct field observations, emails, telephonic communications and consultations with senior management. All this was done following both the obtaining of Unisa institutional permission to embark on this kind of research and the granting of research ethics clearance by the College of Economic and Management Sciences.

As part of the work, energy metres had to be installed in all Unisa buildings. Three types of energy metres were used namely: Elster, Nemo and Schneider. For the period of 6 years plus I was involved in this work, three distinctive PAR Cycles emerged. These are: Cycle 1 (marked by the period 2012–2013), Cycle 2 (covering the time frame 2014–2016) and finally, Cycle 3 (addressed from 2017 to date). These cycles form the basis for presenting the key findings and discussions coming up in the next section.

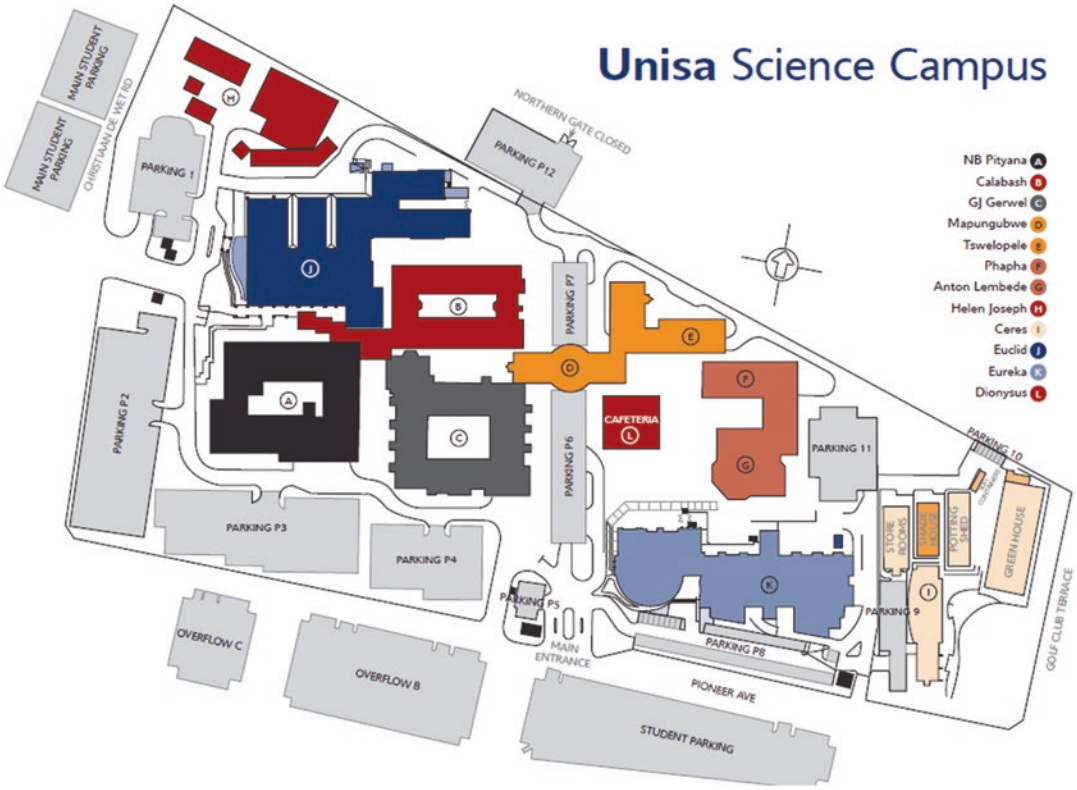

Fig. 3.2 Unisa Science Campus (Source: University Estates 2018)

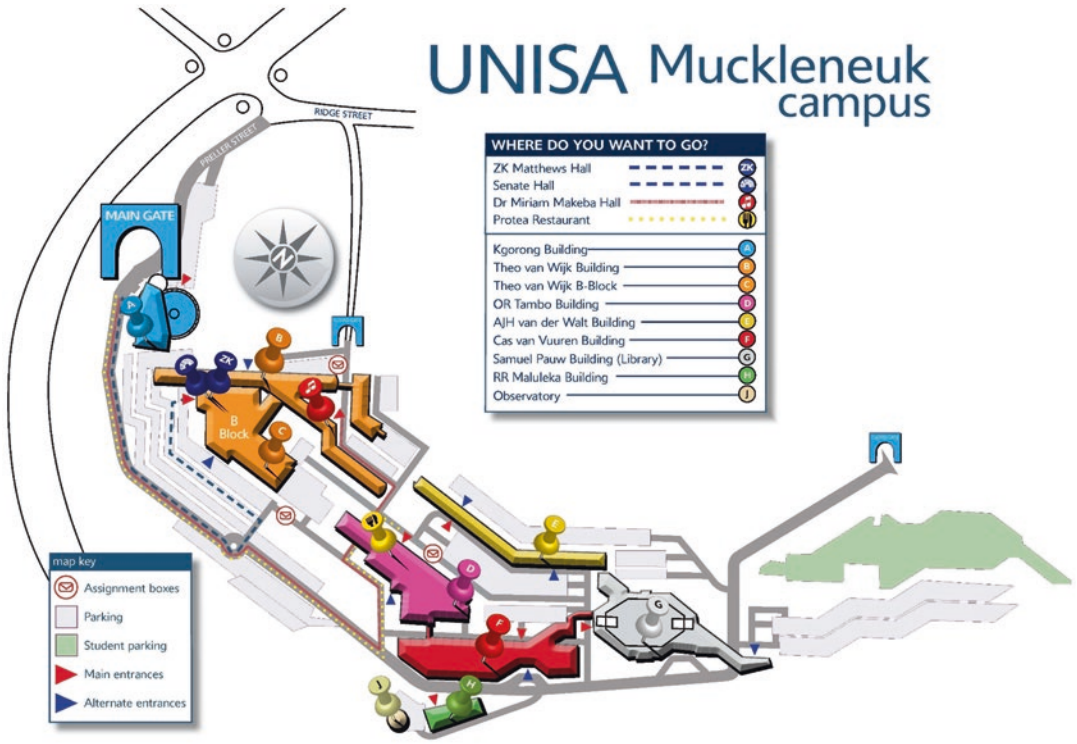

Fig. 3.3 Unisa Muckleneuk Campus (Source: University Estates 2018)

3.4 Presentation of Data and Discussion of Findings

The key findings are presented following the three identified PAR cycles. The Green Economy and Sustainability Engagement Model – GESEM is Cycle 1 (covering the period 2012–2013). The other cycles include seeking outside partnerships and funding to develop the Unisa Energy Master Plan as well as the local development of the Unisa Energy and Carbon Policy (Cycle 2: 2014–2016) and the ongoing projects implementation and scaling up that includes energy efficiency and solar installations (Cycle 3: 2017 to date).

3.4.1 Cycle 1: Green Economy and Sustainability Engagement Model

I started the sustainability journey for Unisa with a vision in September 2012 that resulted in a document written for Unisa Management Committee (MACOM) entitled the "Green Economy and Sustainability Engagement Model (GESEM)". GESEM embedded a roadmap that would take Unisa on pathways that considered environmental and sustainability issues on equal footing as would be done by progressive corporate entities in South Africa and elsewhere in the world, The GESEM was approved by the MANCOM on 22 January 2013, marking a huge step in terms of institutionalisation. From the PAR methodology, GESEM marked the initial Cycle that latter turned out to cover the period 2012–2013.

The GESEM responded directly to many ad hoc initiatives taking place within Unisa both from the administrative and academic perspectives aimed at addressing issues pertaining to the green economy and sustainable development. Such ad hoc activities had some focus on energy and carbon management. However, these commendable ad hoc activities lacked a coherent strategy as they remained uncoordinated. As such, continuing on this path had the potential to reverse the gains made or leave some areas unattended to in terms of what needed to be addressed to realise the full potential of a coordinated GESEM agenda for Unisa. In addition, since a lot of work was taking place at the global level regarding the transition from the Millennium Development Goals (MDGs) to the SDGs (Daniela 2016, 111–126), part of GESEM's work embedded the anticipated new look global sustainable development agenda, particularly matters pertaining to sustainable energy.

Although I took leadership, the GESEM became one of the flagship projects fully endorsed by the Principle and Vice Chancellor (CEO) of Unisa, the Vice Principal for Advisory and Assurance Services and the office of the Executive Director University Estates. From my end, I took GESEM further as my medium to long-term in-reach community engagement programme. Through GESEM, I proposed a number of thematic focus areas that included: Green Economy and Sustainability Policy Development and Incubation; Energy and Carbon Management; Waste, Pollution, Water and Biodiversity; Reporting and External Liaison; as well as Records, Procedures and Awareness.

Some of the noticeable planned initiatives under the Green Economy and Sustainability Policy Development and Incubation thematic focus area included: the refinement of the existing Environmental Sustainability Policy; developing a new baseline for the Unisa Carbon Footprint; developing the Energy and Carbon Policy and developing the Pollution and Waste Policy. Additional initiatives cover developing the Water and Biodiversity Policy; ongoing inputs towards the refinement of the Environmental Risk Register; inputs towards the refinement and/or development of the Green Procurement Policy; and inputs towards the refinement of Unisa Living Green Initiative.

To facilitate the smooth implementation of the GESEM, the Management Committee (MANCOM) agreed that in the short term, existing institutions and staff proposed in the GESEM would be utilised as deemed fit (Fig. 3.4). In the event that existing intuitions and staff might be inadequate, limited outsourcing and contracting could be done unless alternative sources of funding were found. To this end, only one shared secondment post was created for the Deputy Director in the Risk Directorate who had to give 40–60%

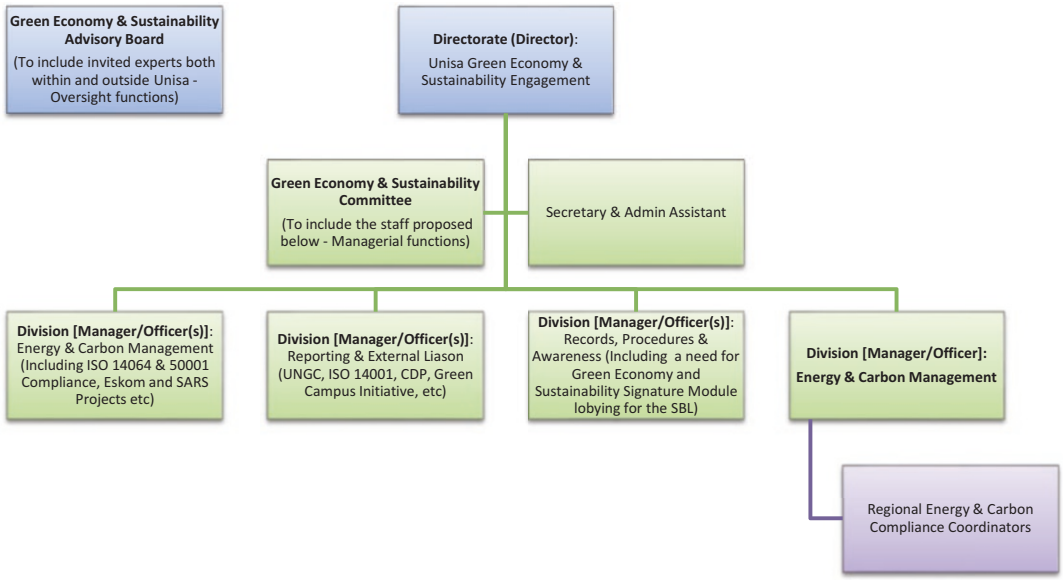

Fig. 3.4 GESEM proposed institutional framework (Source: Author)

of their official time to GESEM under my direct supervision.

3.4.2 Cycle 2: Development of Energy Master Plan and Energy and Carbon Policy

Given the financial constraints and limitations as advised by the MANCOM, in 2014 I initiated a proposal to seek outside funding to assist the development of the Unisa Energy Master Plan. However, on the side-lines I was also drafting the Unisa Energy and Carbon Policy whose key elements helped in framing the Energy Master Plan. These processes marked Cycle 2 in the PAR methodology and study. This Cycle covered the period 2014–2016 and witnessed the approval of outside funding.

As highlighted above, the Unisa Energy Mater Plan initiative witnessed an inaugural partnership between the Private Sector Energy Efficiency (PSEE) programme of South Africa's National Business Initiative (NBI) and Unisa. The PSEE programme's aim is to improve energy efficiency in commercial and industrial companies in South Africa through the provision of various services to assist companies in identifying and implementing energy saving measures. The PSEE programme was launched in December 2013 with support from the United Kingdom's Department for International Development (DFID) and ended in 2015. It offered different-sized businesses (small, medium and large businesses) different types of support required to optimise their energy efficiency. With regard to Unisa, the flagship project changed the programme mandate and extended its scope too. With regard to mandate, the partnership moved away from the private sector into higher education. As for the scope, the partnership covered more than auditing for energy efficiency and leaving a plan for implementing such engaging further in auditing potential for renewable energy and assisting in coming up with reliable carbon emissions baselines. The collaborative agreement was concluded by the Parties concerned on Wednesday 15 April 2015. Through the agreement, Unisa received direct financial support for more than 40% of the total costs associated with development of the Energy Master Plan. The key features of the Energy Master Plan are shown in Fig. 3.5.

The NBI/UNISA PSEE programme stands out as a unique platform that brought together parties

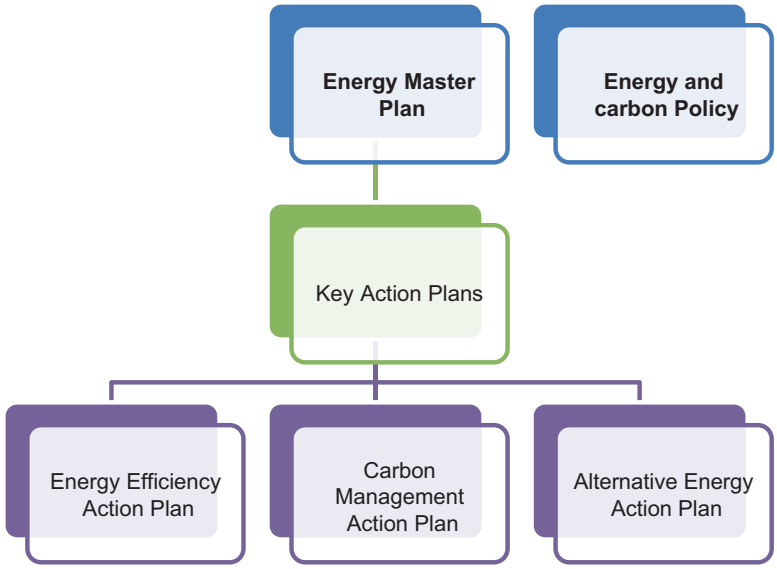

Fig. 3.5 Features of the Energy Master Plan as it relates to the Energy and Carbon Policy (Source: Author)

that were and still are set to ever move forward issues pertaining to environmental stewardship and sustainability. In this regard, the relationship was a rare win-win-win. It was a win for the NBI in partnering, for the first time, with a higher education institution in the PSEE programme; a win for Unisa in cementing its long-term GESEM initiative; and a win for the environment in that this partnership witnessed a true reduction in energy consumption and carbon emissions. Overall, the partnership stands out as a flagship in terms of how the South African higher education sector could possibly come up with innovative ways of addressing critical life issues in line with good environmental stewardship and assist the government and other stakeholders in finding lasting solutions, particularly, in the energy sector. This is what the United Nations SDGs, especially SDG 7 are calling for.

The findings from the audit conducted by AECOM to determine the site readiness for solar energy at the Science Campus (coordinates 26° 9'27.18"S and 27°54'9.75"E) are presented in Table 3.2. These findings informed the development of both the Alternative Energy and the Carbon Management Action Plans of the Energy Master Plan. The Science Campus has 12 buildings occupying a total space of approximately 57,017 m^2. There is also considerable space for car parking amounting to 56,285 m^2 (Unisa 2015: 15). The conditions were found to be appropriate for solar installation if Unisa wished to do so thereby assisting in carbon reduction too. The Grid-tied solar PV systems were deemed the best solution and is the one being followed now. The Grid-tied solar PV had the advantage of lower capital outlay compared to completely off-grid electricity systems.

Table 3.2 Audit for solar readiness at Unisa Science Campus

Description	Level
Sun radiation	2000 kWh/m^2 per annum
Average sunlight hours	6.5 h per day
Ambient temperature	16–26 °C
Humidity	22% (dry) to 96% (very humid)
Average wind speed	1–7 m/s (light air to moderate breeze)
Inland/coastal	Inland
Dust loading	Low

Source: Unisa (2015: 15)

Following the side-line processes in which I drafted the Energy and Carbon Policy that directly speaks to the Energy Master Pan, this Policy was approved by the Unisa Council on 15 September 2016. The approval of the Policy followed extensive consultations both within and

outside Unisa. The principal aims of the Policy, among others are to give strategic direction to and promote continual improvements in energy performance within the context of the Unisa wide energy and carbon management system. Such a system is mainstreamed into the Energy Master Plan and respective action plans aligned to both local and international regulatory and technical specifications. Other aims include encouraging and enhancing a culture of energy saving, reduce carbon footprint and use of appropriate clean energy technologies by employees, students and other stakeholders. This will assist in saving the environment and money. The Policy further seeks to explore opportunities for the generation of clean, renewable and sustainable energy from environmentally friendly technologies such as solar PV. Lastly, the Policy aims to continuously advocate for energy and carbon responsiveness through capacity development, appropriate communication strategies and awareness raising initiatives as well as working towards setting appropriate carbon reduction targets.

Based on the aims presented earlier, three strategic objectives and accompanying targets were set by the Policy. The first strategic objective focuses on significantly reducing electricity consumption (commensurate with scopes 1 and 2 carbon emissions) and adopts clean energy sources and technology. The second strategic objective looks at developing mechanisms to raise awareness about the benefits and opportunities of renewable energy through research, development and innovation and to promote knowledge base on renewable energy and energy efficiency. The third and last strategic objective is stipulated as to continuously train, build and enhance capacity on environmental stewardship for management and employees. Twin strategic targets are spelt out namely: to reduce carbon emissions by 30% between 2016 and 2020 with a 2014/2015 baseline measured in absolute (CO_2e) and relative (CO_2e/m^2) terms; and to reduce electricity consumption by 20% between 2017 and 2020 with 2016 as baseline targeted, measured in absolute (kWh) and relative (R/kWh) terms.

Detailed implementation plans, the identification of opportunities for improvement and detailed reporting systems, including measuring templates have been included in each of the action plans in the Energy Master Plan to further support the Energy and Carbon Policy. The Management Committee is accountable for the implementation of the Strategic Energy Management Plan. All responsibilities and roles of accountability are to be annually reviewed to confirm progress and commitment towards the recommended targets.

Several energy and carbon management focus areas are identified to give effect to the strategic objectives and strategic targets. The focus areas include energy management system (EMS) requirement, energy planning, energy efficiency, renewable energy, carbon management, green procurement, competence and training as well as stakeholder involvement, awareness and reporting. The implementation of key matters raised from the focus areas will be addressed through contracting in and/or outsourcing, internal management and technical expertise, teaching and learning, research and innovation as well as community engagement. The focus areas will also be aligned with Unisa's policies, procedures, processes, systems and technological requirements. The approval of the Policy meant Unisa can now allocate the necessary resources in terms of time, finance, employees and infrastructure in order to attain continual improvement of its energy performance and management systems. In addition, Unisa will participate in local and international initiatives aimed at reducing energy consumption as outlined by organisations that include the United Nations Global Compact.

In order to continually improve energy performance, Unisa will conduct and document its energy consumption and efficiency planning processes. The university is committed to comply with national legislation and other international voluntary initiatives dealing with energy use, consumption and efficiency. As part of implementing the Policy through the Energy Master Plan, Unisa will conduct energy audits to establish energy baseline(s) considering a data period that stretches for one calendar year either as a once off record or an average from a number of years based on energy use and consumption.

There will also be monitoring of energy consumption through the continuous installation of standalone energy metres per building with the second phase targeting installation per each floor. Unisa committed to the use of renewable energy in all its campuses as the second level of intervention wherever economically and practically possible. Although no renewable energy target has been established in the Policy, solar PV is identified as a feasible option in many campuses. In fact, a solar project implementation lifecycle prototype was developed and presented in the Alternative Energy Action Plan (Fig. 3.6).

Stakeholder involvement, awareness and reporting are matters that cannot be overemphasised in policy implementation. Unisa will ensure that employees, students and other stakeholders are made aware of the Energy and Carbon Policy and related documents like the Energy Master Plan and the three action plans embedded in it. This will be done through engaging stakeholders in promotional activities and by developing partnerships with local communities, government, other institutions of higher and further education and the private sector. The university commits to report progress on the implementation of this policy. The Executive Director for University Estates, in collaboration with the Sustainability Office, oversees the implementation of the Energy and Carbon Policy and is supposed to report regularly through established channels to the MANCOM and other authorities including Senate and Council.

Fig. 3.6 Solar Power Plan Project Implementation Lifecycle (Source: Unisa 2015: 37)

3.4.3 Cycle 3: Implementation and Scaling up

The Energy and Carbon Policy is implemented through the tripartite Action Plans from the Energy Master Plan discussed earlier. Although there were limited initiatives in terms of implementation, the scaling up started in 2017, a period that marks Cycle 3 in this PAR study. In terms of energy efficiency, Unisa has initiated projects to install individual energy metres to all its buildings with the view to continuously monitor, report and verify its energy use and carbon management. This was one of the recommendations that emerged from the audit done during the preparation of the energy Master Plan. The detail in terms of the South African Rand (ZAR) value of energy consumed in May 2016 from Fig. 3.5 are shown in Table 3.3. What is of interest is that energy tariffs from the City of Tshwane in which the main campus sit and any other city in South Africa increase by more than 50% during winter times. The month of May falls within the winter period in South Africa. Hence, going solar makes "cents" indeed. Although we have not yet calculated how much savings are there from the solar installation initiatives across Unisa, there is an added advantage in going solar.

Implementation work has been progressing well, especially upscaling solar energy. At the time of completing this chapter, a number of Unisa campuses across the Gauteng Province were witnessing solar installations. Among the campuses now with solar installations are: Muckleneuk—the main campus in Pretoria, School of Business Leadership in Midrand (half way between Pretoria and Johannesburg) and one of the Johannesburg campus called Lenesia. Figures 3.7, 3.8 and 3.9 show some visuals for solar installation on selected campuses.

The RR Maluleka battery backed solar project put the entire building off-grid for non-industrial energy consumption, while the OR Tambo solar project powers the eGarden. Plans are at advanced stages to put more buildings on solar across all the Unisa campuses as deemed appropriate. The solar PV system installed at RR Maluleka is a30kWp Off-Grid. The technical building has two stories and hosts about 80 employees with a total occupancy space of 1268 square metres. Excess power is channelled back into the municipal grid. The total cost to Unisa for the project was R5 million shared between solar PV (R1.5 million) and the retrofitting with new energy efficient equipment (R3.5 million). It is anticipated that by December 2022 the project will have paid back the cost—in 5 years.

A detailed data capturing with regard to tracking trends in energy use from the baseline year (2016) – a reflection of the business as usual approach (no solar PV) and first implementation year (2018) – a reflection of the business unusual approach (with solar PV) was done and the results are presented in Fig. 3.10. The year 2017 was the solar PV and retrofitting year. Details regarding the monthly percentage reductions following solar PV installations for the months whose data was available are presented in Fig. 3.11.

As highlighted earlier, other activities enshrined in the Unisa Energy and Carbon Policy deal with awareness raising. To this end, Unisa is deeply involved with the global Earth Hour movement. Presented in Figs. 3.12 and 3.13 are pictures from the Unisa 2016 Earth Hour involvement. Figure 3.9 shows the Muckleneuk main

Table 3.3 Muckleneuk consumption May 2016 (ZAR)

Period	*Consumption kWh*	*Consumption Net (Excl. VAT)*	*Consumption VAT*	*Consumption Gross (Incl. VAT)*
Off peak	1,067,628	R498,261.99	R69,756.68	R568,018.67
On peak	391,992	R420,215.42	R58,830.16	R479,045.58
Standard	981,384	R649,676.21	R90,954.67	R740,630.88
Total				R1,787,695.13[a]

[a]Exchange rate was averaging US$1 = R16.20 in March 2019
Source: University Estates 2018

Fig. 3.7 RR Maluleka Building Rooftop Solar Farm (Muckleneuk) (Source: Author)

Fig. 3.8 OR Tambo Building Rooftop Solar for the eGarden (Muckleneuk) (Source: Author)

Fig. 3.9 Rooftop Solar at School of Business Leadership (Midrand) (Source: Author)

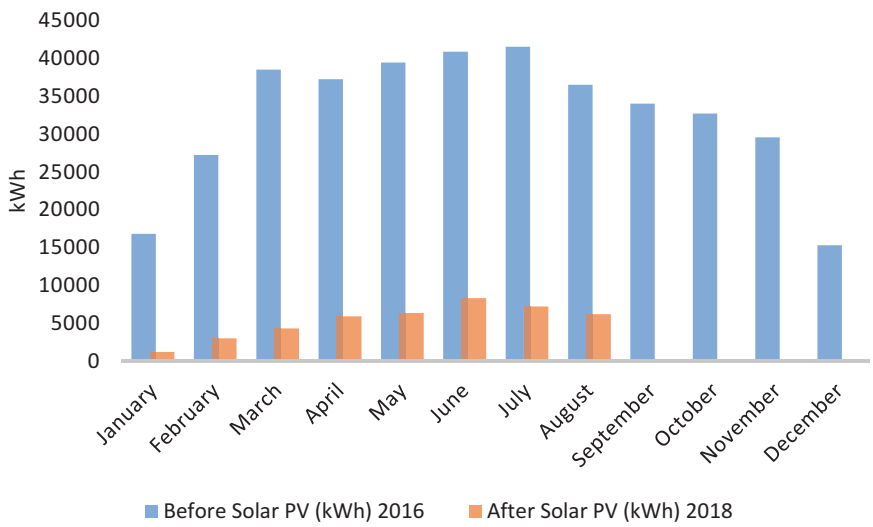

Fig. 3.10 Trends in energy consumption (before and after solar PV) (Source: Author, data supplied by Unisa Estates)

campus in its brightness before the Earth Hour while Fig. 3.12 reflects Muckleneuk within the Earth Hour. The Earth Hour witnesses the switching off of all non-essential lighting in response to the challenge of and the need to raise awareness on climate change and other associated global environmental challenges.

Efforts are also being made to move Unisa towards low carbon transportation, particularly on and during inter-campus connections. To start the ball rolling, two electric vehicles were procured in 2018 (Fig. 3.14). These battery-powered vehicles (e-Vehicles) are used for security patrols at Unisa's main campus. As the main campus occupies a vast area and parking a daily challenge, visitors and staff constantly request the security to take them from point "A" to "B", particularly those that park far away from the build-

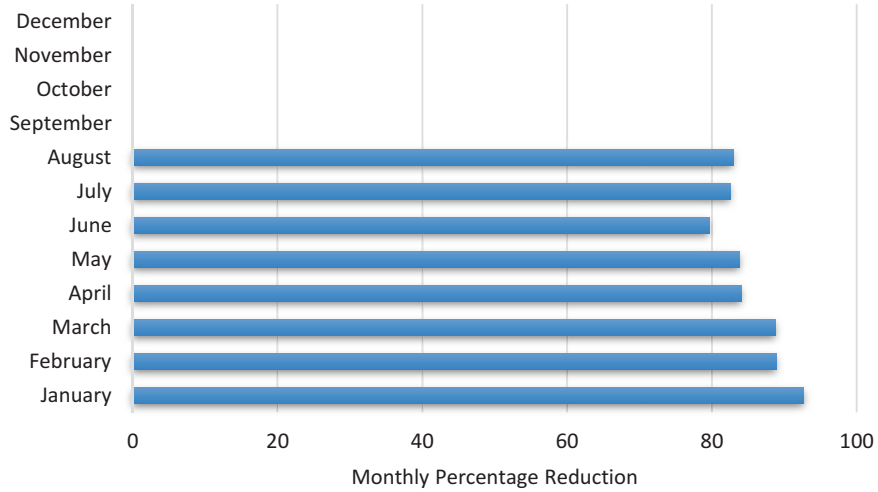

Fig. 3.11 Monthly reduction (percentage) after solar PV (Source: Author, data supplied by Unisa Estates)

Fig. 3.12 Before Earth Hour at Muckleneuk 2016 (Source: University Estates)

ings and venues they will be visiting. To this end, campus stakeholders are requesting that bigger passenger e-Vehicles be bought for local shuttling. In addition, Unisa has gone further to install a solar powered e-Vehicle charging station with two charging points (Fig. 3.15). The charging station was installed in 2018 and any staff member with an e-Vehicle is free to utilise this facility.

3.5 Conclusion

This chapter comes from my lived experience as an academic at the University of South Africa (Unisa) in which I remained a central figure in developing the Green Economy and Sustainability Engagement Model (GESEM). The GESEM had

Fig. 3.13 Within Earth Hour at Muckleneuk 2016 (Source: University Estates)

Fig. 3.14 e-Vehicles for Unisa campus patrols (Source: Author)

a vision to see Unisa match progressive entities in the private sector on how it addresses matters of environmental stewardship that harness energy efficiency, renewable energy and carbon management. The work resulted in the development and finalisation of twin critical policies for the institution namely: the Unisa Energy Master Plan and the Unisa Energy and Carbon Policy. It is evident that these twin policies have been taken seriously by the university as the policy documents have been ratified by both the Management Committee and the Unisa Council. To this end, resources (financial, human and otherwise) have been allocated both within and outside Unisa, with the

Fig. 3.15 Solar powered e-Vehicle charging station (Source: Author)

University Estates now driving solar and energy efficiency projects implementation. The GESEM remains an initiative that can be replicated by other institutions of higher education and learning to contribute towards the global agenda on sustainable energy addressed under SDG 7. As scaling up on solar installation, energy efficient measures and awareness raising through the Earth Hour initiative continues at Unisa, there remains hope that the university will continue leading in this space.

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4 Build It and They Will Come: The Faculty Learning Community Approach to Infusing the Curriculum with Sustainability Content

Will Hong

4.1 Introduction

Perhaps the biggest question that we face as teachers is how best to prepare our students to hit the ground running once they leave campus and begin their professional careers. With respect to sustainability issues, this means instilling in them not only a wide range of skills with which to begin collaboration with others in solving problems (quantitative and qualitative, local and global), but also providing a communicative starting point, a common dialect and concrete objectives using that dialect with which they can begin their work with professionals in other fields. The United Nations (UN) Sustainable Development Goals (SDGs) serve as an ideal starting point for conversation and action that inch us closer to sustainable global living. The SDGs provide a widely accepted framework of collective action, one that has been put to use by actors both in the public and private sector. It is therefore crucial that, regardless of major or field of study, university students have classroom experience that affords them a solid grasp of what the SDGs are, how they provide a framework for action, and where they point us as a civilization.

One problem, then, is that systems-thinking approaches (upon which the SDGs foundationally rest) and the SDGs themselves are rarely explicitly taught in the classroom. Ratified by the UN in 2015, the goals are only a few years old. Although they were rolled out to great fanfare within professional development circles, scant attention has been paid to the goals beyond that space, even within the academy. The societal shifts that sustainability research tends to put forth as necessary often fall squarely within the bounds of the politically or economically infeasible. For instance, the Green New Deal proposed by the progressive wing of the US Democratic Party, marries climate change action with social justice progress, a systems-thinking perspective that squares with the SDGs, yet it has been roundly criticized by conservatives for being wholly impractical, with even some centrist-leaning Democrats calling it purely "aspirational" (Axelrod 2019; King 2019). Over 3 years since their creation, the SDGs have yet to make their way into the classroom substantially, and a crucial opportunity for this generation of students goes by the wayside.

How to change this, then, especially given the growing number of budgetary shortfalls that befall many higher education institutions, especially those public universities that do not benefit from generous institutional endowments? The sustainability-focused faculty learning community (SFLC) model is one that has been effectively

W. Hong (✉)
SUNY New Paltz, New Paltz, NY, USA
e-mail: hongw@newpaltz.edu

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deployed for decades. The SFLC can be created without incurring prohibitive financial cost to the institution. This program leverages an already present interest in sustainability on the part of students and instructors; it expands the learning space to the community of stakeholders beyond the walls of the campus and the natural environment in which the university lies. The SFLC can be tailored to meet the needs and limitations of any higher education institution. In this chapter, I will describe the model and its history in the USA, how colleagues and I at my home campus of SUNY New Paltz created an SFLC and have seen substantive, increasing success with the program. The chapter will also outline the steps one might take in building an SFLC at one's home campus even if there are challenges concerning limited time and resources. I hope to persuade readers that this is something concerned campus citizens can create on their campus. The SFLC value to the community far outweigh its costs and offer a straightforward blueprint with which to start the process of creating own version of the program at other university campuses.

4.2 A Brief History of the Sustainability-Focused Faculty Learning Community

The Faculty Learning Community (FLC) model has proven to be effective in promoting professional development in higher education. Defined loosely as a "community of practice" (Engin and Atkinson 2015), the FLC model addresses a number of management problems pervasive in higher education institutions. These problems include the compartmentalization of faculty within specific disciplines, lack of opportunity to openly network and share research with colleagues across departments and schools, and structural disincentives to even temporarily relieve the "expert" label burden in the pursuit of learning something entirely new. Faculty at all levels, particularly junior faculty and adjunct instructors, routinely report time constraints and work creep as they are continually asked to accept more administrative responsibilities while not seeing a commensurate rise in compensation. Add in the inevitable repetition of teaching a set repertoire of classes, and it is no surprise that faculty burnout and restlessness are common. All this can and often does lead to diminished morale and a sense of collective stagnation.

The FLC model, based on the social theory of learning, brings together interested faculty from different disciplines under the directive of a particular theme or subject matter and can help to address these issues. Four characteristics of professional development make the FLC model generally appropriate in a higher education context with faculty. The FLCs are collective, collaborative, contextualized in a meaningful way, and problem-based (Engin and Atkinson 2015).

Summarizing previous research on FLCs, Elgin and Atkinson expanded on these four characteristics noting that in faculty learning communities, like-minded participants (here, university faculty and staff) work towards a common goal (Eckert 2006). They develop over the course of the FLC activities a sense of collegiality that includes sharing ideas and advising one another as appropriate (Weller 2009, Wenger 1998). There is also a focus on real-world, timely issues (Eckert 2006, Wenger 1998). The FLC also finds efficacy in being problem-based, with participants collectively working towards concrete solutions (Elton 2009, Klenowski et al. 2006). Banasik and Dean (2016) have further observed that the FLCs that include non-tenure track faculty contribute to those members experiencing an increased sense of community and belonging at the institution as well as exposure to new pedagogy and teaching techniques. One might conclude that the very act of bringing faculty together to share teaching and research ideas under the aegis of investigating a subject of common interest has proven an effective way to promote campus community and professional growth.

It seems a logical step, then, for the FLC model to be used within a sustainability framework, and indeed, there is meaningful history of this being the case. In 1992, Tufts University introduced the Tufts Environmental Literacy Institute (TELI) program (Cortese 1992), a week-long environmentalism-oriented faculty training program, which ran for 5 years and saw a lasting

impact at the school even after the program itself ended. Twelve years after the training program, Tufts had over 70 TELI-trained faculty members who were still actively engaged in environmental issues, and the school had grown to offer 21 different environmental degrees (Barlett and Rappaport 2009; Natkin and Kolbe 2016).

Building off the example set by TELI, Geoffrey Chase and Paul Rowland began the Ponderosa Project at Northern Arizona University in 1995 (Barlett and Eisen 2002). Taking cues from Tufts and keeping an eye on sustainability-infused curriculum development as the ultimate goal, they established a two-day program during which faculty would be trained in the fundamentals of sustainability on the first day, and also be offered time to reflect and work on a specific syllabus. Either a revision of an existing class or an entirely new course, during the second day of the workshop would be done. This, in turn, led to Peggy Barlett bringing the Ponderosa model to her institution, Emory University in Atlanta, Georgia, and in 2001, with the guidance of the Northern Arizona University leaders, she created the Piedmont Project, now the gold standard for this sort of sustainability faculty professional development program (Barlett and Eisen 2002, Eisen and Barlett 2006). Moreover, Barlett and Chase have partnered and team-taught workshops in conjunction with the Association for the Advancement of Sustainability in Higher Education (AASHE) helping faculty and sustainability staff from institutions across the USA to design and promote similar programs at their home institutions. By 2012, hundreds of participants in these workshops, representing over 275 institutions had completed the training and brought the SFLC model back to their home campuses (Barlett and Chase 2012).

Given that different institutions have different needs and thus require specific tailoring of any program in order to best serve their faculty and students, many of the SFLCs born of the Barlett and Chase workshops vary in scope and duration, among other parameters. However, there are some common elements put forth as goals by the two pioneers (Barlett and Chase 2012):

1. Foster creativity.
2. Emphasize faculty expertise.
3. Build faculty community.
4. Encourage an interdisciplinary approach.
5. Welcome diverse pedagogical approaches.
6. Make connections.
7. Focus on learning outcomes.

Note should be taken that these goals are oriented around encouraging faculty, typically expected to be authorities in any professional setting, to momentarily let go of that encumbrance and once again position themselves as learners, beginners with experience. This taps into what one imagines as the fuel that drives any person to head for a career in teaching and academics in the first place, namely a persistent thirst for knowledge and understanding and the joy that comes with being in a position to satisfy that thirst. Good teachers were first good students, and creating the conditions for faculty to return, if only for a couple of days, to that state, is much of where the value of the experience lies. The SFLC design asks its participants to use the connections, community, and resources provided by the workshop to draw individualized conclusions regarding how best to develop their future class plans and syllabi to better align with current sustainability content.

The importance of this dynamic cannot be emphasized enough. Most faculty who begin to sense that class content is being dictated to them will likely, and rightfully, turn away, protective of their charge. To that end, the Piedmont/Ponderosa model focuses on providing sustainability material and simply creating the conditions for discovery and collegial sharing of techniques and approaches in order to inspire each workshop participant to choose, from this newly presented content, what might fit best in their classrooms. The personal connections made with other faculty who they may not have otherwise met and, in many cases, community partners who wish to engage students in practical projects beyond the walls of the university is a particularly eye-opening element. As such, participants across many of the now established SFLCs have reported

the SFLC as being valuable and applicable to course revision.

4.3 The SUNY New Paltz SFLC: A Case Study

In June 2015, two New Paltz faculty members, one from the School of Business and another from the Department of Digital Media and Journalism, attended a week-long program in sustainability leadership at the University of Vermont in Burlington, Vermont (UVM). The faculty did not have extensive backgrounds in sustainability studies. UVM's Professional Certificate in Campus Sustainability Leadership (PCCSL) program trains higher education faculty and staff in the fundamentals of sustainability while showcasing the substantive progress that UVM has made as a campus. Such showcasing includes the overhauling of UVM's energy system to leave a smaller carbon footprint, initiatives like a campus bicycle-sharing system to help ease transportation pressures, and the construction of platinum LEED-certified buildings, the cynosure of their campus infrastructure. The program also emphasizes UVM's connection to the community and local institutions like Shelburne Farms, a school and estate outside of Burlington with a long-standing sustainability mission. The week serves as much tangible case study as an information-based learning experience for those coming from universities that have yet to take similar progressive steps.

Most impressive at UVM is that they have not only been successful in promoting sustainability in the curriculum, but that they have gone so far as to make sustainability coursework a general education requirement for all undergraduate students. This is largely due to the momentum created about sustainability content in the classroom. This momentum has been further fueled by the UVM Sustainability Faculty Fellows Program, their SFLC modeled after the Piedmont/Ponderosa initiatives. Spearheaded by two UVM faculty members who attended one of Barlett and Chase's AASHE workshops in 2009 (Natkin and Kolbe 2016), the UVM program, as of 2015, boasted 103 trained faculty from 35 different academic disciplines, across the schools on campus and including ranks from Lecturer to full Professor. Over the life of the program, trained fellows produced 113 sustainability content-rich courses for the UVM's student population of roughly 7500 students (Natkin and Kolbe 2016).

At New Paltz, a regional public university in upstate New York with a student body of approximately 7500, the two UVM-trained faculty members returned in the fall of 2015 determined to create a similar SFLC-style workshop at home. After presenting the idea to the University Sustainability Committee and receiving approval to develop a formal proposal to be presented to the administration, a sub-committee consisting of three faculty members (including the two who had gone to UVM and the campus Sustainability Coordinator) was formed.

The first order of business was to create the goals for the New Paltz program. The goals are as follows:

1. Create a community of faculty/staff who are committed to infusing interdisciplinary approaches to environmental sustainability into the curriculum.
2. Starting with the UN SDGs and a systems-thinking approach, enhance the understanding of environmental sustainability concepts among faculty and students, particularly those not trained in environmental fields.
3. Explore teaching and course design strategies that will engage students in sustainable development from a multidisciplinary approach.
4. Encourage and fund curricular development without content prescription from above.

Recall that in 2015, the UN released the updated Millenium Development Goals (MDGs) as the now 17 UN SDGs, and as we created the program at New Paltz, it made sense to use these SDGs as the conceptual foundation for the program's training. The SDGs were preferred for their comprehensiveness and global application and their immediate relevance to the world beyond the university. In this context, one of the great assets of the SDGs is their breadth—almost

any teacher can come to the SDGs fresh and find their work and field of study located somewhere within the 17 SDGs. This means that training such that an SFLC offers can be structured as widely inclusive from the start, and the training can take advantage of the many resources that the UN and United Nations Educational, Scientific and Cultural Organization (UNESCO) have already published with respect to the SDGs. This provides a framework of action that is systems based from the start, and in the realm of curricular development, UNESCO's document on learning objectives is particularly useful (Tang 2017).

We also chose to make explicit the founding ethos of the training, which is to avoid content prescription and not require participating faculty to teach any particular content or to teach using any specific pedagogical styles. We would ask for concrete curricular change, but structure the training to allow each participant to decide what to change and how to include the SDG content in their work. We set expectations for the faculty participants in the following way:

- Attend four program workshops/breakfasts across the academic year, two each semester.
- Participate in a two-day training institute during the winter session in January.
- Redesign or develop new course material to integrate the concepts of sustainability.
- Evaluate the redesigned course to gauge student attitudes and knowledge regarding sustainability.
- Demonstrate enthusiasm for developing interdisciplinary partnerships in sustainability teaching and scholarship.

Our program, based on UVM's adaptation of the Piedmont/Ponderosa model, consists of two workshops each semester (consecutive fall and spring), which sandwich the centerpiece of the program, a two-day January Institute during which the participants, or "sustainability faculty fellows," receive the lion's share of their training in sustainability content and resources. Faculty participants at New Paltz have had varying levels of experience with sustainability in general, so the two meetings in the fall introduce the fellows to one another and are geared towards laying out basic sustainability concepts. The two meetings in the spring reinforce the work done in January and prepare the fellows to present their revised syllabi at the end of the school year.

The January Institute is divided into one day of intensive learning led by a sustainability expert during which the cohort of program fellows, as well as community partners are invited to participate in the workshop agenda and a second day located off-campus. During the second day, fellows are given the opportunity to reflect on the previous day's content and begin to think through what they want to do with their course revision or class development in adding sustainability content.

To help incentivize participation from already time- and energy-taxed faculty and staff, fellows receive a $250 stipend upon completion of the training and the submission of their revised syllabus. Fellows also have access to additional funding for new interdisciplinary team-taught classes to come out of the training with a sustainability focus. Offering financial compensation is a common element of SFLCs based on Piedmont/Ponderosa model though the amount offered to participants can differ quite a bit. The Piedmont workshop at Emory offers participants $1000, whereas Santa Clara University, where their Penstemon Project follows the Piedmont example, offers $500 to each member of each cohort (Barlett and Chase 2012). At New Paltz, given a strict budgetary climate and a decision on the part of the organizing sub-committee to place less emphasis on the financial compensation and more on the professional development opportunity, we set our stipend a bit lower than other programs have. Initially, we considered having no stipend at all. However, we ultimately decided that even a nominal amount of money provided a good-faith gesture to applicants that was likely to be worth the outlay.

This does touch on the question of why faculty would voluntarily take on additional training such as that put forward by an SFLC. The short answer for us is that there was a latent interest among faculty and staff on campus in becoming more active concerning sustainability and that interest exists as a great untapped reservoir of

positive change and action. Many faculty members have a deep personal interest in sustainability, and once introduced to the SDGs were eager to dive deeply into that content. However, many were not sure how to bring that interest to their research or the classroom. That the program has steady interest and seen continual positive results speaks to the value of providing the opportunity for instructors to connect personal values with professional development. In other words, the monetary benefit helps, but was never seen as the primary appeal of the program. Had it been, surely the program and the others that had inspired it would have failed long ago.

With the initial proposal of 2 years of funding for up to 15 faculty and staff participants per cohort per yearly, the sub-committee presented an official proposal to the Provost's Office, who after a round of minor revisions approved the project, including funding for fellow stipend remuneration and funding for course development. In the end, the New Paltz SFLC is an endeavor supported by the Office of Sustainability, the Sustainability Committee, and the Office of the Provost.

Gaining the Provost's support was crucial not only for the budgetary help, but also for the imprimatur of the administration in the eyes of those who would become fellows. Some of the hesitance to branch out individually and move beyond silos for faculty seems born of a feeling that to do so sees little professional reward. When asked about barriers to progress in developing sustainability-related coursework and working beyond departmental needs, fellows have mentioned "institutional inertia/resistance," "bureaucracy," and "no institutional framework or support for community collaboration at the university level." To have the stamp of approval from the Provost announced to the faculty at New Paltz that not only was it safe to spend time branching out and learning something completely new but that it was officially encouraged. This opened the doors for many to apply to the program and ultimately receive the training.

After a successful 2 years of the program at New Paltz, the Provost has reinstated funding for a third year, including supplemental funding for the development of interdisciplinary team-taught classes.

4.4 Assessment of the Program and Results

As the January Institute has served as the focal point of the training, we surveyed fellows after each retreat in order to assess programming and ultimate pedagogical and material value for the participants. The results show positive responses from the majority of the fellows primarily along the vectors of increased knowledge of sustainability concepts, interpersonal connection with other faculty and staff, and introductions to potential community partners (Table 4.1).

Table 4.1 Participants' response to the SFLC

Question	2017 Retreat (n = 16)	2018 Retreat (n = 14)	2019 Retreat (n = 13)	Total Average
The retreat aided in my understanding of sustainability in general and the specific sustainability issues relevant to my teaching	4.56	4.00	4.27	4.28
The retreat aided me in shaping the course I intend to develop/revise with sustainability content	4.63	3.67	4.00	4.10
The retreat exposed me to new information and resources	4.94	4.67	4.82	4.81
I met colleagues whom I might otherwise not have met	4.94	4.44	4.64	4.67
I am interested in learning more about sustainability education	4.56	4.56	4.50	4.54
I am interested in learning more about sustainability initiatives and trends on campus outside of the academic division	4.75	4.60	4.60	4.65
The retreat met my expectations	4.81	4.30	4.80	4.64

Respondents were asked to reply to each statement with a value of 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree.

Additionally, the survey solicited comments from the fellows asking both what they found most valuable about the training and what they thought might be improved with the next iteration of the program. Some representative comments regarding the positive value of the retreat are shown in Box 4.1.

Box 4.1: Respondents Assessment on the Value of the Training and What Could Be Improved

"An excellent experience that transformed how I'll motivate my students in content-rich information design courses."

"Thank you for hosting this! It was great to connect more with the academic faculty because so many times we do not have the opportunity to share what's going on outside of the classroom!"

"…I was able to establish internal sustainability-based collaborations, which I never had the occasion to initiate in over two years at New Paltz. Being in the same room with the right people fueled discussions which will likely lead to joint work on sustainability problems. …It raised my spirits and allowed me to redirect my frustrations."

"I enjoyed learning more about community partners and about how to integrate sustainability into my courses."

"I liked how there was a larger number of people from the community and other institutions than I expected."

"The opportunity to share ideas and hear what other faculty are thinking about doing with respect to integrating sustainability content in their classes."

"The interaction with my colleagues from all over campus. I learned a lot beyond the intent of the workshop."

"Was very inspiring and increased my enthusiasm for teaching economics. In the context of the SDGs, economics takes on more meaning."

"I loved hearing the stories of the community members as well as the professors who are trying to bring the issues of sustainability into their classrooms."

"This is a wonderful initiative. I hope it continues to grow with leaps and bounds."

"I'm honored to be part of a campus that values sustainability to such a high degree and have been so impressed with the work that the Sustainability Office is doing."

Common themes to emerge from these comments are that the program and the two-day January retreat, in particular, succeed in boosting faculty morale. This comes out through assembling faculty bonded by a common interest in sustainability and by providing the learning context within which to share ideas, pedagogy, and resources. Access to community partners with whom student projects and events can be designed and used in teaching and learning is another cited positive, as it presented opportunities for practical application of the SDGs and sustainability principles in general. These results correspond with those found by Peggy Bartlett and Ann Rappaport in their comprehensive assessment of the TELI and Piedmont projects where they found both programs changed participants' teaching and knowledge of environmental and sustainability issues substantially (Barlett and Rappaport 2009). Critical survey comments tended to focus on the availability of resources and support beyond the two-day retreat and logistical concerns regarding the organization of the two days. Further responses from the participants are presented below.

"Introductions to the community people were rushed, and it would have been good to have more time to hear from everyone. It would have helped make better connections."

> "The two days were overloaded with content … sometimes a bit too much time sitting. It would be refreshing to break out into "think-pair-share" small groups with specific assignments for discussion or something specifically directed.'

> 'Since a lot of the ideas presented were new to me, I needed more time to comprehend them."

> "There was a bit too much information given a bit too quickly."

> "I would have preferred getting information sooner (prior to the morning of) so I had more time to prepare…"

These comments have helped us think about scheduling and small programmatic changes with each new iteration of the program. The observations further assist us on how to strike the right balance between a broader fundamental approach for those new to sustainability and more targeted delivery of resources for those already well-versed in sustainability issues. During 2017–2018, our second year, the cohort included some faculty members who already work steadily in sustainability, and their response to the training was more muted, that while the opportunity to network with others still led to a positive overall experience, the information and resources provided felt too basic for their needs. In the other years' cohorts, the training seemed to be closer to the aggregate sustainability experience level of the fellows.

Finally, we asked participants about future intentions having come through the January Institute training and received many positive responses indicating concrete plans. The responses are shown in Box 4.2. We saw enthusiasm and ambition for changes in the classroom and in research agendas given the SDGs as a guiding framework.

Box 4.2: Required Future Intentions After Experiencing the January Institute Training

"…I plan to push my department to introduce a concentration in sustainability for elementary ed majors."

"I would love to travel to some more sustainability training that has specific links with psychology and education."

"In one of my modified classes, I plan to ask students to work in small groups to take action on a local sustainability issue. My intention is to have them report on their success or hand over the project to a group in the subsequent semester. I think this could be a really good study about what teachers do to help students see that their actions make a difference."

"I would like to investigate the PFOA/S water problem in [neighboring] Hoosick Falls and Newburgh."

"If we can help my students identify a local business/organization that has a product or service for sustainability, and could potentially be marketed overseas, it'll be great help for my MBA class project."

"I am arranging a meeting with the local watershed alliances to initiate new projects."

"Work on aspects of communicating climate change information."

"Continue to pursue sustainable natural materials for industrial application."

"…working on community currencies and how systems can generate positive feedback loops on income generation."

Regarding curriculum results from the two completed years of our SFLC, the program has produced 27 revised or newly developed courses (as verified by fellows submitting syllabi to a common SFLC online repository). The submitted syllabi come from across the university's schools (LA&S, Engineering, Education, Fine Arts) and disciplines (including Mathematics, Digital Media and Journalism, Geography, Economics). Additionally, six SFLC fellows have been funded to develop entirely new sustainability-infused courses, with the first team-taught class to come out of the program being offered to students during the fall of 2018. An additional 13 revised or new sustainability-infused courses as well as proposals for developing new interdisciplinary team-taught courses were expected in the next cohort.

4.5 Proposing and Establishing an SFLC at Your Institution

Given our experience at New Paltz in developing the proposal for a Piedmont/Ponderosa-style SFLC on our campus, some thoughts on how to approach developing a similar program at your home institution including suggestions as to how to position a proposal when speaking with potential funding sources or administrative heads can be offered.

First, it is worthwhile to at least informally assess the local conditions to see if they are conducive to being receptive to this sort of program. Meaning, it is important to get a sense that there is some of the aforementioned latent interest, from faculty and administration, in increasing sustainability content in the classroom. The SDGs framework remains key to such endeavors. In the majority of circumstances, you will be able to find such interest simply by talking with faculty or, as we did in our case, speaking with our Sustainability Coordinator who already had a good sense of the campus dynamics and temperature. This is an important step because you will likely have to find a group of committed faculty or staff facilitators who are willing to do the legwork to get the program off the ground, both in the proposal stage and the active programming stage. For our facilitators, this has meant service in addition to our normal workloads as faculty and sustainability staff, so it is good to know going in that such will be required and that program leaders will have to take that into account given their other responsibilities.

Once you have a group ready to develop a proposal, and depending on whose approval you seek, you need to tailor your argument accordingly. Given that New Paltz does not have the financial resources that many private institutions have (e.g., a large private endowment, high student tuition to help fill the coffers), we knew that for an SFLC to be approved we would have to demonstrate substantive returned value for a relatively low capital investment as well as programmatic relevance to the entire university, not simply a select campus group. To that end, having the SDGs to point to as the framework for the training was of great help because, again, the UN goals are comprehensive by design and allow any faculty member/potential SLFC participant to locate themselves somewhere within their parameters. To reiterate this key point: a strong rationale for centering the SDGs within an SFLC is that by their very design the SDGs invite inclusion in action and projects already underway in both private and public sectors, and they serve as a very accessible *communicative* starting point, one that promotes *ipso facto* a systems-thinking approach and easy cross-disciplinary exchange of ideas and collaboration. That the SDGs have been accepted globally as universal objectives connects even those new to sustainability with much larger global context providing real-world immediacy for faculty and, ultimately, for their students.

Related to this universality point, we also argued the inevitability of higher education moving towards sustainability-related pedagogy if only because the world is quickly approaching a tipping point with climate change (Masson-Delmotte et al. 2018; Watts 2018; Wu 2018) and societal systems across the board will have to be reconsidered in the context of a warming planet. Though the academy is slow to embrace institutional change, the issue will be forced by a world that is evolving faster than the standard pace of academic adaptation. A concurrent shift in curricula that will allow schools to deliver the practical, interdisciplinary skills that students will need as they join a global community faced with previously unaddressed culturally embedded problems is unavoidable. Thus, ways to begin to push that sort of curricular change will need to be found, and efforts like these, put forth and tried. The time to foster creative change is now, in other words, and additionally, the pressure will most certainly come from the bottom up.

Student demand for courses and majors that focus on sustainability topics is rising, and again, given the SDGs as a starting-point framework, this includes not only environmental and ecological disciplines, but also related sustainable economic, political, and social justice areas. Generational research on the attitudes of Millennials (ages 22 to 37) and Generation Z

(under the age of 27) shows an increasing belief in government and public policy to solve problems, higher levels of belief in man-made climate change than previous generations, and an increasing acceptance and expectation of diversity, inclusion, and social equity as societal norms (Parker, Graf, and Igielnik 2019). These attitudes will translate into prospective students looking for schools that offer curricula that align with that expectation and understanding. Institutions that want to continue to attract the best and brightest will do well to develop corresponding coursework if it is not already in place.

The potential penalty for not getting ahead of that curve will be to see applications and enrollments drop. The benefit of actively developing the corresponding course work, however, is the potential to position the institution as a regional sustainability leader, or in coarser terms, to boost the brand of the school. Some universities have already taken the lead in this respect, partnering with AASHE to showcase their respective sustainability-focused faculty training programs as AASHE Centers for Sustainability Across the Curriculum (CSAC). Achieving a reputation as a school that has ample offerings in sustainability has the potential to be a key marketing point for any higher education institution, the long-term recruitment value of which would far outweigh the nominal short-term capital investment in an SFLC program.

Tied to student demand is satisfying the demand on the part of the faculty to introduce sustainability in their teaching. We found that especially junior faculty expressed interest in the training offered by the SFLC, which again, is not surprising given the research expressing the preferences of Millennials as noted above. This is not to discount or exclude senior faculty but more to reiterate the larger point that in creating an SFLC one creates the conditions for faculty with a personal interest in sustainability and the SDGs to bring that interest to their professional work and collaboration in an institution-supported context. What we have discovered, as also confirmed by Barlett and Rappaport, is that much of what seems to be missing from business as usual in the academy is an opportunity for interdisciplinary conversation, events that capitalize on the wealth of expertise and experience of any school's greatest human resource, its teachers. In the context of the SDGs and sustainability in general, the coming together of the experts on campus has a multiplier effect of shared knowledge, affirmation of values, and genuine collegiality and cross-fertilization of ideas with a deeper connection to the practices going on globally.

Finally, we presented the results as reported by other institutions, beginning with the UVM SFF program (since this was the one we most directly modeled our program on), but we also pointed to the history of success nationally as outlined above. Again, since we needed to demonstrate a likely high return on investment, having so many success stories to point to was invaluable in validating our proposal. To this end, we owe much to Cortese, Barlett, Chase, et al., our pioneer predecessors, in leading the way and showing that simply creating the conditions for faculty to move confidently in a particular direction can have a hugely positive and lasting impact on an institution, even if the program that fostered the sustainability or environmental learning itself eventually disappears (Barlett and Rappaport 2009).

4.6 Conclusion

The future of the sustainability-based faculty learning community is one that will hopefully see continued growth in higher education on campuses globally. As discussed in this chapter, in 2017, AASHE partnered with a group of universities in the USA (with now also a center in Hong Kong) to serve as centers for sustainability-based learning for college instructors. At these centers, faculty from neighboring schools can receive training to bring back to their institutions, furthering progress in delivering sustainability content to university classrooms.

Moving forward, there is call for further research into a standardized means of assessing SFLCs as they continue to proliferate in higher education (Natkin and Kolbe 2016). With more institutions creating similar programs, a common

means of evaluating success would be greatly valuable, and as of this writing, AASHE and some of their CSAC leaders are gathering information from institutions in an effort to understand commonalities across programs.

However, perhaps Dickinson College in Carlisle, PA, one of the AASHE centers, reflects the next stage of advancement where they have no discrete major or program in sustainability but instead have reached a level where sustainability is so infused throughout the school's curriculum that there is no need for a separate academic course identifier or study requirement—sustainability is simply considered to be ingrained in all fields of undergraduate study. A wonderful example to help us see what is achievable with strong leadership, vision, and a bit of persistence, an aspirational goal for all of us.

The sign of a good idea is that it grows legs, and the SFLC model has been up and running for some time now. I encourage you to review the literature for additional data and results, but the bottom line is that the reason that you'll see such consistently positive reports from schools that have adopted the program is that it's simply a good idea for which, again, the credit must go to the pioneers who first gave it a shot. It is now vetted, time-tested, and up to you to bring the idea to your campus. After all, sustainability requires not only research, but the application of that research towards progress, concrete action. All it takes is for a few people to step up and decide to do it. As former chess world champion and political activist Garry Kasparov likes to say, "If not you, then who?"

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5 Urban Metabolism and Minority Pulse: An Education and Awareness Campaign Targeting Minority Groups

Gabriela Fernandez and Carol Maione

5.1 Introduction

In 2015, the United Nations called to action their partnering countries and their local governments to adopt a set of targets to tackle the needs of current and future generations towards sustainable development. The 17 Sustainable Development Goals (SDGs) set an agenda to transform our world, protect the human and non-human communities that inhabit it, and promote a more sustainable use of its natural resources. These goals and the related 169 targets depict an inclusive and holistic approach to planning more sustainable cities to respond to rapid urban transformations that are demanding increasing amounts of resources and services (UNDP 2015).

As urban centers expand and become more complex and dynamic organisms, the assessment of all input and output flows that occur in urban environments become a key approach to studying how cities function. The totality of flows entering an urban system in the form of material and immaterial resources and exiting in the form of waste and pollution is called urban metabolism (Ferrao and Fernandez 2013). The study of urban metabolism provides professionals, policy- and decision-makers, and scholars with a tool to understand the dynamics that take place in urban areas and how social, economic, and environmental dimensions are intimately intertwined in modern cities. In this framework, urban metabolism can serve as a lens to measure the performance of a city and assess the needs and well-being of its citizens (Fernandez 2018; Maione 2016).

5.2 Urban Metabolism and Minority Pulse Campaign

As an integral part of the slogan "leave no one behind," the SDGs foster awareness of social, economic, and environmental dynamics for all and require everyone to take urgent action to protect our planet (UNDP 2015). Today more than ever, our societies are made up of a complexity of individuals that differ for linguistic, religious, demographic, and cultural background. Therefore, in order to reach all members of the society, the SDGs can provide a simple, accessible language that everyone can interpret bringing its targets to fruition (Fernandez and Maione 2017).

In 2017, the Department of Architecture and Urban Studies at Politecnico di Milano (POLIMI) in Milan, Italy, and the non-profit organization,

G. Fernandez (✉)
Department of Architecture and Urban Studies, Politecnico di Milano, Milano, Italy
e-mail: gabriela.fernandez@polimi.it

C. Maione
School for Environment and Sustainability, University of Michigan, Ann Arbor, MI, USA
e-mail: cmaione@umich.edu

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Metabolism of Cities based in Brussels, Belgium, partnered to launch "Urban Metabolism and Minority Pulse (UMMP): An Education and Awareness Campaign Targeting Minority Groups" campaign. The campaign advocate for inclusive education across social borders comprehensively addressing vulnerable minority groups that live in urban environments. The initiative set a precedent delivering community- and minority-based education on global challenges including climate change, urban metabolism, and resource consumption. This work differs from other initiatives that tackle SDGs education in that it uses a tailor-made methodology including design, structure, format, activities, and actions. It is designed to allow all users to learn through their preferred communication and learning channels while providing inputs and feedback (Fernandez and Maione 2018).

5.2.1 Focus on the Italian Context

Today, 3 out of 4 Italians live in urban areas. As these numbers are projected to increase in the next two decades, there is a need to ensure that city infrastructure and services adapt to urban transformations. Therefore, the definition of a strategic framework in which governments can operate to foster a more sustainable future for their citizens has become a key target. In 2017, Italy adopted the "National Sustainable Development Strategy (NSDS) 2017/2030." Centered around the principles of the Agenda 2030, NSDS proposes a new vision based on "circular, low-emission economy, resilient to climate impacts and to other global changes endangering local communities, prioritizing the fight against biodiversity loss, alteration of the fundamental biogeochemical cycles (carbon, nitrogen, phosphorus) and land-use change" (Italian Ministry for the Environment Land and Sea 2017).

While efforts have been made to create a SDGs City Index for Italian cities, local specificities arise when we investigate the SDG achievement targets at the level of the city. Previous studies report that all Italian cities have attained similar goals for "SDG 1: No Poverty," "SDG 13: Climate Action," "SDG 6: Clean Water and Sanitation," "SDG 3: Good Health and Well-being," and "SDG 11: Sustainable Cities and Communities," respectively. Contrarily, not much has been done in terms of "SDG 7: Affordable and Clean Energy" as Italian municipalities have not set a roadmap yet to integrating renewable energy technologies in their development plans. Similarly, the alarming unemployment rates and economic crisis are major indicators of gaps in the current system posing a greater burden on the achievement of "SDG 9: Industry, Innovation and Infrastructure" (Cavalli and Farnia 2018).

5.2.2 Target Groups

Italy's population is estimated at around 60 million. With a significant decrease in the number of newborns when compared to the past 5 years, Italy is a rapidly aging country. Approximately, 1 in 4 Italians are aged 65 or older and the number of children and youth under the age of 15 dropped to almost 1 every 10 individuals (Istat 2019). Elderly and children are vulnerable segments of Italy's population. They are exposed to the effects of climate change in cities and the choices and actions of the first group, in terms of resource consumption and production of waste, can affect the availability of the same resources for and the livelihoods of the second group.

In the period 2015–2017, Italian municipalities have increased their expenditure for social services including investments in residential care facilities, integration of disabled persons, and user-friendly urban furniture. The Italian National Institute of Statistics (Istat) recorded an increase in the number of Italians suffering from chronic mental health conditions (approximately three million) and physical impairments (over 13 million) (Istat 2019).

Europe as a whole reports the highest literacy rate of 99% (The Statistical Portal 2019). In Italy, an increasing number of youths can access higher education programs and academic careers.

However, when it comes to climate change, access to information and materials can be limited to certain education environments. For instance, students and academics that participated in workshop activities reported a scarcity of coursework and degrees on climate action and engaging youth in informed opinions and decision-making (Fernandez and Maione 2018).

Over the past 3 years, Istat registered an alarming increase in gender-based homicide rates, with 375 murders in 2017. Not only has domestic violence on women become more common, but also women reported more frequent episodes of sexual harassment in their working environments. Almost half of women aged 14–65 (43.6%) have experienced sexual violence at work in 2017. Women also reported higher unemployment rates, which find their roots in sex disparities, and uneven representation when compared to male colleagues (Istat 2019).

Italy has been defined as "one of the worst countries in Western Europe in terms of gay rights" (The Local 2019). Lesbian, Gay, Transgender, Intersex, and others (LGBTI+) have reported incidents linked to sexual discrimination and hatred. Within the LGBTI+ community, 1 in 5 members have experienced work or physical violence, and this percentage drops to almost 1 in 3 for gay men under the age of 25 years (Centro Risorse LGBTI 2014). Lack of representation exposes them to more vulnerable conditions in modern cities.

In December 2014, it was estimated that Italian cities were home to 50,724 homeless. Statistics report that more than half of homeless people immigrated from North Africa or Eastern Europe, with Morocco, Tunisia, Albania, and Romania recording the higher numbers of migrants. Around 4 in 10 homeless people are Italian male individuals. What they all have in common is a condition of extreme poverty including little or no access to urban resources and infrastructures, exclusion from health care services, and chronic exposure to extreme weather conditions which can increase disease or even death rates (Italian National Institute of Statistics 2014; UNDESA 2017).

5.3 Methods

Education for sustainable development has never been stronger. Global issues such as climate change, rapid consumption of natural resources, and pollution levels require a shift in our lifestyles and a transformation of the way we think and act. As a result, education method systems must respond to the pressing need by defining relevant learning contents, introducing themes that empower all learners, and urging their institutions/universities to include sustainability tailor-made principles in their management structures. This study is designed to guide professionals to integrate sustainable development tailor-made education to existing curricula to spur action and momentum towards the achievement of the SDGs. The guide identifies indicative learning objectives and suggests topics and learning activities for underrepresented populations in the cities of Milan and Mantova, Italy.

The SDGs agenda highlights the importance of education as an explicitly formulated standalone goal, "SDG 4: Quality Education," which is both a Global Goal and a means for attaining all the other SDGs. It is a significant part of sustainable development, but also the key piece to all other goals. Thus, education remains a crucial part of localizing the SDGs in cities (Fernandez and Maione 2018).

Figure 5.1 depicts the study methodology that can be easily replicated, scaled, and adapted to different settings. The methodology is composed of four steps: (a) Objectives allow the learner to identify a set of targets to tackle. (b) Phase I-III are an integral part of the Urban Metabolism and Minority Pulse campaign and provide the learner with: strategies to accelerate awareness and networking on the selected topics; tailor-made workshop activities for seven target minority groups; and guidelines to foster integration and engagement of all users in strategy design. (c) The major goal of the Urban Metabolism and Minority Pulse campaign is to deliver Minority Education. This is characterized by: flexibility and replicability; the use of the SDGs as a tool to help instructors create a simple, user-friendly communication platform that is accessible to a

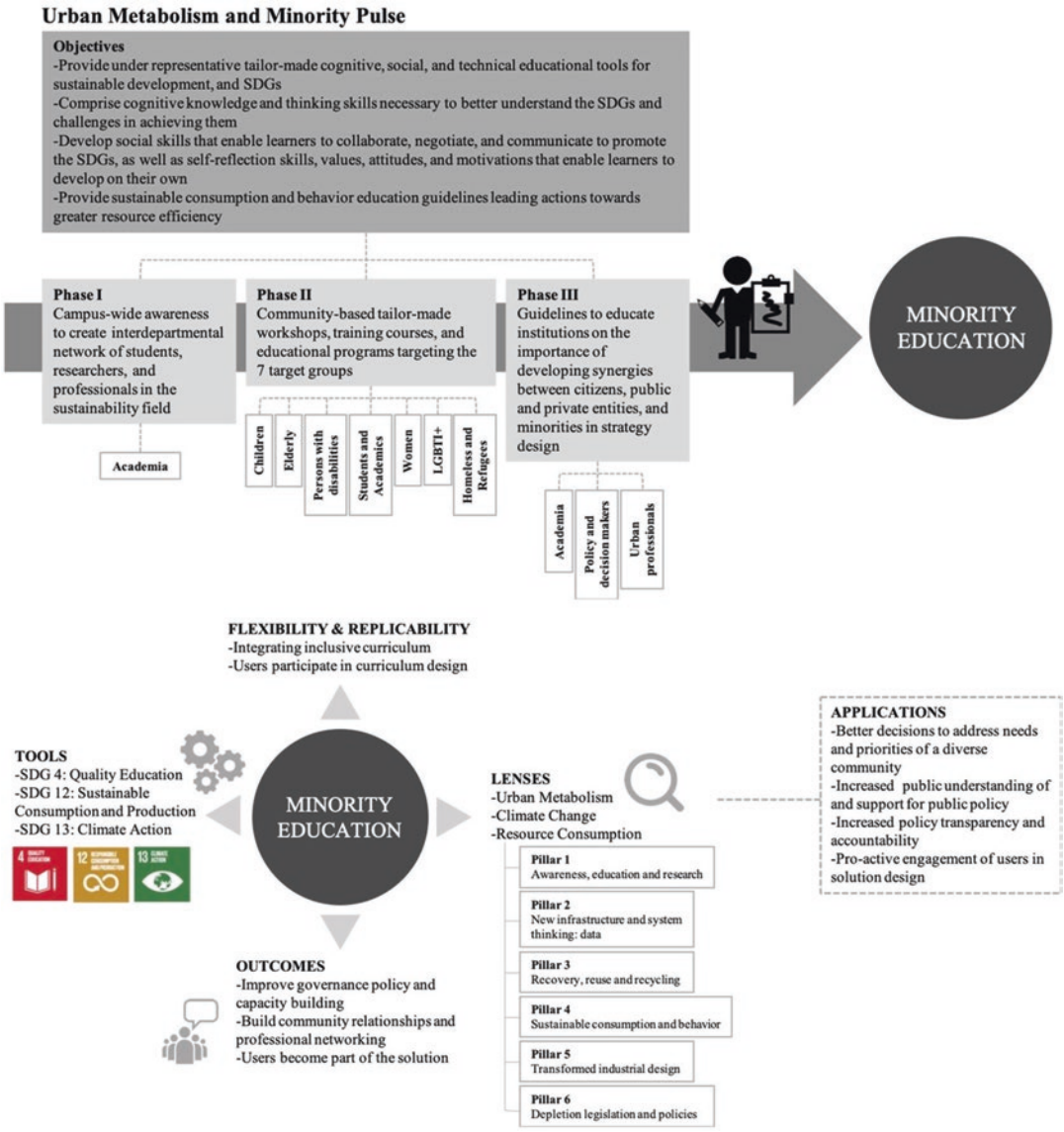

Fig. 5.1 Urban metabolism and minority pulse campaign method overview: (top to bottom) (**a**) urban metabolism and minority pulse objectives; (**b**) minority education framework phases; (**c**) minority education strategies: (flexibility and replicability, tools, outcomes, lenses); and (**d**) education applications (Fernandez and Maione 2018)

wide array of users; the three lenses urban metabolism, climate change, and resource consumption and the related six pillars (described in the next section); and a set of outcomes. This methodology addresses education for the diversity of minority groups using a language that overcomes diversity barriers and disabilities by engaging the final users in the design of the activities, using the user's preferred learning and communication channels, and raising opportunities for creative learning in non-traditional, learner-friendly education environments. Finally, (iv) the methodology outlines a set of tangible application of the study at the level of the city. This is possible through a transition from a society that considers minority a barrier to sustainable development, to

Fig. 5.2 Rethinking the urban metabolism pillars (Fernandez 2018)

one in which minorities become part of the solution by gaining more knowledge about decision-making processes and active roles in the design of solutions.

Figure 5.2 illustrates the six identified action pillars classified using color-based symbol legends. Table 5.1 shows the urban metabolism and minority pulse campaign matrix. The color scheme matrix demonstrates a sequence of cognitive, behavioral areas for learners to educate underrepresented target groups. Table 5.2 shows each pillar categorized and characterized by the type of activity to represent essential strategies in the pursuit of the SDGs. Furthermore, this matrix guide does not aim to be prescriptive, but to provide guidance and suggestions that educators can select and adapt to fit concrete learning contexts to develop sustainability competencies for all learners and empower everyone to contribute to achieving our ambitious and crucial global agenda. The learning objectives, topics, and activities for each under representative population are outlined. The matrix provides guidelines for any specific learner group, including educators and urban professionals, learning settings of ways to localize the SDGs in cities. Educators must define the level of pillar to be achieved by their learning objectives to be achieved by their learner for achieving the SDGs.

There are several key tailor-made education competences for sustainability that are recommended for educators to consider/construct in order to efficiently target, engage constructively and responsibly with today's world. These include cognitive, socio-emotional, behavioral domains, affective, and motivational elements such as knowledge, capacities, and skills and motives based on a specific target audience. Figure 5.2 highlights the key action activities for underrepresented targets categorized in the six pillars as a form to rethinking the urban metabolism: (1) Awareness, education, and research; (2) New infrastructure and system thinking: Data; (3) Recovery, reuse and recycling; (4) Sustainable consumption and behavior; (5) Transformed industrial design and (6) Depletion legislation and policies (Fernandez 2018). Actions and

Table 5.1 Learner key education competencies for sustainability actions (Fernandez and Maione 2018)

Pillar 1. Awareness, education, and research	The learner understands the main drivers of sustainable development, considering all target groups by integrating storytelling, linguistic exercises, visual and spatial learning, and audio activities. In addition, to raise awareness of the importance of equal education for all, using holistic approaches to education on sustainable development and related projects through outreach programs tackling multiple languages and designs and developing ways to promote free and equitable education for all.
Pillar 2. New infrastructure and system thinking data	The learner explores the use of technologies adaptable to all target groups, while considering targets with a lower understanding of technology education. It consists of virtual reality, sensorial and hybrid experience, integrated technology, systems thinking, and strategic thinking to measure their surroundings. The learner can differentiate between an array of technologies to meet the needs of all targets. The learner is able to connect with target groups with little to no access to technology and open source data.
Pillar 3. Recovery, reuse, and recycling	The learner will work closely with target groups to make sure a thorough assessment of the material taught is appropriately addressed and understood. The learner can plan, implement, and evaluate community-based sustainability projects. In addition, to promote low carbon approaches at the local level and self-awareness.
Pillar 4. Sustainable consumption and behavior	The learner is able to influence sustainable consumption behavior through cross-curricular teaching and influence household and personal consumption behaviors. The learner knows the basic principles of sustainable planning and building, and we can identify opportunities for making their own area more sustainable and inclusive.
Pillar 5. Transformed industrial design	The learner is able to compare and assess different business models and their sustainability based on each target audience. The learner is able to develop vision of reliable, sustainable problems, and solving skills. In addition, goals are set based on different target scenarios.
Pillar 6. Depletion legislation and policies	The learner understands how policies can influence the production, supply, demand, and usage of material/non-material through the use of cooperative learning structures. The learner is able to evaluate and compare the sustainability of their and other settlements system in meeting their needs particularly in the areas of food, energy, transport, resources, water safety, waste, inclusion and accessibility, education, integration of green spaces, and disaster risk reduction.

activities related to linguistics, strategic, storytelling, critical thinking, visual and spatial learning, audio, sensorial and hybrid experience, integrated technology, assessment for learning, self-awareness, cross-curriculum teaching, goal setting, problem-solving, and cooperative learning structures.

Table 5.1 shows the campaign key education competencies for sustainability development education. The campaign proposes six pillar competences to consider when working with different types of target groups. The following pillars demonstrate an array of activities, suggestions, and guidelines when developing a curriculum towards the achievement of the SDGs.

To create a more sustainable world and engage with issues related to sustainability as described by the SDGs, individuals must become change-makers for sustainability. Learners require the knowledge, skills, values, and attitudes that empower them to contribute to sustainable development. In order to develop

Table 5.2 Urban metabolism and minority pulse campaign matrix (Fernandez and Maione 2018)

Target groups	Actions								
	Pillar 1. Awareness, Education and Research			**Pillar 2.** New infrastructure and system thinking: data		**Pillar 3.** Recovery, reuse and recycling	**Pillar 4.** Sustainable consumption and behaviour	**Pillar 5.** Transformed industrial design	**Pillar 6.** Depletion legislation and policies
	Linguistics/ Story telling/ critical thinking	**Visual and spatial learning**	**Audio**	**Sensorial & hybrid experience / strategic**	**Integrated technology / systems thinking**	**Assessment for learning / self-awareness**	**Cross curriculum teaching**	**Goal setting/ problem solving/**	**Cooperative learning structures**
Children									
Elderly									
People with Disabilities									
Students and Academics									
Women									
LGBTI+									
Homeless and Refugees									

cross-cutting sustainability competencies, learners must relate the different actions to SDGs and each unrepresentative target group. The campaign can help equip learners with the specific cognitive, socio-emotional, and behavioral learning outcomes that enable them to deal with the challenges of the SDGs based on specific types of target audiences. It is important to understand the specific needs of each underrepresented target group when dealing with specific cognitive, social, and behavioral education implementation activities. Education is crucial for achievement of sustainable development because it empowers learners to take informed decisions and act responsibility towards combating environmental, social, and economic problems. Table 5.2 shows the campaign activities and characteristics matrix. The matrix guides readers on how to use education, especially education on sustainable development, towards the achievement of the SDGs. The rows and columns identify learning objectives and suggest topics and learning activities for each pillar. In addition, the pillars describe implementation at different levels from course design to replicable national/regional strategies. The matrix aims to support policy-makers, curriculum developers, and educators in designing strategies, practices and resources, curricula, and courses to promote learning for the SDGs at the local government, university, and K-12 institutional level.

It is important to understand different types of learning competencies when dealing with children, elderly, persons with disabilities, students and academics, women, LGBTI+, and homeless and refugees. There are other wider societal benefits of putting emphasis on tailoring linguistics, visual and spatial learning, audio, sensorial and hybrid experience, strategic learning skills, and

critical thinking skills. Some targets are social or visual learners, others embrace their individuality and the unique way they learn, others create pictures (i.e., graphs, maps, and diagrams) to outline complex concepts, or retain data more than others. However, there is not a one-way educational method that fits all solution. As a result, it is important that the learner is aware of all the different learning styles and language. This will allow learners to incorporate enough information in their curricula to address all the different learning needs.

5.4 Discussion and Conclusions

As a part of the slogan "no one should be left behind," this study designs a set of cognitive, social, and behavioral methodology and tailored criteria toolkits to educate and develop awareness on themes related to climate change, urban metabolism, and resource consumption behaviors with reference to "SDG 4: Education," "SDG 12: Sustainable Consumption and Production," and "SDG 13: Climate Action," respectively. In contrast to conventional development agendas that focus on a restricted set of dimensions, this study uses the SDGs as a common language to educate the most vulnerable members of society to create a replicable policy-toolkit with a set of tailored methodology and educational strategy actions addressing underrepresented populations in the context of Northern Italy. More specifically, the study target seven minority groups: children, elderly, persons with disabilities, students and academics, women, LGBTI+, and homeless and refugees. Furthermore, the sharing and creation of knowledge, data, experiences, and storytelling allow urban professionals to promote awareness, conservation, and preservation, towards localizing the SDGs by 2030. The Urban Metabolism and Minority Pulse campaign proposes, in the future, to extend the unrepresentative research studies to other cities with diverse languages and cultural background, and even to underdeveloped contexts, as well as developing new replicable criteria language, cognitive, and linguistic approaches for the next generation of learners.

By enabling learners to increase the quality of teaching and learning sustainable development education cognitive and social criteria, targeted audiences are more likely to succeed. Sustainable development education policy needs to integrate system measures of quality through tailor-made methods when dealing with the social, economic, and environmental dimensions of sustainable development. More specifically, the learner can deal with different types of people, lifestyles, needs, ages, languages, and cognitive competences to envision sustainable lifestyles and to encourage others to engage in sustainable practices while reflecting on their own individual consumer behaviors.

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6 Integrating Core Sustainability Meta-Competencies and SDGs Across the Silos in Curriculum and Professional Development

Paul Woods Bartlett, Milena Popov, and John Ruppert

6.1 Introduction

Curriculum has been identified as the weakest area of systemic improvement on campuses by the Association for the Advancement of Sustainability in Higher Education (AASHE) and the organization Second Nature. Operational concerns (e.g., energy efficiency and recycling) have made the greatest gains in AASHE's Sustainability Tracking and Assessment Reporting System (STARS) reports and Second Nature's University President's commitments to Climate Action Plans.

Sustainability is often introduced ad hoc into courses lacking comprehensive design at the course and program levels. Learning objectives are seldom reviewed or assessed. Students generally graduate with adequate sustainability conceptual knowledge, but less often with the disposition or capability to make change in the variety of institutions and communities they find themselves working and living in.

What does effective sustainability curriculum look like? An effective sustainability curriculum is deliberately constructed with the aim to graduate students with the capacities to be effective systemic change agents. We find that the key framework and world view to be built upon the ethic of care for self, others, environment/nature, and knowledge. We find the key elements of effective curriculum design to be "Sustainability Meta-Competencies" (SCs), United Nations Sustainable Development Goals (SDGs), and case studies integrated with socio-scientific inquiry (SSI) pedagogies.

How do we effectively support faculty in bridging these practices into their classrooms across different disciplines? Applying the key elements and ethic of care framework above we have constructed simple templates for teaching sustainability and environmental justice across the curriculum in faculty development workshops and eco-literacy workshops for non-faculty staff.

This chapter draws upon our personal experience and practice of teaching sustainability and environmental justice in dedicated courses in sustainability and environmental justice and across the curriculum in physical science, life sciences, social science, and art, at four public and private universities. We are inspired by the shared experience and wisdom of the

P. W. Bartlett (✉)
John Jay College of Criminal Justice, City University of New York and Fordham University, New York, NY, USA
e-mail: pbartlett@jjay.cuny.edu; pbartlett@fordham.edu

M. Popov
John Jay College of Criminal Justice, City University of New York, New York, NY, USA
e-mail: mpopov@jjay.cuny.edu

J. Ruppert
Saint Peter's University, Jersey City, NJ, USA
e-mail: jruppert@saintpeters.edu

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Sustainability Curriculum Consortium conceived as a community of practice as an affiliate of AASHE to collectively address the problems and needs outlined above. The extensive research on science and environmental education is drawn upon for our pedagogy, including our own ongoing research on civic engagement with ecosystem science and socio-scientific inquiry pedagogy (Ruppert & Bartlett 2018; Ruppert et al. 2018, 2019; Bartlett et al. 2019).

6.2 Theoretical Framework

Our design and understanding of effective sustainability curriculum is founded on a theoretical framework of the ethic of care, domain-based moral development, and the sustainability meta-competencies, and socio-scientific inquiry pedagogies informed by the AIR-V epistemic cognitive framework (Barzilai and Zohar 2014; Chinn et al. 2014; Ruppert & Bartlett 2018; Ruppert et al. 2018, 2019). We follow this section with the articulation of the design of professional development workshops based on this theoretical approach.

6.2.1 Ethic of Care

We approach teaching sustainability and environmental justice through the framework of the relational theory of the ethic of care for self, others, environment/nature, and knowledge.

Carol Gilligan developed a grounded theory of moral development from a qualitative research study of young women making moral decisions about abortion and weighing ethical issues of care and harm to self and others (Gilligan 1977, 1993). At the time, women were pressured by society to prioritize care for others over care for self. Gilligan discovered one had to balance care for self to be best capable of care for others. Nell Noddings (1984) applied the ethic of care to education, and Russell and Bell (1996) extended the theory to ethic of care for environment/nature including non-human beings and made the ethic of care a cornerstone of ecofeminism, animal rights, and ecojustice. We find it useful from our research on civic engagement with ecoscience to extend the ethic of care to care for knowledge (Ruppert & Bartlett 2018; Ruppert et al. 2019; Bartlett et al. 2019). We also posit that the ethical care for knowledge be inclusive of place-based local knowledge and indigenous knowledge and ontologies (Fundaccion Pachamama 2008; Aoki Inoue & Moreira 2017; Barkin 2018).

It is more conventional to contrast anthropocentric vs ecocentric worldviews, but we find it more fruitful to contrast care with harm and balance care for self, others, environment, and knowledge. Ounvichit (2017) circumvents the conventional dualism by evaluating children with degrees of three poles of care: ego (self and family), others (community), and nature, where one can score high on all three without one as a tradeoff for the other.

Pope Francis's renowned encyclical of integral ecology Laudato Si' (Francis 2015) is written through the framework of ethic of care for "our common home" and was published in coordination with the promulgation of the United Nations Sustainable Development Goals (SDGs), which we also see as mutually reinforcing.

6.2.2 Domain-Based Theory of Moral Development

A complementary theory of moral development to the ethic of care is Larry Nucci's relational domain-based theory of moral development. Nucci's research finds that morality is not in practice absolute, but is contextual, each individual engages in moral-based reasoning and action relative to a context that can shift with time and place (Domain Based Moral Education [DBME] 2017; Nucci 2008; Nucci and Turiel 2009). Consequently, Nucci's research has found that apart from a very small percentage of psychopaths and sociopaths, most people engage in moral reasoning, but with different contextual domains. This is an important complement to the ethic of care, because for us to work together collectively for sustainability, we need to be able to not mistakenly judge others to be immoral, but

instead seek to understand the contextual domain of their values and morality, and communicate with that understanding.

6.2.3 Sustainability Learning Core Meta-Competencies

Debra Rowe, president of the U.S. Partnership for Education for Sustainable Development has challenged us to go beyond a focus on conceptual knowledge in education and shift our attention to develop student capacities to become agents for systemic change. This means integrating values, attitudes, behavior, and ethics with other education reform pedagogical strategies in the classroom (National Research Council [NRC] 2012, 2007; Sadler and Donnelly 2006; Sadler et al. 2011; Zeidler et al. 2005; Zeidler 2016; Feinstein & Kirchgasler 2015; Cagle 2017; Ruppert & Bartlett 2018; Ruppert et al. 2019). Ideally, this also involves activities that provide students with experience of self-efficacy and collective efficacy of systemic change (Svanström et al. 2008).

Wiek et al. (2011a, b, 2015) and Rieckmann (2012) from a research group at Arizona State University (ASU) and Northern Arizona University have identified, from the sustainability practitioner and research literature reviews and their own experience, various competencies that they have consolidated into five key categories of systems thinking, futures thinking, values thinking, and strategic thinking which converge in practice and pedagogy as collaborative (teamwork) problem-solving competence necessary to become effective change agents. Theres Konrad at Leuphana University of Lüneburg, Germany is collaborating on a joint graduate program with ASU that explicitly develops these competencies with graduate student self-assessment (Konrad et al. 2018). This produces a self-awareness of students on how their competencies are developing, and how they can take an active role. The work-in-progress is demonstrating success of this approach.

Penn State University (PSU) Sustainability Institute (PSSI 2019) engaged in a qualitative and quantitative research study of their own practices in classes and programs to identify core sustainability learning core meta-competencies (Engle et al. 2016, 2017; Buckland and Engle 2018). The authors use the term meta-competencies to highlight that the subjects were aware of and self-directing the learning process with the competencies. The pedagogical implications are to be explicit and direct in the curriculum when implementing the curriculum. PSU identified these five core meta-competencies to include system thinking, temporal thinking, interpersonal literacy, ethical literacy, and creativity/imagination. Later, in a webinar (Buckland and Engle 2018), add the strategic thinking competency of Wiek et al. (2011a, b, 2015) as equally important. PSU's elevation of creativity/imagination to a core meta-competency is an important contribution to this literature and practice, which we also make the case for in our discussion below.

The Sustainability Curriculum Consortium [SCC] (2016) has prioritized sustainability competencies and is working collaboratively with the National Council for Science and the Environment (NCSE) to develop sustainability program learning outcome guides based on "sustainability core competencies."

Rieckman (Rieckmann 2017) has extended and integrated sustainability competencies into learning objectives for a (UNESCO 2017) resource: Education for sustainable development goals: Learning objectives.

6.3 Professional Development: Faculty and Staff

In this section, we articulate our design of professional development workshops based on the theoretical approach of the ethic of care and sustainability competencies. Following this section, we go into more detail on the importance of the core sustainability competencies and how they can be implemented in the classroom.

6.3.1 Sustainability Across the Curriculum

The sustainability across the curriculum faculty development workshop we designed is based on the MacGregor et al. (2014) AASHE bioregional workshop template. Faculty form small groups within the same or similar disciplines. Faculty identify the big ideas in their courses, close to the "trunk of the course," and not in the small outlying "branches." When finished, participants are provided with an extensive set of sustainability concepts on cards, some with detailed explanations on the back. Workshop facilitators guide participants to match cards to their big ideas. It is helpful to have facilitator assistants work with each team, as some sustainability concepts may need to be explained in the context of their discipline. From these associations, faculty develop class activities, helping each other in their team, or selecting one course example per team, depending on available time.

We add to the MacGregor et al. (2014) template two additional stages: participants matching activities with sustainability core competencies cards, and one or more of the 17 Sustainable Development Goals (SDGs). We have found these two stages easier for participants than matching sustainability concepts, effecting more confidence and satisfaction in the exercise. The competencies often prompt the faculty to enrich their proposed student activity, the creative/imaginative competency in particular. The sustainability goals help faculty connect their discipline and locality with practical projects and policies and help students connect the local to the global. Participants are introduced to the course mapping exercise developed by Buckland and Engle (2018), whereby they see how they cover some of the sustainability core competencies in their courses with activities that were already in their curriculum, and can enrich their courses by covering all of the competencies in more depth. Time permitting, faculty are introduced to the "Campus as a Living Laboratory" and AASHE STARS, deepening the local to global connections. For the final stage of the workshop, time permitting, faculty are introduced to the Environmental Justice Atlas (2019) and Seeds of Good Anthropocenes 2019 case studies to explore bringing into their courses. Information about local sustainability and environmental justice organizations is shared with the participants for potential field trips, student projects, and service learning.

6.3.2 Eco-literacy Staff Development

While "sustainability across the curriculum" workshops are expanding across the globe, eco-literacy workshops for non-faculty and non-programmatic staff are less common (Bartlett et al. 2019). Whereas the "big ideas" of courses is a path to incorporate sustainability into the curriculum, we use the ethic of care and domain-based moral development approach with staff who choose a non-academic career path and have a wide range of values and perspectives. Our starting point is to ask the staff participant what they care most about in life and do not want harm to come to. Participants write what and who they care about on cards, just like we did with faculty with big ideas in their courses. We then distribute cards of sustainability and environmental justice concepts and issues as we do in faculty workshops, and work with the participants to see what concepts and issues could affect who and what they care about. This may require indirect and direct guidance of the participants to make and understand the connections of sustainability and what they care about.

We open the discussion of the whole group and ask what they would like to know more about. We invite our librarians to show them how to get quality sources and volunteer their services. We inform them about the SDGs, which they also match to what they care about.

Follow-up workshops are proposed to be held by faculty with specialized knowledge about what they care about and to also develop staff Engle and Wiek's "sustainability meta-competencies" (system and temporal thinking, ethical literacy, interpersonal/intrapersonal literacy, creativity/imagination, strategic thinking) to

enable staff to become effective change agents for their community and on the job. We can then recruit staff workshop participants to be on a campus bottom-up green team to complement our Sustainability Council and help bridge the divide between staff and faculty.

6.4 Sustainability Learning Competencies

As mentioned above we follow in our implementation and discussion here the five sustainability core learning meta-competencies identified Engle et al. (2016, 2017) and Buckland and Engle (2018) from their research of existing classes and programs at Penn State University: system thinking, temporal thinking, interpersonal literacy, ethical literacy, and creativity/imagination. We pay particular attention to creativity/imaginations, since it is not emphasized in other work, and we believe generally deficient in higher education.

6.4.1 System and Temporal Thinking

System thinking and temporal thinking can be taught directly or indirectly. We aim to provide students with many instances of complexity and how to be comfortable with uncertainty. A Delphi study by Ruppert and Duncan (2017) found that an important big idea of ecosystem science is understanding that it is impossible to know all the connections, relationships, and importance of elements and boundaries of an ecosystem. By teaching ecological case studies (e.g., Walker and Salt 2012; Healy et al. 2013; Environmental Justice Atlas 2019; Seeds of Good Anthropocenes 2019; Temper 2015), students discover the difficulties of human interventions and predicting impacts on ecosystems. Case studies and place-based student activities can teach students the contingency of knowledge and the importance of local and indigenous knowledge (e.g., Healy et al. 2013; Temper 2015). The concept of socio-ecological systems becomes more understandable with concrete examples (e.g., Tsurusaki and Tzou 2014; Walker and Salt 2012; Healy et al. 2013; Temper 2015; Mobus & Kalton 2015). Students discover that human society is not separate from nature and the environment but is an intimate part of it with complex feedbacks. We can find various degrees of realization in classroom discussions and reflection essays, and some students can experience profound epiphany and identity shift (e.g., Nazir and Pedretti 2016; Carlone et al. 2014; Cagle 2017; NWEI 2019).

The fields of ecological economics and political ecology were developed to better understand and teach complex systems and human connections to their environments (e.g., social metabolism); they aim to be transdisciplinary, reconceptualizing economics as part of the biosphere and natural system and grounded in ethics (Timmerman 2012), an important correction to conventional academic economic discipline and pedagogies that characterizes impacts on habitat and the environment as externalities (Healy et al. 2013; Temper 2015).

Environmental justice case studies can reveal that behind most harmful impacts on the environment and ecosystems is an economic distributive justice issue: some people benefit, and others are harmed (Environmental Justice Atlas 2019). System and temporal thinking help reveal these interconnections. Climate justice is also an issue of intergenerational distributive justice, as the present older generation benefits, the young and future generations will suffer, as we can see argued in the youth climate justice lawsuit (Juliana v. U.S. 2019).

The American Meteorological Society (AMS) course materials (2014) include "eInvestigations" internet computer labs. Students are guided to find and evaluate real historic and current climate data from government and scientific sources, just as scientists do, and thereby gaining a better understanding of what is known, what is unknown, and levels of uncertainty. Making sense of climate data from air, land, and oceans provides students with an exposure to interrelationships of physical systems, long temporal scales. AMS offers a Climate Diversity Workshop (2018) that teaches non-climate scientists from

all disciplines how to teach climate science, since the need cannot be fulfilled by the limited amount of teaching climate scientists.

The Sustainable Human and Environmental Systems (SHES) group (Focht et al. 2018: xxi) sees system thinking as the most fundamental and elevates system science and system thinking to the status of a "supradiscipline" pedagogy:

"In sum, the SHES approach maintains a holistic perspective throughout all of its stages. It does so by using a supradisciplinary pedagogy that conceptualizes both sustainability situations and sustainable alternatives in systems-thinking terms. By progressively revealing more of the systemic and interactional complexity of the sustainability situations, the SHES approach helps students to gain a more thorough and nuanced but always holistic understanding of the systems and system interactions that are essential to realizing the SHES vision. The use of the SHES approach to diagnose the sustainability challenges posed by these situations makes it possible to prescribe targeted interventions to transform the situations into alternatives designed to achieve sustainable outcomes. The implementation of these prescriptions through social learning leads to increased capacity on the part of the stakeholders to contribute more effectively to the emergence of sustainable societies."

6.4.2 Inter- and Intrapersonal Literacy

Engle et al. (2016, 2017) found in their research that interpersonal literacy is the biggest barrier to producing change agents, the same reason we stress communication and the use of peer to peer education including team work.

We convey to students in their own class experience and through case studies the importance of recognizing the distributed and contingent nature of knowledge, with no one person having comprehensive and diverse expertise, and the importance of local and indigenous knowledge (Roth and Lee 2012; Feinstein & Kirchgasler 2015; Aoki Inoue and Moreira 2017; Fundaccion Pachamama 2008; Barkin 2018). The ability to communicate with one another and function as a community of practice is essential to achieving sustainability and resilience.

Howard Gardner (1983) developed the theory of multiple intelligences based on empirical research. While some individuals may have natural different levels of abilities, these intelligences can be learned and taught. He identified both inter- and intrapersonal intelligences among seven discernable intelligences. Daniel Goleman popularized the finding in his book "Emotional Intelligence: Why it can matter more than IQ" (Goleman 1995). Although the theory originated in education, it became more popular in business literature, as a competency often missing from college graduates where learning has overstressed analytical cognitive intelligence. Emotional intelligence includes being aware of one's own emotions and others', the ability to manage emotions intrapersonally and interpersonally, and thereby be better able to communicate and function in a community of learning and practice.

The Psychology of Climate Change Communication guide (CRED 2009) is extraordinarily useful for teaching and sharing with students how to effectively communicate sustainability science and engage in productive collaboration in and out of school. Team wikis (e.g., Blackboard and ePortfolio), podcasts (audio, video, and animation), and art projects (e.g., eco-fashion show) are effective activities to develop inter- and intrapersonal literacy and creativity/imagination. Facilitated discussions (online or in-class), blogs, and reflection essays on exams provide further opportunities for student development of the "meta" awareness of how they are learning and communicating and developing their own competencies.

Student individual work (including midterm reflection essays) and team work are presented to the entire class to expand peer-to-peer learning, and to flip the audience of their work from instructor to students and the public. ePortfolio and voice-thread are exceptionally good platforms for students sharing and expanding their modes of expression from written to aural and visual. We employ class wiki ePortfolios and individual student ePortfolios.

There is resistance with many students to teamwork, but that is often an indication on how much the intrapersonal and interpersonal competencies need to be developed. Individual grading of student levels of participation can overcome the fear of teammates bringing their own grade down. Guided inquiry of team work by the instructor at each stage can help get through resistance and foster deeper learning and retention.

6.4.3 Ethical Literacy

We define the ethical literacy competency to be the ability to recognize and understand one's own values, values of others, and the multitude of societal values including the values of indigenous cultures (Engle et al. 2016, 2017). The relational domain-based theory of moral development discussed above holds that morality is not absolute, but contextual, each individual engages in moral-based reasoning and action relative to a context, a context that can shift with time and place (Nucci 2008; Nucci and Turiel 2009).

The Canadian Truth and Reconciliation activities are generating a surge of sustainability curriculum in environmental education, drawing upon indigenous knowledge, ontologies, and world views. The University of Hawaii Center of Excellence incorporates indigenous knowledge and experience in the curriculum.

Our pedagogy is based on eliciting from students what they care about as the starting point and guiding them to see how they are connected to issues of sustainability and environmental justice. The sustainable development goals help make sustainability problems more concrete and actionable.

Our pedagogical approach is also informed by the research and practice of teaching "Socio-Scientific Inquiry (SSI)" and "Socio-Scientific Reasoning (SSR)" in K-12 (Sadler and Donnelly 2006; Sadler et al. 2011; Zeidler et al. 2005; Zeidler 2016; Ruppert & Bartlett 2018; Ruppert et al. 2018, 2019). Instructors guide students to address complex sustainability "wicked" problems that do not lend themselves to simple solutions, and due to the impact of many other peoples and ecosystems, require a moral reasoning process.

As is for other competencies case studies, place-based projects and field trips can be effective to develop ethical literacy. Nazir and Pedretti (2016) took urban students into the wetlands and handled reptiles. Students initially had adverse reactions to the "icky" mud and "ugly" creatures. With some prompting, a student took the lead with fellow students, identifying with her fears and discomfort. Over time, students became comfortable with the reptiles and the environs, expanding their egocentric identity toward an ecocentric identity to include wetland ecosystems and the non-charismatic creatures that inhabit them. Tsurusaki and Tzou (2014) designed a curriculum that investigated water use and pollution in Puget Sound. Students started out being overwhelmed by the scale of pollution and water use but could not see their personal and small communities contribution to be significant. The instructor guided the students collective research efforts where they became acquainted with each part and interaction of the human system with the ecosystem. Students came to an understanding of their own complicity and what could be accomplished on the individual level and community level.

One of the authors creates an action assignment in every course to connect the student directly outside of the classroom to a sustainability or environmental justice issue as an observer or as a participant. Ideally this is done at an event or with an environmental justice organization but can also be done on social media.

The new literature on post humanism and interspecies being builds upon animal ethics (e.g., Lloro-Bidart and Banschbach 2019). Art education methods are particularly successful in generating affect and expanding ethics beyond the human and are discussed in the following section.

6.4.4 Creativity/Imagination Competency

While Wiek et al. (2011a, b, 2015) with the Arizona State University (ASU) Sustainability Institute and Rieckman (Rieckmann 2012, 2017) with ASU and (UNESCO 2017)identify creativity

as a sub-competency for sustainability, the Penn State University's research studies elevated creativity/imagination to the level of an *essential* core meta-competency (Engle et al. 2016, 2017; Buckland and Engle 2018). The authors find that podcasts, team projects, and the use of ePortfolio multimedia software facilitate student expression and the creativity/imagination competency. The following section is contributed by Milena Popov who teaches sustainability in the Art Department and an Environmental Justice Program.

In our time of global ecological crisis with unpredictable outcomes and scenarios, developing creativity/imagination competence is becoming increasingly important. As Engle et al. (2017) noted, creativity/imagination competence creates an "ability to envision, develop and apply innovative and strategic solutions, frameworks, etc. in order to adapt to changing and challenging situations… identified by research participant as necessary for addressing unforeseen outcomes and scenarios; not addressed in other categories" (Engle et al. 2017:12). Student reflections in their self-assessment essays in our classes show that students are also aware of the importance of this competence. While students recognize the importance of all sustainability competences, a majority of students stated that they have developed in our courses creativity/imagination and that this is the competence they would like to develop further. Some of the reasons students stated for the necessity of developing creativity are lack of abilities of individuals to create and innovate, to create solutions on their own, to envision different things and to see them from different angles, and thus to make sustainable changes in the world. They noted how class' creative assignments (such as creating a green make-over of an unsustainable building or a waterfront), presentation of creative science and art projects (such as underwater city in Japan and Rising Currents exhibit in Museum of Modern Art in New York), as well as field trips (to High Line park for example) inspired them and changed their behavior toward the environment. Some students described creativity as the key for the future. The many students that stated they developed creativity in these courses, also stated they would like to develop it even more in the future. From some of the students' reflections, we have also seen that creativity/imagination competence is seen as something not only related to art/design, but also logical thinking and science. For example, one student noted that creativity/imagination competence helps a person to grow and develop logical thinking, while others stressed that with creativity one could envision the space exploration and colonization. This thinking might have stemmed from our interdisciplinary approach to teaching sustainability and the way creativity was presented in this particular class. Linking art and science into one large field (or seeing them as two faces of the same coin) is not something new. Historically, art, science, and religion were one large field, before they were separated in the time of Humanism (with the birth of modern science and aesthetics, and not coincidentally in the time of Industrial Revolution). The starting point of this segregation (and the origin of Cartesian dualism) can already be seen in Ancient Greece (the source of admiration for eighteenth-century humanists), where this division, not accidentally, went parallel with the separation of man from nature. When opposing the dualisms man-nature and art-science, in historic and contemporary tribal societies, for example; one can see the unity between art and science (as well as religion) and at the same time between man and nature. A shaman in tribal societies stands in for both artist and scientist (as well as a religious leader) that is equipped with talents and knowledge to cure societal illnesses (as a whole from its roots, rather than just treat its symptoms). If we look at our environmental crisis, it is a problem that is at the same time a physical and a moral one in its nature. Thus, scientific innovations (as a single view approach) cannot solve this multifaceted problem alone. For example, as Hardin (1968) noted there are no technical solutions to overpopulation since the technology cannot cure the root of the problem—create a mind shift. What is needed here is an interdisciplinary approach to problem-solving—an art-science unity, as a single endeavor that Edwards (2018) calls "aesthetic creating" is needed to cure the ecological crisis. Moreover, as Edwards

pointed out, humanity cannot just value innovations that have a more immediate and tangible effect (based on science and often profit driven), but also needs to value innovations that have long-term humanitarian goals—cultural innovations, even if their effects are not immediately seen or obvious (Edwards 2018). Arts that are not just arts for arts' sake tend to have the ambition to bring awareness of the moral problems of society and bring about the cure. In our time of ecological crisis, diverse eco-arts as well as eco-design have shamanistic goals—to cure this crisis. For example, cli-fi novels, films, theatre plays, and artworks help humans visualize diverse negative scenarios that can happen if the future is not ecologically sustained, while bio-remedial artworks and reclaimed green architecture directly remediate environmental problem sites. "Eco artists are … visionaries inventing new means of art-making that are capable of addressing the Earth's mounting vulnerabilities and crises" (Weintraub 2012:1). They employ various strategies to achieve their goals such as visualization, dramatization, metaphorization, satirization, and instruction. "Eco artists are at liberty to summon imagination, vision, wit, humor, exaggeration, ridicule, glorification, and every other expressive means that artistic license allows" (Weintraub 2012:2).

Arts can reach human emotions—to move their hearts, and thus change the way humans think and act, while showing them new possibilities (such as the visions of a future) without constraints of the known. Two students have stated in the earlier mentioned class self-assessments that by developing creativity/imagination competence they were able to see their wasteful lifestyle and change their behavior since they now have the ability to constantly think of new ways to solutions, adding that they wish to use their creativity to create larger, local and even global solutions in the future. It is important to keep developing students' creativity/imagination competence since it enables them to open up and start thinking outside of box—be open to new and different possibilities. As one student noted, with creativity one can always envision many different things in a new way, and in a different way that others can envision. Thinking outside of box further creates the ability to imagine scenarios and envision the future. Some students mentioned that by developing creativity in these classes, they develop critical thinking and the ability to see beyond what they think they can do—thus teaching them that nothing is impossible. They stated that creativity helped them envision something and develop an idea that can be applied to real-world situations. One student added that our classes give the ability to students to anticipate for the present and the future.

In art's ability to reach human emotions and inspire behavioral changes, it also lies the opportunity for the creation of empathy toward other humans, as well as non-humans, and thus reconnects with nature in order to solve the ecological crisis that resulted from this disconnect. Eco-arts as new trends in philosophy such as posthumanism, new materialism, object-oriented ontologies, and theories of social assemblage recognize the continuity between all living things, as well as non-animate nature—have an ecocentric approach as opposed to an egocentric approach (striving for the Post-Anthropocene in reaction to the Anthropocene).

Regarding fostering empathy toward other human beings, the world's first Center for Empathy and the Visual Arts was recently established at the Minneapolis Institute of Art with the mission to research and create strategies and tools for museums around the world to promote empathy by using works of art. As museum's director says:

> A visitor to our museum has the opportunity to experience works of art made over the course of some 5000 years, from every corner of the globe. One of the most meaningful aspects of this encounter is the awareness it can awaken of a common humanity—an immediate sense of connection between the viewer and someone who may have lived in a very different time and place… Thanks to the Mellon Foundation, we're proud to take the lead with partners across the country, in studying how to spark and nurture empathy through the visual arts, so that Mia and all art museums can contribute even more toward building a just and harmonious society (Daley 2017).

With the same goal a traveling Empathy Museum is created, where in one of the art exhibits visitors are asked to walk in someone else's shoes while listening to audio-recorded life story by that person (Empathy Museum 2019).

Climate change effects are not equally distributed today around the world and due to many factors (such as geographic location, income, gender, race) some people experience these effects more than other people. For people that do not experience much of the effects at the moment, it is hard to imagine how it feels like to be affected by climate change. It is even harder to imagine what life on Earth would be like in the future. Works of art used in the classroom (such as cli-fi literature, visual artworks, films, documentaries, theatre plays) can help students imagine these scenarios, as well as step into someone else's shoes. Further effects are achieved if students are asked to create their projects that would address environmental issues and create empathy. For example, in our sustainability and environmental justice classes students create theatre of oppressed plays to showcase an environmental injustice case, as well as to enact a solution—bring a justice to the presented case. In another type of group art project, our students are given (or are asked to choose) an environmental problem site (such as polluted river or land, or an abandoned or otherwise non-environmentally sustainable building or structure) and are assigned to create ecologically sustainable remediation of this site, achieving the justice (and feeling of empathy) for not only human, but also non-human nature. On the other hand, in some individual artistic assignments students create their understanding of their connection to environmental problems. In one of these assignments, fashion footprint assignment students are asked to look at the labels of their clothing and accessories, and then create an environmental map based on that data and their research on various environmental injustices caused by the fashion industry, while at the other consumption self-portrait type of assignment students keep a written, photo, or video journal of all items he/she throw in trash in several days or weeks, and then create a visual display of the collected data—of their waste (in any artistic media chosen by students, such as video, poster, drawing, poetry, sculpture, or photo-installation). Learning by teaching (LbT) technique is then applied in our art projects assignment where students are asked to bring environmental problem awareness to the audience (in an ephemeral public art installation, and interactive public art installation proposal) and showcase sustainable solution (in eco-fashion show).

It is not accidental that newly developed course on eco-art and design is very popular among our students and it is gaining in popularity. This interdisciplinary course introduces students to various ways artist and designers (including architects) deal with global environmental challenges and asks students to create their art as part of an engaged cultural dialogue. Already in the third semester, the enrollment for this course reached the maximum. The fourth semester the course was offered online for the first time and right away reached the maximum, which was retained in all subsequent semesters. Due to students' interest, the course now runs four semesters a year with the continuous maximum enrollment.

6.5 Meta-Cognition, Awareness, and Assessment

We employed the New Environmental/Ecological Paradigm – Revised instrument (Dunlap and Van Liere 1978; Dunlap 2008) as a self-assessment pre and post course since it is well established. The instrument consists of 15 questions with no correct answers that can be used to score the degree the participant has the NEP-R viewpoint. Most students show an increase in total score pre and post, indicating a shift in values and attitudes. Ordinarily we do not expect to see larger shifts in values and attitudes in a single class but aim to do so in a program or degree. The changes were not large, but what was most interesting is the student reflection on what questions students changed their responses and why. In addition, what was interesting was students understanding of the wide range of values and attitudes in their classmates by comparing their responses with others.

This is a learning outcome we aim for, an awareness and understanding of one's own values, others, and societal values. This is also taught in climate/sustainability communications directly, but it has greater impact when students become aware of it though the NEP-R. This stimulates further reflection on differences students had on Discussion Board and class discussion. Of interest is the few students that had a decline in score (one to three students per class). A common reflection in these cases was that the students didn't know how they felt about an answer before class, or that they were trying to give the answer expected or wanted by the instructor pre but had more confidence in expressing their values post. Some students critique some of the questions posing dichotomies, since they felt the issues to be more complex. Overall, most students respond that they are aware of their values and others', achieving our meta-cognitive objective.

We are looking for other instruments to supplement the NEP-R that are more consistent with the virtues of the three ethics of care for self, others, the environment and knowledge discussed earlier (Ruppert et al. 2018; Russell and Bell 1996 ; Gilligan 1977, 1993). Ounvichit (2017) reports an instrument her team developed that circumvents the pitfalls of the dualist opposition of anthropocentric vs ecocentric of the NEP assessment with an instrument that assesses three prongs of egocentric (self and family), homocentric (human), and ecocentric ethics, where one does not diminish the other. Ounvichit's case study (2017) found:

> [T]he 11 children who demonstrated ethical development engaged more in the higher-order thinking while the other four did not. The four children who could touch on the ecocentric level were keener about summarizing their knowledge for presentation. Understanding the relation between the thinking patterns and the ethical development tendencies helped environmental educationists understand the value of embedding thinking skills in arranging constructivist environmental education.

The Yale Program on Climate Change Communication (2019) developed an open source instrument that categorizes participants into the "Six Americas" of climate change perspectives that they have developed with extensive surveys and analysis and have distilled from 36 questions to 4 questions (SASSY! The six Americas super short survey 2019). Most students reported to the instructor the top two levels of concern for global warming. These results were not aligned with their NEP-R results, suggesting their responses were influenced by what they expect the instructor or society wants them to be. Subsequently the SASSY! self-assessment was given and reported anonymously which resulted in a greater range of results. The instrument has the value of self-awareness and societal awareness, as students try to figure out why they are in the category they were assigned, and see themselves relative to others in society, and understand the diverse points of view. Some students noted that they were not in the alarmed category because although they were concerned about global warming, they realized they have not acted on global warming through their own behavior. This was a wakeup call to personally become more politically active. Requiring an action assignment that has an impact outside of class provides students the opportunity to act and share with the class their experience. The SASSY! (2019) self-assessment helps provide the self-awareness and motivation to act. In a number of students' final reflection essays, they recommended the last class to be devoted on what can they do about climate change, sustainability, and environmental justice. One student lobbied the class to do a class action, like a sit in at a bank that funds fossil fuel.

The Sustainability Literacy Test (SuLiTest 2016, Décamps et al. 2017) of the Higher Education Sustainability Initiative (HESI) is a UN SDG partner and a work in progress. On the individual student level its greatest value is as a learning instrument of the wide scope of sustainability. When students get the wrong answer, they are shown the "expected" answer with an explanation and a reference. On the course level, the pre and post scores are important for benchmarking and see the gains in overall score. But what is most significant is the change pre and post of three different types of students, the students that score highest and lowest in pre-course assessment, and the students that have the greatest gains. The reflection essays provide the

instructor with the self-understanding of the scores of the students. Generally, the students with the higher scores do not change as much as others. Only one or two students with low scores pre have similar low scores post.

One interesting case is a student who was disappointed to receive a B minus on a final multiple choice test (from the publisher's test bank) after receiving the same grade on an online test bank. The instructor was surprised too, as she did extremely well on a team video project, interviews of participants in a March for Science, demonstrating she met many of the learning objectives and competencies of the course. However, she had a 37% increase in her SuLiTest score, indicating she had learned a lot in the course. The instructor noticed there were quite a few B climate science students that did not change much on conceptual knowledge evaluation from midterm and final but did on the SuLiTest. This was surprising, since, although the climate science students were exposed to a few SDGS, the SuLiTest has very few science questions. However, the gains in sustainability competencies evident in their projects and reflection essays must have provided the intuition to have more correct answers on the SuLiTest.

Many students had a similar critical appraisal as the instructor, that the SuLiTest asks too specific subdomain data questions, and not enough key concept or science questions. This is an impression some of the authors also had from taking the SuLiTest themselves. This is perhaps a problem with the validity of the SuLiTest, and/or the large scope of sustainability.

The results for the competencies and SDGs were erratic—in many cases going down while others went up. This implies the total score is more accurate than the breakdown. For instance, a breakdown category may have one to four questions per test. This is too small of a sample to assess a breakdown category for an individual student. This results in puzzlement of many students in their final reflection essay; they can't understand how they declined in a particular area. The class averages have all increased from pre to post, indicating progress is being made, but we are not confident that differences between classes on the SuLiTest are significant at the limited scope of our implementation.

We conclude that the SuLiTest is useful for students to discover what they know and what they don't know but has shortcomings for assessing individual student progress.

We find that conscious use of assignments that draw upon all of the competencies will reveal student accomplishments in the course and program. Quantitative instruments are like models, all are wrong, but some are useful.

6.6 Conclusion

We find that a focus on sustainability competencies in the curriculum design elicits best practices and works well with teaching the sustainable development goals. Place-based teaching and case studies are effective methods to connect all the dots and make practical sense of the complex sustainability challenges we face. Sustainability programs and professional development workshops will benefit from a comprehensive use of the key competencies with the sustainable development goals.

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7 Role of Higher Education Institutions in the Implementation of Sustainable Development Goals

Leocadia Zhou, Norman Rudhumbu, Jenny Shumba, and Abiodun Olumide

7.1 Introduction

The complex and interconnected nature of challenges facing society today is evidence enough that a multidimensional approach that puts education at the centre is desirable to solve them. Evidence shows that education contributes to improved livelihoods, rapid economic development, better health outcomes, reductions in gender inequities, strengthened support for democracy, and greater concern for the environment among other contributions (Organisation for Economic Co-operation and Development, OECD 2016; United Nations Educational, Scientific and Cultural Organisation [UNESCO] 2014, 2016). In the same vein, affirmed that sustainable development cannot be achieved anywhere in the world "without the capacity-building contribution of an innovative higher education system", hence, some of the cogent roles of the universities are to build human capital targeted at socio-economic development, poverty eradication, institution of good governance, and the building of more equitable societies to ensure the maintenance of peace and stability. Even the United Nations (UN) Agenda 2030 recognises that certain sustainable development goals (SDGs) can be better achieved through the intervention of universities. The acknowledgement of the centrality of education in the achievement of SDGs by the UN therefore places huge responsibility on African higher education institutions (HEIs) with regard to how they can more effectively contribute to sustainable development to ensure achievement of SDGs (Albareda-Tiana et al. 2018a, b; Tandon 2017; Grau et al. 2017). Several authorities also recognise the potential role of HEIs in supporting the SDGs initiative. El-Jardali et al. (2018a, b) assert that HEIs are uniquely placed to lead the cross-sectional implementation of SDGs as articulated in the UN Agenda 2030 since they are the ones that provide an invaluable source of expertise in research and teaching. Supporting the above assertion, Junyent et al. (2018: 20) aver that, "it is historically acknowledged that universities have played a critical role in leading the social transformation in communities through scientific research, creation of innovative solutions, and the education of intellectuals".

L. Zhou (✉)
Risk and Vulnerability Science Centre, University of Fort Hare, Alice, South Africa
e-mail: lzhou@ufh.ac.za

N. Rudhumbu
Faculty of Science Education, Bindura University of Science Education, Bindura, Zimbabwe
e-mail: nrudhumbu@buse.ac.zw

J. Shumba
University of Fort Hare, Fort Hare, South Africa
e-mail: Jshumba@ufh.ac.za

A. Olumide
Department of Educational Management, University of Ibadan, Nigeria, Ibadan, Nigeria

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The above therefore means that universities and all other HEIs have the capacity to generate, interpret and disseminate relevant knowledge that can assist in the achievement of SDGs especially if they are able to first translate SDGs into measurable and specific targets through the matching of academic capital with public policy priorities in their countries and developing relevant knowledge and skills in community members. While the process of integrating SDGs into the structures and operations of HEIs has been rather painstakingly slow, it still goes without saying that HEIs are key change agents in the transformation of the world into a better and sustainable world as articulated by Koester (2013) and Tilbury (2013). The overall role of HEIs therefore, and as explained by, should be to educate game changers of the future to be able to function in key positions in building a more sustainable world. In Zimbabwe for example, the government has supported HEIs by encouraging them to review current curriculum as well as develop new ones in order to capture and integrate issues of sustainability in the teaching and learning processes as well as in research (Mapira 2014, 2017). Similarly, in South Africa good practices are noted through the introduction of the South African Research Chairs initiative (SARChI) and Centres of Excellence (CoEs) in HEIs.

7.2 Literature Review

Quality HE should lead to sustainable development, that is, should result in the development of a society that meets the needs of the present without compromising the ability of the future generations to meet their own needs too (Nevin 2008). This conceptualisation of sustainable development therefore acknowledges that while development may be and is necessary to meet human needs and to improve the quality of life, it must proceed without depleting the capacity of the natural environment to meet present and future needs (Nevin 2008; UNESCO 2017a, b; Vilalta et al. 2018). This therefore means that HE should be provided in a manner that prioritises effective management of the natural environment to be able to ensure the maintenance of a delicate balance between current and future needs.

SDGs, therefore, provide an ethos for HE to re-invent itself and to rethink teaching, research and community engagement. Part of this re-invention relates to HEIs using strategies that promote the following sustainable development activities:

- Developing a high quality, diverse yet integrated curriculum with programmes that are professionally strong, academically rigorous, morally sound and relevant to the needs of society
- Building educational institutions that "speak", breed and demonstrate innovations and knowledge for addressing challenges faced by society as well as adequately prepare populations to cope with globalisation-related challenges
- Empowering students to become critical, ethical and reflective citizens who possess the ability to evaluate situations and make evidence-based decisions.

According to Vilalta et al. (2018), for every citizen to be able to actively participate in the implementation of SDGs, a certain level of skills, values, knowledge, and attitudes needs to be fostered hence the importance of HE. Strategies which HEIs can therefore use to support SDGs which are shown in Fig. 7.1 and discussed in the section that follows include research, education, governance and operations, and public engagement (partnerships and collaborations).

7.3 Strategies of Integrating SDGs into Higher Education

There are several strategies, which universities can use to ingrain SDGs into practice. Such strategies according to Albareda-Tiana et al. (2018a, b) call for a paradigm shift in education and this shift requires not only transforming institutional responsibility but also curriculum and research re-orientation to be able to better serve the needs of the current and future generations. The paradigm shift is highly possible because, according

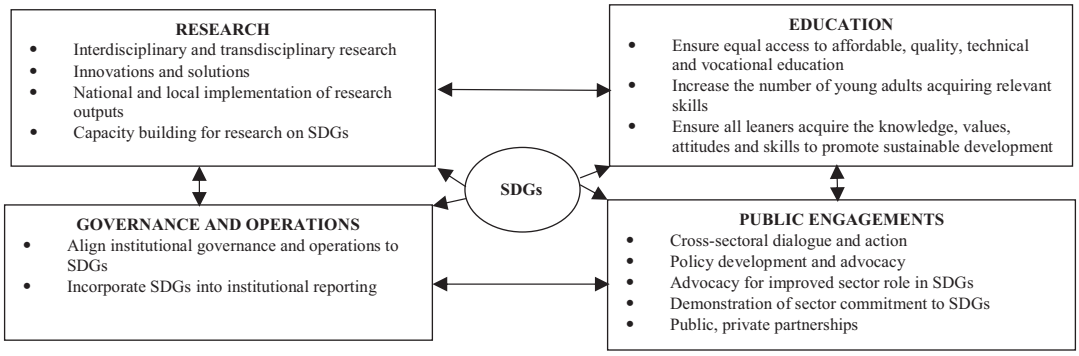

Fig. 7.1 SDG dimensions (Adapted from Hooey et al. 2015)

to Sustainable Development Solutions Network (SDSN) (2017), HEIs are in a unique position in societies because they are neutral and trusted by stakeholders and according to Vilalta et al. (2018), such a position allows them to promote and facilitate dialogues, and to create spaces for collaboration between and among multiple stakeholders. Figure 7.1 shows the four dimensions of SDGs and how they interact with each other to support effective implementation of SDGs. The success of the implementation of SDGs depends on the extent of interaction between and within the dimensions.

7.3.1 The Research Dimension

Through their extensive research capabilities and activities, HEIs have a critical role to play in providing the necessary knowledge, evidence base, solutions and innovations to support the achievement of SDGs (Galiay 2017). Through responsible research and innovation (RRI), the institutions can come up with well-researched frameworks that facilitate innovative teaching and effective institutional governance to support SDGs. RRI is premised on research integrity that highly prioritises research ethics (Hiney 2017; Lang 2017). Such a focus then means that all and any research activity puts the informants at the centre in terms of ensuring that all responses are accorded the highest confidentiality; fully informing the participants of their rights in a study and that they are at liberty to revoke their consent at any point of the study whenever they uncomfortable to continue participanting in the study. At any point of a study whenever they felt uncomfortable; and seeking informed consent from the individual participants of a study. The above is in line with the following four critical research principles as articulated by von Schomberg (2017):

- Involving end-users early on with regard to ensuring that participants to any research, right from the beginning, understand the research purpose, consent to it and are clear about their rights
- Choosing societal objectives together with stakeholders
- Opening access to research data for all stakeholders
- Opening ample access to research resources for all stakeholders

As organisations possess expertise, HEIs need to take a lead in facilitating inter-stakeholder dialogues and actions as well as, according to Vilalta et al. (2018), developing joint courses or participating in research groups with other HEIs locally and externally on issues related to sustainability and promoting capacity building in the area. Vilalta et al. (2018) also argue that through research spearheaded by HEIs, policy makers are in a position to make evidence-based decisions on issues related to sustainability leading to innovative solutions. Key themes that HEIs can thus lead in research on sustainable development for the advancement of SDGs include environmental

protection, poverty alleviation, citizenship, peace, ethics, responsibility, democracy and governance, human rights, gender equity, corporate responsibility, natural resources management and biological diversity (Nevin 2008; Nicolai and Aiazzi 2017). Engaging in research in such a wide range of sustainability-related topics will not only generate new and relevant knowledge but will also lead to better informed policy development as well as effective teaching on issues related to sustainable development.

As already alluded to earlier, research, particularly responsible research and innovation, is critical for the achievement of SDGs. Through analysing and identifying policy inconsistencies, research by HEIs contributes to the enhancement of the understanding of interconnections of SDGs leading to the development of metrics that promote their effective implementation as well as the effective monitoring of the implementation process (Griggs et al. 2017).

7.3.2 Education

Besides providing students with the much-needed knowledge and skills, education orients students to be able to understand their responsibilities in society enabling them to deal with the complex and connected contemporary challenges. As such education should be transformative to develop students who demonstrate critical and creative thinking within and between the traditional academic disciplines to enable interdisciplinary learning for change (Junyent et al. 2018). Through quality teaching, education should be able to produce graduates that are change agents and that can successfully contribute to the improvement of their communities in either their personal and professional capacities or both. A shift therefore from confirmative learning to transformative learning is needed and this will involve institutional willingness to change. Transformative learning is characterised by the use of participatory pedagogies that promote critical thinking and critical self-reflection that ultimately lead to transformed modes of thinking, behaviour and actions. Identify two types of critical reflective thinking as content reflection and process reflection. Content reflection relates to reflection done on the content or knowledge that students acquire with regard to whether it develops them into critical thinkers who can act as future sustainability leaders.

Process reflection on the other hand relates to reflecting on whether the methodology is a participatory one such as problem-solving methods which develop critical thinkers. The above is in line with the assertion of Leal Filho et al. (2017) who argued that developing critical skills in students is a strategic role of HEIs for promoting sustainable development. Hence, according to HEIs should begin to operate as knowledge and reflection institutions that develop critical thinkers and not just to act as teaching institutions that transfer knowledge. The above then means that transformative learning is a learning process that motivates learners to critically reflect and question their assumptions and beliefs focused on a sustainable future.

There are many other strategies that can be used to ensure education supports SDGs. Among such strategies is open and distance learning to ensure that education is accessible to all wherever they are. This approach casts the net much wider for those requiring more knowledge and skills to support the implementation of SDGs. Lane (2017a, b) argues that open education is an important contributor to the achievement of SDGs as it ensures equitable and quality education to be accessed by all, thus promoting lifelong learning opportunities for all. Other studies show that in a well-established, properly regulated HE system that is supported by technology, open educational resources (OERs) and distance education modalities can increase access, equity, quality and relevance of education as well as narrow the gap between what is taught in HEIs and what economies and societies demand (Gookol-Ramdoo and Rumjaun 2016; OECD 2016). Making relevant education more accessible therefore reduces the skills gap and leads to the achievement of the SDGs.

7.3.3 Governance and Operations

Incorporation of principles of SDGs into institutional governance, operations and the general institutional culture is critical for the realisation of SDGs in HEIs. For SDGs to be realised through institutions effort, they must first be part of the institution's culture so that each member of the institution feels part of them and demonstrates them in all the activities and processes of the institution. This means that sustainable development should then be viewed as an institutional commitment reflected in institutional management, the curriculum and its implementation, research and extension services (Junyent et al. 2018). Another critical element of institutional governance that supports SDGs is ensuring that the issue of sustainability does not become a preserve for a few members but should permeate all corners of the institution and be the responsibility of all the member of an institution. This, according to Johnsen (2018) and also Junyent et al. (2018), means that sustainable development should be the heartbeat of institutional culture and should be supported by and resonate with institutional policies.

7.3.4 Public Engagements

El-Jardali et al. (2018a, b) argue that SDGs provide HEIs a unique opportunity to re-interpret institutional strategies and determine structures and mechanisms needed for strengthening engagements between HEIs, governments and communities. One such mechanism is public engagements through research partnerships and collaborations. Strengthened partnerships and collaborations of universities with governments and communities are key to the achievement of SDGs as they have potential of contributing to the solutions of cross-sectoral challenges facing society (Jha et al. 2016; Van Tulder et al. 2016). By establishing partnerships and collaborations and by clearly defining areas of collaborations, HEIs can contribute to knowledge and skills transfer as well as contribute to the provision of sustainability services to society. Collaborations allow for and cultivate a symbiotic relationship between collaborators and allow groups and individuals to learn and mutually benefit from each other. This assertion is also supported by Turner and El-Jardali (2017) who argue that by assuming a collaborative approach, HEIs and other critical partners will enhance opportunities for exchange and integration of knowledge and skills between them leading to the achievement of SDGs. In this collaborative context, communities, industry and other partners stand to benefit from the academic expertise of HEIs while HEIs in turn can also benefit from the practical knowledge and technical expertise of other partners. Through collaboration, and as experts, HEIs can also facilitate dialogue across multiple actors (government, private sector, academic and scientific community, civil societies and the public), presenting a platform to come up with better informed and politically supported decisions about how to support SDGs. This, according to Greenhalgh et al. (2016), will lead to knowledge co-production and co-creation which in turn may result in increased societal impact in the solution of the complex twenty-first century challenges.

7.4 Implementation of SDGs in Different Countries

7.4.1 Good Practices in the Implementation of SDGs in Zimbabwe

In the context of Zimbabwe, issues of sustainable development as a means of supporting the successful implementation of SDGs has been embraced through various approaches (Mapira 2014, 2017; Zimbabwe Broadcasting Corporation 2018; BOOST Fellowship 2019; UNESCO 2017a, b; Climate Adaptation UNDP 2016). According to Mapira (2014, 2017), one approach in which issues of sustainability in universities have been embraced is through the teaching of environmental education at undergraduate level. A number of universities in Zimbabwe that include Great Zimbabwe University, Midlands State University, University of Zimbabwe and

Bindura University of Science Education teach environmental education at the undergraduate level.

Another approach which HEIs in Zimbabwe use to support the implementation of SDGs has been through partnerships with business leaders and students to form what is called Enactus Zimbabwe (BOOST Fellowship 2019). Enactus Zimbabwe is a grouping of academics, students and business leaders for the purpose of forming teams in university campuses to create and implement community sustainability projects as three-year cycle initiatives. These projects are meant to empower communities while at the same time developing students' skills and perspectives to become effective value-driven leaders. According to BOOST Fellowship (2019), the Africa University, Bindura University of Science Education, Chinhoyi University of Technology, Great Zimbabwe University, Harare Institute of Technology, Midlands State University, National University of Science and Technology, Solusi University, University of Zimbabwe, Women University Africa and Zimbabwe Ezekiel Guti University have been partnering Enactus Zimbabwe to transform lives and shape a better and more sustainable world through the use of entrepreneurial projects. Most of these universities have been in the Enactus Zimbabwe since 2004. Most of the community sustainability projects target both SDGs and prevailing community challenges facing Zimbabweans that include unemployment, women empowerment, poverty, climate change and environment degradation (BOOST Fellowship 2019).

The third commonly used approach by HEIs to supporting the implementation of SDGs is advocacy through the participation of students in sustainable development forums (UNESCO 2017a, b; Zimbabwe Broadcasting Corporation 2018). In 2016, the United Nations Association of Zimbabwe (ZUNA) organised a United Nations (UN) universities meeting whose theme was: Implementing the transformative agenda 2030. The purpose of this meeting of Zimbabwe university students was to increase youths' participation and awareness of the work of the UN in Zimbabwe with regard to the implementation of SDGs. This initiative provided university students with an opportunity to be able to lead sustainability activities in communities and at national level. In 2018, HEIs supported students from Zimbabwe to attend a youth summit in Accra, Ghana whose theme was peer learning, circle of networks, partnerships and international SDGs solidarity (Zimbabwe Broadcasting Corporation 2018). This summit enabled Zimbabwean students to network and learn from their peers from other universities across Africa on how to support the implementation of SDGs.

The fourth commonly used approach by Zimbabwean HEIs to support the implementation of SDGs is partnership with civil society organisations (CSOs) (Climate Adaptation UNDP 2016). Universities in Zimbabwe benefit from partnering with CSOs by taping on these organisations' expertise on local knowledge and their deep connection with local people in the implementation of SDGs. One of the Zimbabwean universities, the University of Zimbabwe has been in partnership with a CSO, Oxfam since 2014. The purpose of this partnership has been to scale up climate change adaptation measures and reduce the vulnerability of rural communities especially women to the impacts of natural disasters (Climate Adaptation UNDP 2016).

One major issue that has been affecting effective implementation of sustainable development programmes in HEIs in Zimbabwe is the lack of capacity. To this end, the Voluntary National Review (2017) shows that there had been intervention by the United Nations through the Zimbabwe United Nations Association (ZUNA) to capacitate both HEIs staff and students on how to actively implement SDGs. To date 300 students and many lecturers have been trained through the SDGs lecture series for universities programme. In 2018, the University of Zimbabwe and the European Union went into partnership to introduce a master's programme in renewable energy.

7.4.2 Good Practices in the Implementation of SDGs in South Africa

In South Africa, there are institutions, centres and departments at various universities that mainstream SDG agendas. Examples of such institutions are presented in Table 7.1.

Table 7.1 HEI actors in the implementation of SDGs in South Africa and their activities

Actors/implementers	Activities
Research chairs	
Exxaro, UNISA	Undertaking SDG research on green building evolution, SDG7 to ensure access to affordable, reliable, sustainable modern energy. Scaling up SDGs implementation on emerging cases from state, development and private sectors,
Albert Luthuli Centre for responsible leadership (SDG hub) (University of Pretoria)	Linking policy makers with SDG relevant research and innovation (Fourie 2018)
University of Cape Town Spacelab Research Chair in the Department of Electrical Engineering	Examining ways in which space technologies can be harnessed to meet the SDGs in Africa. Identified food security as a theme that could be used to support the achievement of several SDGs, and have proposed the development of a Space-based Agricultural Information and Monitoring System for Africa (SAIMSA)
Department of Science and Technology (DS)/ National Research Foundation (NRF) SARChl chair in mineral beneficiation UCT	Discussing the mining atlas, Mapping mining to the sustainable development goals: a preliminary atlas was conceived as a joint project and developed by the Columbia Centre on Sustainable Investment (CCSI), the UN Sustainable Development Solutions Network (SDSN), the United Nations Development Programme (UNDP) and the World Economic Forum (WEF). A draft was issued for public consultation in January 2016

Source: Author

7.4.3 Good Practices in the Implementation of SDGs in Nigeria

Nigerian universities are part of gap analysis on each SDG, members of the National Committee on SDGs, part of leadership of the research component of the implementation strategies and part of implementing SDGs in each of the 36 states and at institutional level (Okebukola 2017). Table 7.2 shows actors in the implementation of SDGs in Nigeria and some of their activities in mainstreaming SDGs.

7.5 Challenges in the Integration of SDGs in HE

The integration of SDGs into HEIs comes with challenges. Tandon (2017) is of the view that the achievement of SDGs depends on the revisiting of the curriculum and pedagogy of teaching in HEIs in order to ensure that all programmes and courses can successfully integrate sustainable development. The biggest challenge HEIs face in the implementation of SDGs is the disciplinary rigidity in these institutions. Matching the SDGs into single disciplines is difficult (Tandon 2017). In many HEIs, programmes are populated with courses that lecturers jealously guard and would not allow them to be removed in favour of courses in sustainability. As a result, the only option in many of the HEIs is coming up with

Table 7.2 HEI actors in the implementation of SDGs in Nigeria and their activities

Actors/implementers	Activities
Smart city strategy and SDGs for building construction framework in Lagos (Department of Architecture and Department of Building, University of Lagos)	Studies on smart city strategies for innovative, sustainable building constructions in Lagos.
University of Ibadan Centre for Sustainable Development	Unveiled gigantic communication flex supporting tool to inform the university and public at large

Source: Authors

parallel programmes which deal with issues of sustainability. For example, programmes such as environmental education, and others could be appropriate parallel programmes. However, instead of coming up with new programmes, HEIs could instead come up with a flexible, transdisciplinary approach for effective implementation of SDGs.

The second challenge relates to current pedagogy in use in many HEIs which is teacher-centred and does not allow for critical thinking. Classroom-based teaching is viewed as being inadequate for achieving SDGs. A different kind of learner-centred hands-on approach called engaged teaching is preferable for the effective implementation of SDGs. Tandon (2018) argues that using the engaged teaching approach is important in that concepts, theories and principles are learnt through direct application and interpretation. As an example, in an environment where there is limited water, students and faculty can work together with members of the community and other experts about various practices, strategies and policies of water harvesting, storage, distribution and pricing instead of only theorising in the classroom.

The third challenge in the effective implementation of SDGs includes lack of institutional management support on initiatives that may have ramifications on issues of resource allocation and time. The Global University Network for Innovation, GUNi, the International Association of Universities, IAU and the Association of African Universities, AAU (2011) reported that most institutions did not receive any economic, material and infrastructure support for sustainable development projects or activities. The report showed that there was no relationship between size of institution and the amount of funds allocated for sustainability activities. Funding for sustainability initiatives in big and small institutions ranged from as low as less than $20,000 to over $200,000 per year. These funds were received mainly from development partners and foundations, governments, private sector and university internally generated funds.

The fourth challenge according to Okebukola (2018) includes lack of staff trained in sustainability-related issues. Lack of integration of sustainability in traditional education disciplines in HEI contributes to the paucity of trained staff and is thus a factor in the limited detailed implementation of SDGs. For instance, GUNi, IAU and AAU (2011) made known that only 26% of institutions offer specific sustainable development degree programmes meaning the majority, 72% do not, and the rest do not even have information about the course. The human resource shortages are due to poor working conditions, poor salaries, lack of academic freedom and other related issues (NEPAD 2005). Staff development in the area of sustainability is still lagging among sustainability practices in universities. This is why in the context of Zimbabwe the United Nations has had to intervene with training called SDG lecture series in universities. The fifth challenge affecting effective implementation of SDGs in HEIs is lack of modern technology which militates against effective and efficient communication and knowledge sharing.

7.6 Conclusions

Mainstreaming the SDGs in the modus operandi of all university activities is important for their entrenchment and related developments. To this end, firstly, there is the need for awareness of what SDGs mean for and to the lecturers, students, researchers and all beneficiaries of products of higher education, so as to create room for acceptance of the SDGs, their goals and all they entail.

Second, institutions of higher education need to create a learning hub specifically meant to house all activities of the SDGs.

Each faculty and department should review its curriculum, to include the learning of SDGs in both the undergraduate and postgraduate course/programmes. In this way, students would be exposed to the rudiments of SDGs, thereby generating the attention the SDGs need for enhanced implementation. This curriculum reform has to be part of larger efforts seeking to change the focus in African universities. HEIs need to consider how sustainability gets incorporated into what and how they teach and research and engage

with communities. Various workshops and seminars have to be organised in order to make the public be aware of what SDGs are all about. Such a process is underway at Stellenbosch University in South Africa, with 254 projects identified that relate to the UN's lofty goals.

There is need for collaboration between various institutions of higher learning of the developing and developed countries, so that each can gain from how far everyone had gone at embracing SDGs. Members of institutions of higher learning should be funded by their institutions to attend foreign conferences that deal with SDGs around the world. Clubs that would promote SDGs should be established by the students, under the direction of academic staff members in the institutions of higher learning.

There are many opportunities for universities to collaborate on teaching, research and information exchange and dissemination. This should be done through well-supported, coordinated academic networks that incorporate public and private partners throughout the continent—and beyond.

It has also been argued that researchers based in Africa have traditionally had relatively limited contact with their colleagues elsewhere on the continent. This probably is partly because of colonialism: universities tended to maintain contact with their former colonial nations after independence but are slow to build relationships with their peers in Africa. There has been some progress in addressing this imbalance, as illustrated most recently by the formation in March 2015 of the African Research Universities Alliance in Senegal. This is a network of 15 leading higher education institutions from eight African countries. Its goal is to train research managers as well as promoting cooperation between universities when it comes to research.

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8 Role of Universities Towards Achieving Climate Change-Related SDGs: Case of Chinhoyi University of Technology, Zimbabwe

Olga L. Kupika, Alexio Mbereko, and Varaidzo Chinokwetu

8.1 Introduction

The Intergovernmental Panel on Climate Change (IPCC) acknowledges that climate change is a global challenge whose management requires collaboration and an integrated approach with efforts from different sectors of society (IPCC 2018). We will argue in this chapter that African institutions of higher education, particularly universities can contribute immensely to the achievement of the United Nations landmark 2030 agenda and its 17 Sustainable Development Goals—the SDGs. Universities contribute directly to Goal 13 which specifies the need to, 'Take urgent action to combat climate change and its impacts' (United Nations 2015). Universities play their role through engaging in various activities in the search for regional and local solutions to impacts of climate change (Filho 2010). Such actions include research, raising awareness and understanding of climate change amongst their students and stakeholders and the dissemination of relevant information.

The American College and University Presidents Climate Commitment (ACUPCC 2018) noted that higher education institutions have a critical role to play in preparing society to adapt to the impacts of climate disruption by providing research and education around adaptation strategies and science. In the USA, leading universities have developed a suite of common energy-efficiency and renewable generation strategies aimed at energy use-reduction and achieving climate action plans (Van Otto et al. 2018). To reach these goals, Mazhar et al. (2019) reiterated that academic institutions and think tanks are uniquely placed to broken links between different sectors and assist with cross-cutting approaches to achieving the climate change-related sustainable development goals. This is achieved through helping educate the next generation to be critical thinkers and leaders on issues of sustainability and climate change (Council of Ontario Universities 2017). Universities in the West have contributed immensely to climate change research and in bringing the problems associated with it to the fore (ibid). Universities in Africa have also started engaging with climate change research especially in the last two decades. However, such research and dissemination efforts are affected

O. L. Kupika (✉)
School of Wildlife Ecology and Conservation, Chinhoyi University of Technology, Chinhoyi, Zimbabwe

A. Mbereko
Faculty of Social Sciences and Gender Transformative Sciences, The Women's University in Africa, Harare, Zimbabwe

V. Chinokwetu
Institute of Lifelong Learning and Development Studies, Chinhoyi University of Technology, Chinhoyi, Zimbabwe

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by limited financial resources and a fragmented approach to development initiatives (Filho 2010). Thus, it is crucial to assess the current and potential contribution of universities to the attainment of the Sustainable Development Goals 13. This is important to guide the allocation and use of resources in this space. To attain this goal, the following objectives have been proposed:

13.a Implement the commitment undertaken by developed country Parties to the UNFCCC to a goal of mobilizing jointly USD100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible.
13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in Zimbabwe.
13.2 Integrate climate change measures into national policies, strategies, and planning.
13.3 improve education, awareness raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning.
13.b Promote mechanisms for raising capacities for effective climate change-related planning and management, in LDCs, including focusing on women, youth, local and marginalized communities.
13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
13.2 Integrate climate change measures into national policies, strategies, and planning (Source: United Nations 2015).

In this chapter, we use the case study of Chinhoyi University of Technology to critique the contributions of universities towards the achievement of SDG 13.

Close cooperation between universities, municipalities, and the state has been documented in the western world (Knuth et al. 2007). Such cooperation has yielded different successes. For example, The International Climate Change Information Programme (ICCIP) of the Hamburg University of Applied Sciences coordinates various initiatives for cooperation with universities interested on matters related to climate change (Filho 2010). Higher Education Institutions in the United Kingdom (UK) also engage in various climate change mitigation programmes such as the universities' carbon management plans (CMPs) with key elements of carbon management planning such as senior management leadership training, carbon foot printing, carbon reduction targets, stakeholder engagement, funding and resources, governance and evaluation and reporting (Lemons 2011; Knuth et al. 2007). In the USA, universities are poised to play a key role in grassroots effort by targeting their own emissions and by working with other local actors to develop climate change mitigation programmes (ibid). Researchers at the Pennsylvania State University have collaborated with university administrators and personnel to inventory campus emissions and develop mitigation strategies (Knuth et al. 2007). However, even though many universities all around the world are undertaking notable efforts in tackling the challenges posed by climate change, few such works are widely documented and disseminated.

Climate change is anticipated to have and is already having negative impacts on developing countries (IPCC 2018). Its biophysical impacts include severe water shortages, increased frequency of extreme weather events such as droughts, floods, leading to incidents of loss and damage of life and infrastructure (Sango and Nhamo 2015). The impacts of loss and damage are leading to negative consequences for the economies of many states, including shrinking public budgets, decreased availability of finances, negative impacts on industries such as agro-based industries and tourism, as well as negative impacts on livelihoods, leading to low resilience. Given the severity of these impacts, it would be reasonable to assume an obvious increase in the magnitude and scope of research on climate change and its impacts.

Climate change has exacerbated the risk of environmental disasters in vulnerable communities and ecosystems. African societies are more susceptible to climate change perturbations because of chronic poverty, poor infrastructure,

low levels of education, and this has necessitated the development of research on community needs and their capacity to adapt. To date, climate change research in universities has focused on theoretical and empirical study on barriers which hinder the handling of matters related to climate change at institutions of higher education (IHEs) (Filho et al. 2019) across the globe. This chapter focuses on the contributions of CUT to the climate change agenda, by placing the institution in a broader context. Literature demonstrates that universities can be key players in climate change governance networks enlisting stakeholders across different scales and spheres—public, private, and civil society (Bulkeley and Betsill 2005; Shackley and Deanwood 2002). African universities have tended to limit their contributions to classroom education, dissertations studies, and participating in several local and international workshops, seminars, and conferences (Sanni et al. 2010). Such events and activities promote visibility, networking for students and disseminate of information, African universities continue to broaden their influence through strategic partnerships as in the case of western universities presented above. Such exposure also builds capacity for early career researchers who get the opportunity to learn, partner, and collaborate on issues related to climate change science, adaptation, and mitigation.

Ryan et al. (2018) identified five broad approaches which universities can adopt towards incorporating climate change issues in their curriculum. The approaches focus on teaching, research, community engagement, innovation, and industrialization as follows:

- Focused Degree Programmes: degrees focused specifically on teaching the complex problems and solutions to climate change.
- Focused Researched Centres: research centres dedicated to understanding and solving the complex problems the world faces as a result of climate change.
- Optional Modules and Extra Qualifications: additional learning which can be undertaken by both students and staff to understand climate change.
- University-wide Integrated Initiatives: integrating climate-change awareness in teaching across the whole higher education institute, reaching various disciplines and departments.
- Trans-university Integrated Initiatives: externally led integration of climate-change awareness into university teaching and collaboration between universities (adapted from Ryan et al. 2018).

Universities in the southern Africa region also operate within the framework of five pillars, that is, teaching, research, community engagement, innovation, and industrialization. Using a case study of the Chinhoyi University of Technology (CUT), this chapter highlights the extent to which universities in southern Africa incorporate the climate change agenda in their curriculum within the framework of the five pillars. The current higher education system in Zimbabwe operates under the 5.0 Education Strategy which is anchored on teaching, research, community engagement, innovation, and industrialization towards achieving the sustainable development. Thus, we predict that CUT as a university whose mandate is to promote technology, innovation, and wealth creation has the potential to contribute to achieving the climate change agenda. This can be achieved through providing innovative solutions which address climate change impacts thereby contributing towards SDG 13.

8.2 Methods of Data Collection

This chapter adopts the framework (with five pillars) proposed by Ryan et al. (2018) to explore on how the existing curriculum incorporates the SGDs agenda specifically SDG 13-related programmes at CUT, Zimbabwe. CUT's main campus is located within the town of Chinhoyi environs (17° 21' S, 30° 12' E) in Mashonaland West Province, northern Zimbabwe (Fig. 8.1). The town of Chinhoyi is in the Mashonaland West Province about 120 km north of Harare on the road to Lake Kariba and the Zimbabwe-Zambian border.

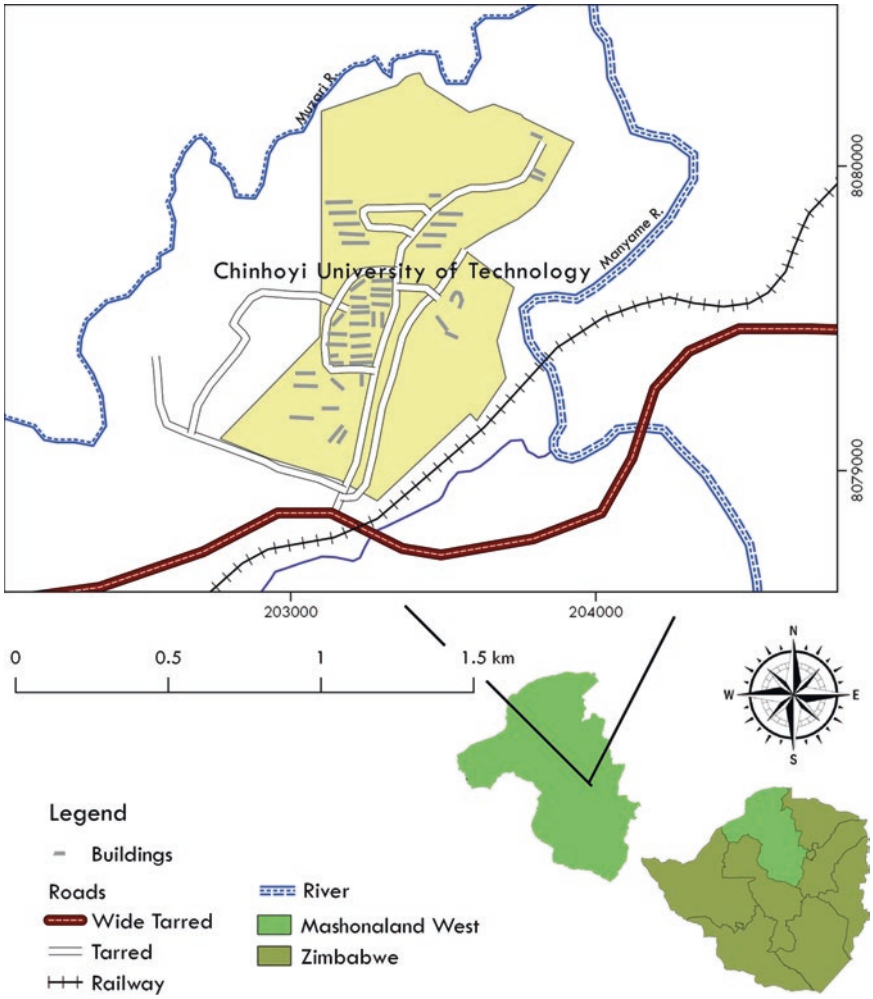

Fig. 8.1 Location of Chinhoyi University of Technology, Zimbabwe

CUT is an educational institution whose mandate is teaching, learning and research, community service, innovation, and industrialization.

The chapter is based on a documentary review (i.e. of academic literature and official records) content analysis of official records to analyse current undergraduate and postgraduate degree programmes offered as well as research projects done at CUT that incorporates climate change elements. Using key words related to climate change, extracts from the relevant undergraduate and postgraduate courses, the 2016–2020 Strategic Plan and the 2017 annual reports are examined and presented to demonstrate how they contribute towards SDG 13. This chapter also presents case studies of university research activities which promote climate change initiatives and collaboration on climate change-related issues. Secondary data from the education institutions' website was also a data source. This largely involved in an internet-based scoping of schools at CUT to gain a broad overview of what is being taught as it relates to climate change. Published journal articles that relate to climate change were reviewed and these were obtained from the Google Scholar, research gate, academia, and CUT Institutional Repository. Internet scholarly

search engines such as Google Scholar were used with inquiry guided by inputting the following words or phrases, 'CUT+ climate change', 'climate change & CUT', 'drought', and 'climate variability' to identify scholarly articles published by CUT academia. The CUT repository or database was also checked for articles on climate change issues covering the period 2015–2019. To ensure that the most appropriate documents were obtained, each document, especially the abstract or summary, was first scanned to check whether it covered the relevant issues following the preview, question, read, summarize (PQRS) system proposed by Cohen (1990). This system resulted in the review of documents on climate change science, impacts, adaptation, and mitigation. For records, following methods by Spellerberg (1998) and Brockington and Igoe (2006), the data collection concentrated mostly on original records or sources rather than reviews. Programme regulations and synopses, academic bulletins, and CUT Annual reports for the period 2014–2018 were also searched for key terms related to the climate change issues. Module synopses were downloaded from the CUT website and academic bulletins, respectively. Key terms such as climate change and global environmental change were used for the search. Data were collected between November 2018 and March 2019. Data analysis was done mainly through content analysis where academic programmes were examined for their content as stated in their module nomenclature and synopsis. The articles were eventually categorized based on themes as informed by literature. This was done to identify and analyse elements that covered or addressed topical climate change issues.

8.3 Findings and Discussion

The Chinhoyi University of Technology offers research-based degree programmes and community outreach programmes which contribute towards climate change adaptation and mitigation in Zimbabwe and Africa at large.

8.3.1 Climate Change-Focused Curriculum and Community Outreach Initiatives

CUT has various programmes with modules focused specifically on teaching the complex problems and solutions to climate change. Findings from the document search indicate that three schools out of seven, namely the Schools of Wildlife Ecology and Conservation, Agricultural Sciences and Technology, Engineering Sciences and Technology, and the Institute of Lifelong Learning and Development Studies offer programmes with modules focusing directly or indirectly on climate change-related elements. Overall, the modules focus on the nexus between climate change and sustainable development agenda thereby tackling climate change adaptation and mitigation issues. For instance, in the School of Wildlife Ecology and Conservation (SWEC), modules focus on climate change policy and governance issues, climate change and biodiversity management, impacts on wildlife resources as well as the adaptation and mitigation efforts in the wildlife and fisheries sector (Table 8.1).

The School of Agriculture Sciences and Technology (SAST) focuses on a wide variety of climate change niche areas including climate smart agriculture; farmer-oriented climate change information and extension services, climate resilience, improved food security (e.g. edible insects and indigenous fruits project), improved technologies, and cattle breeding (Table 8.1). Two undergraduate degree programmes out of six, incorporate elements related to climate change. The Bachelor of Science Honours degree in Agricultural Engineering (a 5-year full-time programme with specialization in either mechanization or irrigation) focuses on climate change as one of the key research thematic areas. Although some programme modules do no directly mention climate change, modules such as water resources cover aspects related to climate change. The Bachelor of Science (Hons) degree in Animal Production and Technology enhance students' knowledge on the nature and underlying causes of the most pressing environmental concerns,

Table 8.1 CUT programmes and modules with climate change elements and associated SDG 13 objectives and targets

School	Undergraduate and Postgraduate Courses	Modules with climate change elements	SDG 13 objectives and related Targets
School Of Wildlife, Ecology And Conservation	Bachelor of Science (Hons) degree in Freshwater and Fishery Science (4 years)	Climate change and aquatic ecosystem health	13.a Implement the commitment undertaken by developed country Parties to the UNFCCC to a goal of mobilizing jointly USD100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in Zimbabwe 13.2 Integrate climate change measures into national policies, strategies, and planning 13.3 Improve education, awareness raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning 13.b Promote mechanisms for raising capacities for effective climate change-related planning and management, in LDCs, including focusing on women, youth, local, and marginalized communities 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries 13.2 Integrate climate change measures into national policies, strategies, and planning 13.3 Improve education, awareness raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning
	Bachelor of Science (Hons) degree in Wildlife Ecology and Conservation (4 years)	Wildlife ecology, plant ecology, fundamentals of social ecology, principles of freshwater and fishery sciences; rangeland ecology restoration ecology, ethnobiology, protected area management; biodiversity conservation and sustainable development	
	Bachelor of Science (Hons) degree in Environmental Conservation and Geo-Informatics	Global environmental change	
	MSc in Biodiversity Conservation	Society and natural resources	
School Of Engineering Sciences And Technology	Bachelor of Engineering (Hons) degree in Production Engineering (5 years)	Water resources management	13.3 Improve education, awareness raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning
	Bachelor of Engineering (Hons) degree in Fuels and Energy (5 years)	Solar energy technology. Environment, energy, and sustainable development	

(continued)

Table 8.1 (continued)

School	Undergraduate and Postgraduate Courses	Modules with climate change elements	SDG 13 objectives and related Targets
School Of Agricultural Sciences And Technology	Bachelor of Science (Hons) degree in Animal Production and Technology (4 years)	Pasture, rangeland science and technology	13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in Zimbabwe 13.2 Integrate climate change measures into national policies, strategies, and planning 13.3 Improve education, awareness raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning 13.b Promote mechanisms for raising capacities for effective climate change-related planning and management, in LDCs, including focusing on women, youth, local, and marginalized communities 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries 13.2 Integrate climate change measures into national policies, strategies, and planning 13.3 Improve education, awareness raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning
	Bachelor of Science degree in Agricultural Engineering Honours with options in Mechanization and Irrigation (5 years)	Climate change	
	Bachelor of Science (Hons) degree in Food Science and Technology (4 years)		
	Bachelor of Science (Hons) degree in Biotechnology (4 years)		
	Bachelor of Science (Hons) degree in Environmental Science and Technology (4 years)		
	Bachelor of Science (Hons) in Crop Science and Technology (4 years)		
	Master of Science in Post Harvest Science and Technology		
School Of Hospitality And Tourism	Bachelor of Science (Hons) degree in Hospitality and Tourism (4 years)	Environmental management and sustainable development	13.b Promote mechanisms for raising capacities for effective climate change-related planning and management, in LDCs, including focusing on women, youth, local, and marginalized communities
	Bachelor of Science (Hons) degree in Travel and Recreation (4 years)	Sustainable recreation and environmental management	
Institute Of Life Long Learning	MSc Sustainable Technologies and Livelihoods		13.3 Improve education, awareness raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning

Source: Chinhoyi University of Technology (2015)

including an analysis of sustainable development, community-based natural resource management and climate change. The modules also cover climate change and adaptation issues (Table 8.1). SAST aims to enhance support for improved climate information and services to contribute to climate-sensitive planning in Zimbabwe. Considering that Zimbabwe as an agri-based economy, such efforts have the potential to contribute towards ensuring food security as well as institutional developments to manage potential threats from climate change.

Promoting sustainable livelihoods and technologies in the fight against climate change is a key niche area for the Institute of Lifelong Learning and Development Studies. The Master of Science (MSc) in Sustainable Technologies and Livelihoods programme offers a mix of

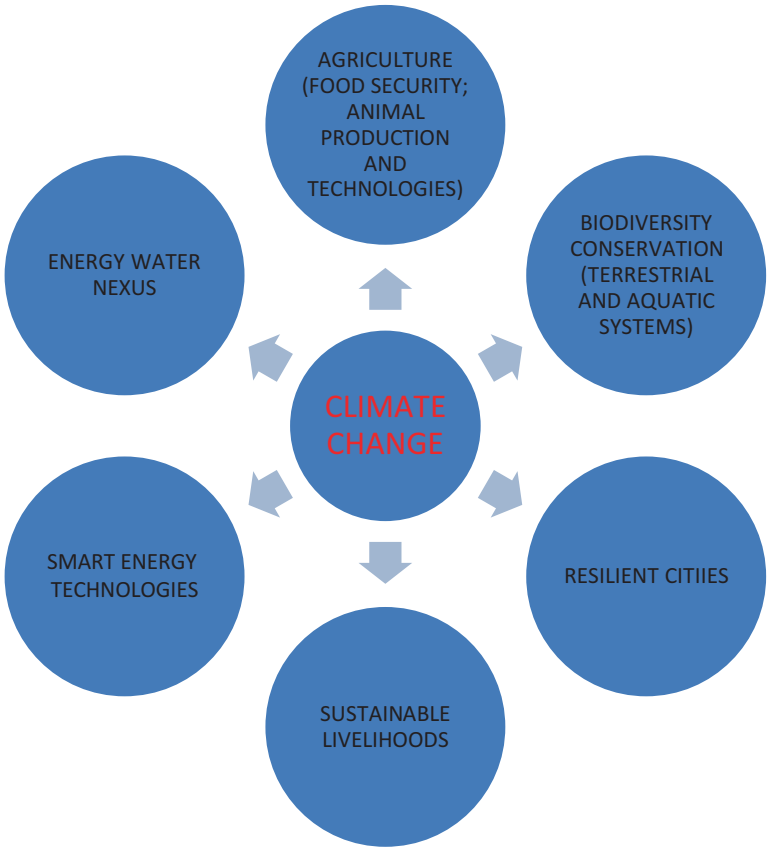

Fig. 8.2 CUT research thematic areas directly related to climate change (Source: adopted from Chinhoyi University of Technology (2017))

practical and theoretical learning on climate change, with a strong focus on indigenous adaptation technologies (Table 8.1). The programme has a unique opportunity for students to conduct research for their Master's thesis with the public, non-governmental organisations (NGOs), and private sector organizations in various parts of the country. However, at the undergraduate level, CUT does not have any dedicated degree course programmes which focus directly on climate change. Instead CUT focuses its teaching of climate change from both ecological and social perspectives. The modules (Table 8.1) employ a problem-based learning approach, introducing students to critical issues such as climate change and social justice, asking them to propose innovative solutions to these complex problems.

8.3.2 University-Wide Climate Change Research Initiatives

University-wide research activities at CUT are guided by the mandate and the strategic plan. All research activities are informed by the teaching units and contribute towards innovation, creativity, and wealth creation for the nation. University-wide climate change-related broad thematic areas (Fig. 8.2) aim to contribute towards technology, innovation, and wealth creation in the face of climate change.

The University's seven schools and the institute forge synergies and strategic alliances with industry and commerce through their respective areas of specialization including climate (Chinhoyi University of Technology 2017). CUT

offers funding opportunity for capacity building towards climate change-related programmes and training extra qualifications. For instance, in 2011, CUT offered early career researchers (ECRs) internal grants to promote interdisciplinary research on nature, causes, and impact of environmental change and to contribute to the development of management strategies for coping with future environmental change. In 2014, researchers from the university were awarded a grant to participate in a climate change-related programme focusing on the interface between climate change and cities, sustainable development, and sustainability and inequality. In 2015, another group of researchers got funding for a multidisciplinary project aimed at interrogating the environment and technology nexus in Zimbabwe using a landscape approach for livelihoods and food security. This research enrolled four postgraduate students studying climate scenarios, seasonal variability and change, tourism, agricultural value chains, and livelihoods (Chinhoyi University of Technology 2015).

8.3.2.1 Climate Change Education: Seminars, Conferences, and Symposia (2014–2018)

CUT has also facilitated and hosted such internal and external events as which incorporate the climate change agenda as highlighted in Table 8.2.

The First Institute of Lifelong Learning and Development Studies International Research Conference held 2–5 August 2016 was aimed at exploring the nexus between technology, language, indigenous knowledge, development, and sustainability. It hosted researchers who under the sub-theme of sustainable development presented climate change research issues. Response to climate-induced disasters, climate change impact on food security, vulnerability to climate-induced water shortages, building resilience to climate change, determinants to climate change adaptation options, Indigenous Knowledge Systems (IKS) and climate change adaptation, IKS and agriculture as a response to climate change, IKS and food security, and environmental governance.

Table 8.2 Conferences hosted by CUT and climate change-related themes

Name of conference	YEAR	Climate change-related themes
Enhancing And Promoting Academic Excellence International Research Conference 2015	2015	Water technology and climate change Renewable and sustainable energy Water technology and climate change Food security and food quality Natural resources conservation
The First Institute of Lifelong Learning and Development Studies International Research Conference: Interfacing Technology, Language and Knowledge Management with Sustainable Development	2016	Climate change adaptation

Source: Fieldwork 2019

8.3.2.2 Climate Change Research Outputs from CUT Academics (2015–2019)

The academic staff in CUT engages in multidisciplinary and interdisciplinary climate change-related research as part of the university mandate. Table 8.3 summarizes the selected research outputs for the period (2015–2019) based on climate change thematic areas.

The research outputs mainly focus on climate change science, impacts, adaptation, and mitigation. Selected CUT researchers have also published a book as an output of CUT-OXFAM collaborative research on local community experiences on weather and climate information dissemination in farming systems in Zimbabwe. The book investigates climate trends in selected areas in Zimbabwe and how the trends have impacted the agrarian dimensions of rural livelihoods. It also explores extension approaches that potentially link with weather and climate information

Table 8.3 Selected climate change academic research outputs (2015–2019)

Thematic area	Selected authors (2013–2019)
Climate change adaptation	Kupika et al. (2019); Mubaya et al. (2017); Svubure et al. (2018) Sango and Nhamo (2015); Mubaya and Ndebele-Murisa (2017a, b); Mubaya et al. (2017); Ndebele-Murisa and Mubaya (2015); Mubaya and Ndebele-Murisa (2019); Mubaya et al. (2016), Utete et al. (2018a, b, c)
Climate change mitigation	Svubure et al. (2018); Kupika et al. (2018)
Climate change impacts and vulnerability	Kupika et al. (2017a, b); Utete (2018); Ndebele-Murisa and Mubaya (2016); Sango and Nhamo (2015); Ndebele-Murisa and Mubaya (2015); Mubaya et al. (2016); Utete et al. (2018a, b, c); Chemura et al. (2016)
Climate change policy/governance	Kupika et al. (2017a, b); Mubaya et al. (2017); Kupika and Nhamo (2016a, b); Mubaya et al. (2015a, b); Ndebele-Murisa et al. (2017)
Climate change science	Maúre et al. (2018); Chagonda et al. (2015)
Climate change and gender	Garutsa et al. (2018)

Source: Authors

systems. There is also an examination of the policy contexts for smallholder farming adaptation. In addition, CUT researchers also have collaborations with other universities such as University of KwaZulu Natal (UKZN) on a book project related to climate change management using Indigenous Knowledge Systems (IKS).

8.3.3 Trans-university Integrated Climate Change Initiatives

CUT is working in alliances to integrate and foster climate teaching across the higher education system. Integrating climate change teaching and initiatives into broader university initiatives, aims not only at teaching students, but also staff members. This approach is used by institutions across the globe. CUT encourages externally led integration of climate-change awareness into university teaching and collaboration between universities and other stakeholders (Table 8.4).

The university engages in a number of business development projects such as the Farm Research, Teaching and Extension Unit (FRTEU) which aims to contribute towards the integration of teaching and to learn at the same time enhancing agricultural production and food security. Such initiatives are dedicated to understanding and solving the complex problems which the nation faces as a result of climate change. Other projects are on aquaculture and climate change, value addition of agricultural products, training farmers on jam production, and the National Pre-Breeding cattle project which supports farmers in developing climate change resilience (Chinhoyi University of Technology 2017). Climate change mitigation-related projects include the Solar PV training and Tobacco barn design all contributing to the smart energy agenda (ibid).

CUT works closely with the Climate Change Department in the Ministry of Water, Environment and Climate to enhance climate change research and community outreach initiatives. Thus, CUT and other members of staff are affiliated to climate change-related initiatives and programmes for purposed networking, collaboration, and dissemination of climate change information. The university has Memorandum of Understanding with civic organizations focusing on a series of climate change-related events, activities, learning on climate change, available to their staff, students, and local community members. The MOUs are operationalized as a result of staff and students' efforts to embed and communicate activities and projects on climate change and other sustainability issues. For example, academics and students can undertake projects with the Great Limpopo Transfrontier Conservation Area (GLTFCA) linking these to their coursework, internship placements, and research activities.

CUT recognizes that climate action requires the engagement of all sectors, interests, and stakeholders. Research and community outreach and engagement programmes (Table 8.4) illustrate how the university is integrating climate-change

Table 8.4 Chinhoyi University of Technology Research and Community Service Initiative programmes related to Climate Change

Stakeholders and partners	Name of project	Area of collaboration/intervention
Public sector (including government departments)		
Local authorities, e.g. urban municipalities (Harare Municipality)	Future Resilience for African Cities and Lands (FRACTAL) Program	Sustainable urban planning and management of a city's energy and water resources towards resilient Development pathways
RDCs (Chiredzi and Hurungwe)	Delivering Innovation and technology through the Reinforcement of Agricultural and Multidisciplinary research capacity for the benefits of small-scale farmers in TFCAs (DREAM) project	Climate smart agriculture; more resilient and diversified production systems for small-scale farmers in TFCAs through innovative management options of rangeland/natural resources at human/nature interface. Less degraded environment and more resilient social-ecologic systems
Government ministries and departments (Ministry of Agriculture, Ministry of Climate Change, Water and Environment, Ministry of Local Government; Forestry Commission)	FRACTAL, OXFAM, DREAM	Sustainable urban planning and management of a city's energy and water resources towards resilient Development pathways; climate-related information and extension services; climate smart agriculture
Civic society, NGOs, and private sector		
Gaza Trust (Chiredzi)	Cultural community development initiatives in the Greater Limpopo Trans frontier Conservation Area (GLTFCA)	Climate smart agriculture
The Association of Commonwealth Universities (ACU); DFID UK	Climate Impacts Research Capacity and Leadership Enhancement (CIRCLE)	Coordination and funding to strengthen the mechanisms of research uptake and support institutions to develop and realize a clearly defined strategic approach to climate change research
Local universities (CUT, NUST, UZ, Bindura University of Science Education (BUSCE), University of Zimbabwe (UZ))	Delivering Innovation and technology through the Reinforcement of Agricultural and Multidisciplinary research capacity for the benefits of small-scale farmers in TFCAs (DREAM) project	More resilient and diversified production systems for small-scale farmers in TFCAs through innovative management options of rangeland/natural resources at human/nature interface. Less degraded environment and more resilient social-ecologic systems
Regional universities (University of South Africa, University of Ibadan, Nigeria, University of Fort Hare (South Africa))	Climate Impacts Research Capacity and Leadership Enhancement (CIRCLE)	Hosting Climate Impacts Research Capacity and Leadership Enhancement (CIRCLE) programme Post Masters Fellows
OXFAM	Strengthening weather and climate information dissemination in semi-arid Zimbabwe	Climate-related information and extension services
Red Cross Red Crescent Climate Centre, CSIR, ICLEI, SEI Oxford, START, Aurecon, SMHI, UK Met. Office, NASA, Lawrence Berkeley National Laboratory, EC Joint Research Centre UK Department for International Development (DFID) and the Natural Environment Research Council (NERC).	Future Resilience for African Cities and Lands (FRACTAL) Program	Advance scientific knowledge about regional climate responses to human activities. Stakeholders and researchers are working to co-produce relevant knowledge that will support resilient development pathways and enable decision-makers to better integrate pertinent climate knowledge into their resource management decisions and urban development planning
Agriculture and Livestock Research Institute	Climate Impacts Research Capacity and Leadership Enhancement (CIRCLE)	Hosting Climate Impacts Research Capacity and Leadership Enhancement (CIRCLE) programme Post Masters Fellows (Association of Commonwealth Universities 2018)

awareness, reaching various disciplines and departments as well as externally led integration of climate-change awareness into university teaching and collaboration between external stakeholders and other universities. However, findings from the review present limited examples of how the university is contributing towards industrialization within the context of climate change.

8.4 Conclusions

This chapter sought to identify the role of universities in southern Africa towards fulfilling the climate change agenda through a case study of CUT seeking to understand how universities mainstream climate change issues in their curricula. The chapter provides evidence of local, national, regional, and international efforts made by CUT as a relative newly established and upcoming university towards contributing to the climate change agenda. Most of the climate change-related activities aim to fulfil the SDG 13 focus of addressing climate change impacts, adaptation, and mitigation. Despite its wide efforts, the university still needs to introduce optional modules, extra qualifications, and additional learning course which can be taken by both students and staff to understand climate change across all disciplines.

We argue that universities can play a key role in helping to meet the various challenges posed by climate change. However, the means to do so are not always widely known, nor are there clear mechanisms through which matters related to climate change may be systematically included in university programmes. Climate change is a complex and multifaceted event such that, many higher education institutions tend to limit the teaching of climate matters to a few disciplines without taking into account the full picture of the challenge. Climate change has been recognized as a disaster that needs urgent and effective solutions to prevent a future catastrophe. Generally, universities may help to foster a broader understanding of the challenges of climate change by: providing adequate teaching programmes vis-a-vis the proper inclusion of matters related to climate change in teaching beyond the traditional, technical subjects; ensuring a stronger emphasis on applied research into climate change which integrates technical issues with social and economic ones hence opening the way for a holistic understanding of the problem and its ramifications; fostering a deeper involvement of students in the process of understanding climate change through activities ranging from campus-based initiatives to the organization of climate friendly events so as to allow universities to practise what they preach.

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9 Opportunity to Foster Urban Innovation Through Universities: The Case of Madrid

Carlos Mataix, Julio Lumbreras, Sara Romero, Manuel Alméstar, Jaime Moreno, Javier Mazorra, Kathleen Kennedy, Annalyn Bachmann, Juan Azcárate, Ángeles Cristóbal, and Rosa Ferré

9.1 Introduction

PlatformA, created by the Innovation and Technology for Development Centre at the Technical University of Madrid (itdUPM) in collaboration with the MIT Center for Collective Intelligence (CCI), has successfully produced a multidisciplinary network of professionals to help achieve the Sustainable Development Goals (SDGs). The project consists of a virtual and physical context to re-invent the city of Madrid where the City Council plays a critical role as part of the core team. The platform combines technology, innovation, and new governance models through:

- Listening to citizens and university community to identify their challenges and needs
- Co-creating, through collective intelligence, prototypes and pilot projects answering identified challenges
- Experimenting, demonstrating, and iteratively designing co-created solutions
- Proposing public policies and services tested in the campus

The role played by the itdUPM is providing an impetus for transformative, collaborative connections between the stakeholders engaged in this novel process. This project is aligned to other initiatives around the world that may be viewed as the expression of a new generation of universities working towards sustainability transformation. Therefore, the living lab for sustainable innovation in Madrid reinforces the idea of higher education as a context for experimentation around sustainable social and technological practices through interdisciplinary practices, breaking down silos in universities.

Higher education institutions are increasingly expected to serve as active contributors to urban development, worldwide, addressing hard problems,

C. Mataix · S. Romero · M. Alméstar · J. Moreno
J. Mazorra
Innovation and Technology for Development Centre (itdUPM), Technical University of Madrid (UPM), Madrid, Spain
e-mail: carlos.mataix@upm.es; sara.romero@upm.es; manuel.almestar@upm.es; jaime.moreno@upm.es; javier.mazorra@upm.es

J. Lumbreras (✉)
Technical University of Madrid (UPM), Real Colegio Complutense at Harvard, Cambridge, MA, USA
e-mail: julio.lumbreras@upm.es; julio_lumbreras@hks.harvard.edu

K. Kennedy · A. Bachmann
MIT Center for Collective Intelligence, Massachusetts Institute of Technology (MIT), Cambridge, MA, USA
e-mail: kdkenn@mit.edu; annalyn@mit.edu

J. Azcárate · Á. Cristóbal · R. Ferré
Madrid City Council, Ayuntamiento de Madrid, Madrid, Spain
e-mail: azcaratelj@madrid.es; cristoballma@madrid.es; direccionartistica@mataderomadrid.org

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such as climate change (Global University Network for Innovation [GUNi] 2017). Few would deny the need to strengthen the mission of having universities embody their role as a space for the exchange and growth of knowledge.

Literature shows that, apart from disciplinary expertise, in order to design and implement solutions it is essential to deal with systemic problems by engaging a diversity of stakeholders, with varying levels of power. Henceforth, faculties need to interact with a range of actors, inside and outside the academic community and to take into account differing mental frameworks, languages, cultures, and interests.

In this chapter, we present a process of change implemented by the Innovation and Technology for Development Centre at the Technical University of Madrid (itdUPM) in liaison with the Madrid City Council. Both of these public organizations are located in Madrid in Spain. The process is expressed by a platform. We say process as a "platform," as opposed to a "project," because the majority of initiatives dedicated to systemic social changes are designed in the form of projects, thus limiting themselves by dealing with specific topics, unlike platforms, which are driven towards transforming complex systems (Espiau 2017). The objective of the platform is to foster sustainable innovation in the city of Madrid by engaging a diverse group of stakeholders through collaboration between public agents of Madrid, the university, and the city council.

Founded in 2012, the itdUPM has successfully managed to create an interdisciplinary collaborative network of faculty, doctoral (PhD) students, and non-academic professionals with a common interest in promoting action research for sustainable development. The itdUPM also works as an interdisciplinary platform, propitious to co-create innovative technical and organizational solutions to address sustainable development challenges both at the UPM Campus and within the broader society.

PlatformA is a concrete example that combines the knowledge and interests of diverse agents through a high level of experimentation and eagerness to explore the unknown. It is called a platform because our goal was to initiate a process of creating public-to-public partnerships, and to open the conversation to more agents who are initiating similar processes.

The first section after this introduction explains the concept of a living lab, as well as describing the case of PlatformA in Madrid. The following section highlights the premises that drove our initial steps. In the third epigraph, we delve into the practical application of PlatformA and explain the process of creation and evolution of the platform up to this present moment. Finally, we propose a series of open-ended questions to apply and connect this conversation to a myriad of similar worldwide experiences.

9.2 PlatformA Between the Technical University of Madrid and Madrid City Council

The aim of "PlatformA" is to stay tuned to societal problems and to test prototypes and pilots of public policies and services in order to solve urban problems through collective intelligence using the campus as a test bed and living lab for innovative solutions. The role of PlatformA is to integrate technology, innovation, and new governance models through a multifaceted approach, which includes:

- Understanding the challenges and needs of community members
- Utilizing collective intelligence to co-create prototypes and solutions that answer these challenges
- Working with these solutions to improve their design through experimentation and demonstration
- Proposing the viable solutions and public policies that were tested on campus

The platform is a series of fostering, sharing, and inspiring processes between public and private stakeholders. It is boosting a novel multi-actor partnership towards sustainable transformations and the 2030 Agenda for Sustainable Development that enshrines the 17 related SDGs.

The role played by the itdUPM is to provide a "connecting tissue" for provoking, accelerating, and sustaining transformative collaboration among different disciplines and actors. This project is aligned to other initiatives around the world that may be viewed as the expression of a new generation of universities working towards sustainable transformation. Therefore, PlatformA for sustainable innovation in Madrid reinforces the idea of higher education as a context for experimentation around sustainable social and technological practices through interdisciplinary practices, breaking down silos in universities (Robinson et al. 2013).

The role the Madrid City Council plays within this platform is fundamental. PlatformA focuses on Madrid's local policy for Air Quality and Climate Change in Madrid (Plan A 2017). The policy was named Plan A because it affects the "air" we breathe and, moreover, because there is no "Plan B." Plan A aims to create a sustainable city that guarantees the health of its inhabitants against pollution and strengthens the city against adverse impacts of climate change. For this reason, PlatformA's own trademark includes the capital letter "A" represented in Plan A.

Several studies show that air quality is one of the main problems facing cities both from a health and economic perspective. For instance, Pascal et al. (2013) showed that the largest health burden in 25 European cities was attributable to the impacts of chronic exposure to $PM_{2.5}$. Complying with the $PM_{2.5}$ World Health Organization (WHO) guidelines would add up to 22 months of life expectancy at age 30, depending on the city, corresponding to a total of 19,000 deaths delayed. The associated monetary gain would total some €31 billion annually, including savings on health expenditures, absenteeism, and intangible costs such as well-being, life expectancy, and quality of life.

Therefore, the plan A was designed as a tool for local environments to reduce atmospheric pollution, contribute to climate change mitigation, define strategies for adaptation to climate change, and save money. The plan's objective is to transform Madrid into an urban area characterized by increased quality of life and to consolidate a shift towards a sustainable urban model. This plan is a fundamental piece of a broad "Strategy for Sustainable Urban Development" put in place to face the environmental and social challenges that Madrid, being a large metropolitan area, faces (Plan A 2017).

The origin of PlatformA began a decade ago when several professors from the Technical University of Madrid began working with civil servants from Madrid's City Council in developing projects for measuring the air quality. Due to this trusting relationship, in 2017, PlatformA was designed. Figure 9.1 presents the concept of the structure of PlatformA, which is a linear simplification of the model in order to facilitate comprehension.

PlatformA's processes function in two directions. On one side, citizen's petitions and unexpressed necessities are directed to decision-makers and public politics. On the other side, guidelines and political requirements, such as Plan A, require citizen's empathy and action.

9.3 Focus of PlatformA

The design of this platform starts from various premises that define the work and the relationships we believe are necessary to initiate a long-term process.

9.3.1 Adapt the Concept of a "Living Lab" to a Local Context

The concept of living labs was coined by professors William J. Mitchell, Kent Larson, and Alex Pentland at Massachusetts Technology Institute (MIT) during the first decade of the twenty-first century. It was defined as an open innovation ecosystem or environment centered on practices and uses in the field of Information and Communications Technology by the users themselves (MIT 2010). The MIT scientists posit that living labs represent a user-centered research methodology that can be used for testing, design, validation, and improvement of multiple and complex solutions involving real-life environments.

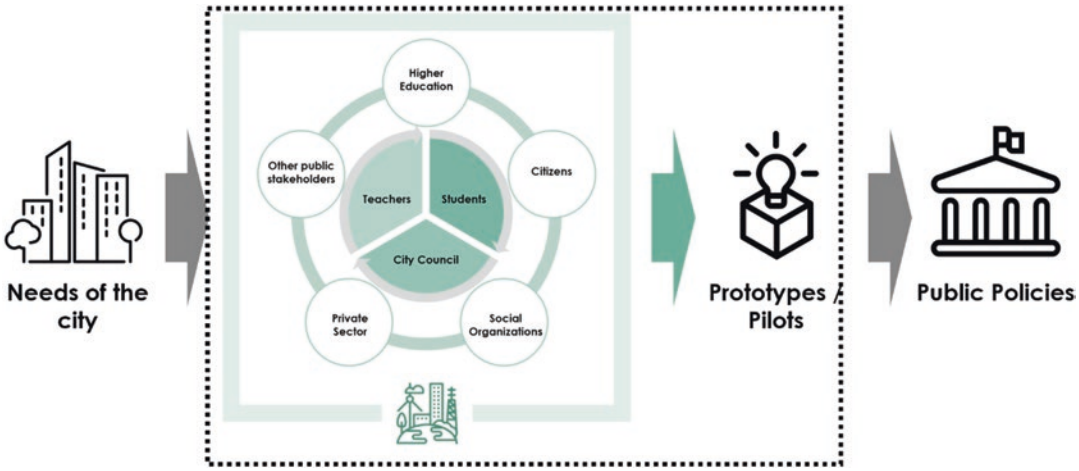

Fig. 9.1 Conceptual structure of PlatformA. (Source: itdUPM 2018)

Living lab is an "ecosystem where various actors coexist and where an innovation culture is generated, able to secure innovation projects based on co-design and co-creation by all the actors involved" (Duarte 2016). Spanning a particular area of action (a region, a city, a neighborhood, or a building), the living lab concept implies a whole research and innovation process in which the user is, systematically, a co-creator, a tester and a judge working through innovative ideas, scenarios, concepts, applications, and technological devices in real-life environments (Duarte 2016). Bergvall-Kareborn et al. (2009) mentioned that living labs introduce new ways of managing innovation processes with the underlying idea that the starting point for innovation should be people's ideas, experiences, and knowledge, as well as their daily needs of support from products, services, or applications.

Living labs are often associated with the concepts of analyzing complex problems in a real-world situation. In the last years, there have been many approaches to creating living labs—some of them are focused on networks and some on systems or ecosystems (Leminen 2015). Verhoef et al. (2019: 136) defines a campus living lab as "an integrated organizational, technological, and socio-economic approach in which a university uses assets and facilities to investigate, test or demonstrate innovative technologies or services from, with and for their community, in co-creation with all stakeholders."

However, living labs are often primarily focused on university campus facilities without usually thinking of the broader impact, and ways to produce systemic change by upscaling solutions. The approach of "PlatformA Madrid" extends past the development of a prototype and overcomes challenges of scaling-up activities. Therefore, PlatformA aims at creating a context in which scaling-up prototypes is part of the process.

Moreover, under the current predominant system of calls for proposals, initiatives have no margin of error because they must demonstrate the completion of their proposed activities in the initial proposal, approved by a private or public convene. This results in a limited space for innovation. The PlatformA process recognizes that these types of projects always have a high margin of error and require space for experimentation and action in order to produce structural results. The aim of constructing platforms involves interconnecting entities and projects through a basis of objectives, methods, and systems of evaluation shared with the overarching goal of having a lasting, meaningful impact (Espiau 2017).

Similarly, the Madrid Plan for Air Quality and Climate Change calls for urban challenges that demand the creation of new alliances and processes of co-creation and a collective intelligence dedicated to understanding and forging Madrid's transformation.

9.3.2 Try "Another Operative System"

The dominant norms, processes, and values that constitute our current "system of operation" are the way in which we presently tackle our problems. This system was designed in the past and presupposes the linearity and predictability of the processes of change. It is, therefore, not at the height of the challenges and goals of the 2030 Agenda, which are characterized by uncertainty and complexity. We need a "second operative system," which will initially have to be compatible and coexist with the current operative system (Mataix 2018).

In order to do this, it is necessary to overcome "expert" and "top-down" approaches that lead to very limited results, and instead build an authentic movement of transformation that connects a multitude of private and public actors through a shared vision and common goals. This approach requires a deep understanding of the values and narratives that are expressed over a predetermined problem (or geographic space) and associate the vision of the future we desire with a battery of interconnected initiatives (Espiau 2017). The hope is to utilize collective intelligence to overcome the traditional challenges decision-makers have faced when solving similar problems.

PlatformA harnesses collective intelligence by applying a ground-up, crowdsourcing approach to problem-solving. Malone (2018: 20) defines collective intelligence as "the result of groups of individuals acting together in ways that seem intelligent." PlatformA's approach ensures that the Madrid City Council has access to the voices and opinions of all possible stakeholders within the greater community because it provides mechanisms of participation that would not be available otherwise. The ultimate goal of the collective intelligence process is to create smarter, better functioning communities through the use of multifaceted processes like PlatformA.

9.3.3 Facilitating the Process of Integration Based on Habits, Values, Collaborative Practices, and Continuous Education

The itdUPM has demonstrated that this kind of process of change requires an important job of integration and facilitation of diverse perspectives and narratives (Mataix et al. 2017). Working in a truly cooperative and multi-actor environment requires empathy, generosity, and tolerance to mistakes. Thinking of leadership, for instance, there is a tendency to consider leadership as an individual characteristic. This holds; however, leadership is also partly a property that is developed within groups and organizations. Work within platforms of innovation requires new forms of more distributed and transformative leadership (Mataix 2018). Tools, such as PlatformA, help facilitate coordination between differing sectors of society and help mitigate some of leadership issues faced by traditional problem-solving methodologies (Malone et al. 2003).

9.4 Methodology and First Pilots

The methodology of the work is based on management processes that are more open and flexible than current ones. In order to function as a platform of innovation, PlatformA acts as an innovative listening platform that stimulates participation as well as the co-creation of solutions adaptable to each context. The transformation of cities requires new processes of participation and action that foster and take advantage of collective intelligence and the creative energy of all persons.

PlatformA's methodology combines offline and online dimensions. The fundamentals have been designed by the itdUPM, the City Council of Madrid, and the Center for Collective Intelligence of the Massachusetts Institute of Technology (MIT), through the online ideation

and prototyping platform called Climate CoLab (https://www.climatecolab.org).

To start running the platform, the City Council of Madrid posed three challenges, which are described in the following paragraphs. They are categorized according to the three dimensions to fight against climate change: monitoring, mitigation, and adaptation.

The first challenge is related to strengthening climate change monitoring in Madrid by developing indicators and promoting monitoring and evaluation of Plan A. In order to do this, it has been initially identified as necessary to improve the current network of air quality sensors installed throughout Madrid and expand the databases with other environmental and climate indicators that have not been considered so far. The expansion consists of a climatic network to analyze urban temperature trends and heat island dynamics. Phenological indicators will be progressively incorporated. Data viewing tools and open data outputs available to the research community have been designed by university IT experts.

The second challenge is the sustainable transformation of mobility in Madrid as an effective way to mitigate GHG emissions. To do so, two initiatives are being implemented. The first one is the development of an App called MaaS (Mobility as a Service) to increase mobility efficiency in the city. The second is a contest using the Climate CoLab platform to improve work mobility in two of the UPM campuses (Madrid Moncloa and Madrid South), where more than 2000 students, faculty, and administrators will participate in proposing and selecting initiatives to increase the sustainability of the transportation system in those campuses.

The third initiative is based on "naturation," understood as the action to foster nature development in the city (Briz 1999). The application of solutions based on nature are strategies for urban adaptation to climate effects (vulnerability and resilience against climate change). Matadero-Madrid is a cultural center in the south of the city dedicated to contemporary art and digital culture that will act as a space for testing out urban nature. The first pilot under this initiative is the "Mutant Action Programme," which uses Matadero as a study venue for applying climate adaptation solutions based on nature. The artists involved will build a "hybrid" (and perhaps "cyborg") garden for the twenty-first century in which the container go hand in hand with its contents to suggest new uses of infrastructure and to tell stories about the possibility of establishing, through mutualism, new ways of the relation between materials and nature.

Three specific working groups were created to face each challenge. They include professors, researchers, students, companies, and officials from the municipality. Each group has a professor from the itdUPM, a civil servant from the City council to lead the process, and a facilitator from the itdUPM that covers the necessary mediation, arbitration, and coordination role. Given the open-ended characteristic of the process, each group has been increasing significantly in size to around 20 people per group.

On top of the working groups, there is a leadership group that meets every month to debrief and orientate the process. It is composed of the nine people (three faculty, three civil servants, and three facilitators), who are leading the process plus additional experts depending on the topic covered in the meeting. Many of those meetings are followed by a large group meeting where the whole community shares experiences and decides on the next steps to take. Figure 9.2 shows an outline of the work process, including several phases that are completed through specific meetings that took place either at the itdUPM's facilities or at the City Council's facilities.

The first phase of this process consists of exploring and empathizing with the problem at hand. Within it, the first step is creating a preliminary outline identifying people and resources needed for the resolution of each challenge. This was done through an interdisciplinary approach and multi-agent participation. Through this, a concrete objective to be achieved and the associated roadmap were specified.

The second phase is centered around creating connections with existent resources, as innovation is not solely based on creating new things, but on connecting unconnected resources. For this reason, in this stage, we analyzed initiatives

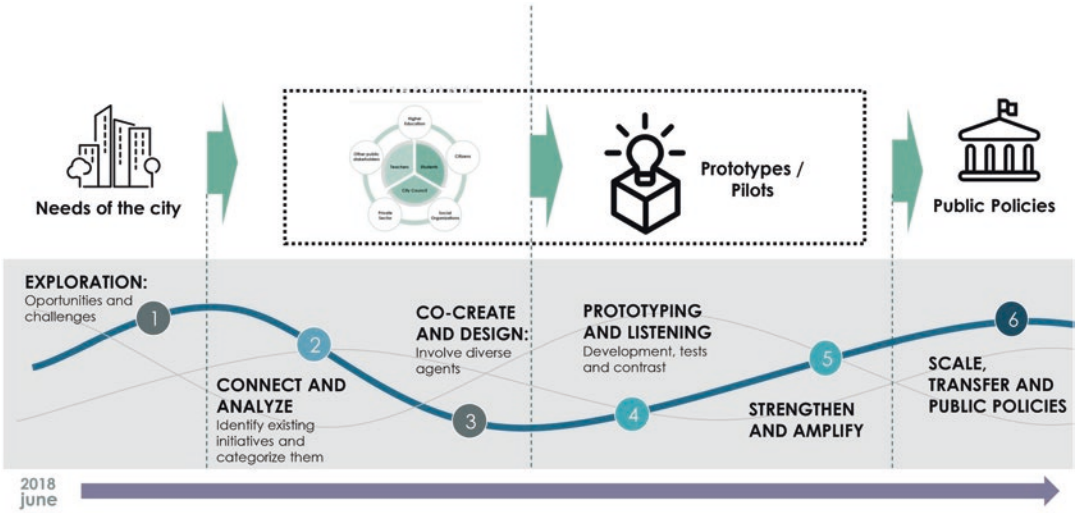

Fig. 9.2 Work process of the PlatformA. (Source: itdUPM 2018)

and prototypes that were carried out in the city, and we created initial mappings of previous research projects that helped in identifying information gaps.

Through these analyses, we established categories of prototypes that require different kinds of developments. This initiates a phase of co-creation and design, that is being carried out at the time of writing this book chapter. As for scaling-up, experience demonstrated that lineal approaches based on one pilot/prototype that is scaled-up or exported to other contexts do not face the complexity associated to social challenges (Quagiotto and Radojevic 2014).

PlatformA includes the "design for scalability" concept (Mataix 2015), which consists of designing in a context of multi-stakeholder relationships where scalable prototypes arise in a way that is connected from their origin with other initiatives orientated to systemic innovation. These design logics are based on spreadness and on decentralized and fuzzy systems, which are less control dependent, and more efficient to spread initiatives on a larger scale.

The time frame was adapted to the milestones set in Plan A: the year 2020 and 2030. Both are two different time horizons. On the one hand, the objectives for improving air quality are marked by the immediacy associated with the protection of people's health and the need to comply with current legislation. On the other hand—although the objectives framed within the mitigation and adaptation of climate change present synergies with those regarding air quality—they have a long-term vocation, with an associated horizon to 2030 (Plan A 2017).

9.5 Involvement of Different Stakeholder from a Public–Public Partnership

The platform also aims to relate diverse stakeholders from multiple areas with different perspectives: academia, public administrations, private companies, and civil society. Platforms must carry out a selection of partners on a local level (local authorities, businesses, and social entities), intermediary entities (specialists in topics that will be discussed), and international institutions that allow for the exchange of knowledge and reinforcement of their brand. This group of organizations forms the network of actors linked to the platform to identify the needs and adequate strategies for the successful implementation of the program within a concrete territory

Table 9.1 Stakeholder incentives to participate in PlatformA

Stakeholder	Benefits/Incentives
Academia	Develop new models to promote interdisciplinary research, teaching, and social innovation Campus re-generation and connection with the city Listening to society and incorporation of global agenda
Public administration	Support to develop sustainable policies (fostering environmental and social equity) Strengthen public programs through knowledge and experimentation developed in the platform Strengthen city staff's skills and commitment
Private companies	Test technological and organizational solutions Improve listening skills, specifically to the young population Develop new business models and technology-based social entrepreneurship
Civil society	Solve daily problems Increase social impact Access to expert knowledge and ability to systematize learning processes Process evaluation and continuous monitoring
Shared for every stakeholder	Complementarity of resources and skills Alignment with global trends and with the sustainable development goals Connection with pioneering initiatives Visibility and connection between initiatives Shared resources

Source: Authors

(Espiau 2017). Each of these partners has diverse interests and incentives to participate in this initiative as shown in Table 9.1.

During the first months, several collaborative instruments are being designed to allow a balanced diversity with mutual benefits and enough flexibility, such as face-to-face meetings, a web page, a repository (http://www.itd.upm.es/living-lab/), and practical workshops.

9.6 Discussion and Next Steps

The PlatformA process presented in this paper builds from the concept of living labs in universities, but goes beyond them, using the campus as a test bed for pilots and prototypes that could be upscaled to the city level aiming at transforming the city towards sustainability. The platform is evolving according to experience. During the process, we have learned the importance of: (a) creating both an online and offline space for collaboration, (b) taking care of the relationships between stakeholders creating a holding environment to promote participation and engagement, (c) incorporating cultural and territorial dimensions through a transversal listening process, and (d) combining and balancing terms set by municipal policy with deep and long-term listening.

The platform is also aligned to other initiatives around the world that may be viewed as the expression of a new generation of universities working towards sustainability transformation. Some examples are McConnell Foundation and CRIEM - McGill University at Montreal, Canada and BETABLOCKS initiative, a partnership between Emerson College, the architecture firm Supernormal, and the Boston Mayor's Office of New Urban Mechanics in the United States of America. Therefore, during the process we are also creating a knowledge base to share with international initiatives to improve higher education as a context for experimentation around sustainable social and technological practices through interdisciplinary practices, breaking down silos in universities.

Next steps are shown in Fig. 9.2, and they are associated with pilot projects and prototypes to scale up and transfer to public policies and public services. We are working on classifying pilots and prototypes according to their nature and relevance, and on developing ways to establish a long-term collaboration between partners (including private companies) incorporating intellectual property rights along with open innovation.

Furthermore, a need for specific education from city officials and other stakeholders was identified. Therefore, we are working on an

ad-hoc course to learn about the main principles of organizational change, leadership, and implementability at urban level. The course will be taught by UPM faculty, but with external professors and with an experimental approach. The students (city officials, other faculty, private company employees, non-profit employees, people from neighborhood associations, and citizens) will work together on specific problems for the city transformation and will learn about system principles and collaboration skills while moving forward projects and developing implantation plans.

Quantifying the tangible impact of these types of living labs will be important to understand their role in facilitating meaningful change towards sustainable development. We hope to assess the influence of the prototypes and public policies generated throughout this process to measure the effectiveness of such methodologies. This will be an important step in scaling and adapting the platform to fit other contexts. Based on our lessons learned from PlatformA, we hope to development a concrete methodology of hybrid problem-solving that can span sectors, different problem areas, and geographic regions.

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10 Enhancing the Roles and Responsibilities of Higher Education Institutions in Implementing the Sustainable Development Goals

Mphemelang Joseph Ketlhoilwe, Ntha Silo, and Kgosietsile Velempini

10.1 Introduction

The SDGs call for universal social, environmental, and economic inclusivity. They were conceived from MDGs' experiences to a more inclusive global agenda strengthened by proper governance. The universal applicability of the goals affects educational institutions. The inclusion of education as one of the seventeen goals of the 2030 Agenda for sustainable development is an acknowledgement of the role education plays in social, environmental, economic, cultural, and political dimensions within the planetary boundaries (The United Nations Educational, Scientific and Cultural Organization, UNESCO 2017; Vladimirova and Le Blanc 2016). The role of HEIs in the implementation of SDGs is to enhance a balanced universal and inclusive economic growth without compromising social and ecological issues to achieve agenda 2030 (Kopnina 2017; Sonetti et al. 2019).

M. J. Ketlhoilwe (✉) · K. Velempini
Department of Languages and Social Sciences Education, University of Botswana, Gaborone, Botswana
e-mail: KETLHOMJ@mopipi.ub.bw; kgosietsile.velempini@mopipi.ub.bw

N. Silo
Department of Primary Education, University of Botswana, Gaborone, Botswana
e-mail: SILON@mopipi.ub.bw

The 17 SDGs, their targets and indicators challenge HEIs to review their curriculums seeking to align them with global challenges for sustainability. The goals are said to be integrated, global in nature and universally applicable. For example, Goals 4 and 8 promote capacity building of teachers, scholarships for higher education, and a global strategy for youth employment while Goal 17 promotes partnerships. The goals are an appropriate and relevant sustainable development agenda for the fourth industrial revolution. The targets are defined as aspirational and global, with each government setting its national targets, guided by the ambitious global agenda but taking into account national circumstances (UN 2015). The SDGs require the inclusion of all, extending common but differentiated responsibilities to all people, countries, and actors. HEIs are among multiple actors with a critical role to achieving the objectives of SDGs. HEIs are challenged more than before to enhance the knowledge economy for universal sustainable development. This may not be successfully achieved by individual institutions. The process needs collaboration, partnership, integrated and transdisciplinary approaches by institutions, knowledge production networks, and governments working towards a common goal for a sustainable future. This chapter explores the role HEIs (can) play in promoting the implementation and achievement of the SDGs recognizing that although the goals are inclusive and universal

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there is always room for innovation to further promote greater sustainability than currently envisaged. Power et al. (2015: 8) posit that

> The primary function of HE is the production, distribution, and consumption of knowledge, through teaching, research, and community engagement. The purpose of HE is traditionally viewed as an investment to build the necessary human capital for economic development but has more recently become more complex and nuanced to include the role it can play in building an inclusive and diverse knowledge society.

The principal mandate of HEIs is to educate and train current and future leaders, scholars, workers, and professionals to lead society to a sustainable future. Therefore, HEIs' curriculum, research agendas, and community engagement should be geared towards addressing sustainability challenges (Sonetti et al. 2019). By researching sustainability issues and theories, institutions can contribute to the society's understanding of sustainability challenges and develop new technologies, strategies, and approaches to address these challenges (AASHE 2019). HEIs research agendas should adopt a transdisciplinary research process to identify common problems and co-produce knowledge that delivers sustainable solutions. Research trends into sustainability issues and solutions could be part of all HEIs research agendas. HEIs must be capacitated to be able to deliver graduates with generic skills, such as critical thinking and behavioural skills, and the technical skills required to address labour market and innovation requirements (Power et al. 2015).

10.2 Background

SDGs provide an opportunity to accelerate fundamental, transformative shift in thinking, values, and action by all of society's leaders and professionals, as well as the general population for envisioning and making tangible sustainable future (International Institute for Applied Systems Analysis 2018). SDG 4, target 4.7 offers the greatest evidence of the need to transform education to fix traditional educational systems that are still prevalent in many HEIs (Global Alliance to Monitor Learning 2017). SDG target 4.7 says,

> 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 Statistics Division 2019: 1).

Cortese (2003) correctly observed that several structural aspects of the current system that prevails in most HEIs contribute to the problem. He notes that interaction between human activities, the economy, the environment technologies and policies for a secure, just and an environmentally sustainable future are among the most complex and interdependent issues with which society must deal with, and all these issues cross over disciplinary boundaries. However, higher education is still generally organized into highly specialized areas of knowledge and traditional disciplines along the lines of all the issues outlined above, resulting in professionals who are ill-prepared for cooperative efforts to respond to the complex sustainability issues outlined by the SDGs. Cortese (2003: 16) contends that 'designing a sustainable human future requires a paradigm shift towards a systemic perspective emphasizing collaboration and cooperation'. Observation in much of the HEIs in the south seems to confirm that much of higher education still stresses individual learning and competition.

Salmi (2016) posits that it is widely recognized that the ability of a society to generate, adapt, and apply knowledge is critical for sustained economic growth and improved living standards and that rapid technological progress, the spread of global value chains, and the increasing importance of knowledge-based capital mean that knowledge has become the most important factor in economic development. If it is, as many will agree, the key role of HEIs is to produce and disseminate knowledge that can transform societies for a sustainable future as envisaged by the SDGs, specifically SDG 4, then the next question would be; 'What is knowledge, and what is the purpose of producing and disseminating this knowledge in society that can bring about transformation to respond to the SDGs?' With renewed

accent having been placed upon social and economic objectives through the SDGs (Kopnina 2016), it seems one of the central concepts that is emphasized and outlined in these SDGs is 'sustained and inclusive economic growth' (UN 2015). According to Cortese (2003), we would be missing a critical point, if we are to go by those who believe that knowledge produced and disseminated by HEIs is of value, if it only aims at furthering certain narrowly defined developmental and economic/market aims of our nations. Cortese (2003: 16) goes on to argue that learning as evidenced in HEIs and seen in the global south is still fragmented, along the lines of faculties, responding to 'long-established incentives (tenure, research) and professional practices are often discouraged from extending their work into other disciplines or inviting interdisciplinary collaboration'. While it is a rational argument that HEIs are one of the primary spaces where developmental and economic/market capabilities are to be promoted, and that many of the skills that people acquire at universities do play key economic functions, Sen (2005) argues that, the point of HEIs is to create the conditions for humans to actualize their capabilities and agency to meet target 4.7 of the SDG4 for example. And some of the key capabilities that economic systems ought to be promoting are those that make us able to think of humans as rational animals who take full responsibility to enhancing their existence. This can be achieved by breaking barriers between structured disciplines.

Against this background, we would strongly oppose the conception which seemingly insinuates that disciplines such as languages, literature, philosophy, psychology, and social studies are separate and stand-alone entities where even investments by a number of governments in the south nations are relatively limited when it comes to expenditure on these disciplines as evidenced by the limited student quota in these fields. While we do acknowledge the importance of scientific disciplines that focus more on economic and industrial applications, evidence is abound that seems to indicate that investment by most governments in the south is more on these than the former. This, we argue, can impede implementation of SDGs because if the belief is that HEIs should only equip graduates with knowledge that only furthers their economic pursuits or to meet market needs, without enhancing their very human existence (in terms of soft skills), the purpose of HEIs in meeting the SDGs, specifically Target 4.7 of SDG 4 would be lost. As Salmi (2016) would put it, knowledge is indispensable not only for economic growth but also for social development purposes.

HEIs require a shared paradigm shift for curriculum, research, and community engagement to tackle global challenges and in delivering the skills and evidence needed for implementation of the 2030 Agenda (AASHE 2018). In 2018, Commonwealth Education Ministers committed to the Curriculum Framework for the SDGs, a framework document across formal, informal, and non-formal education at all levels, from preschool to lifelong learning (AASHE 2018).

10.3 Curriculum Reforms

Expanding and reforming HEIs effectively link to SDGs through activities such as research, community outreach, and knowledge exchange may be costly. However, making the SDGs part of the curriculum could open students to more interdisciplinary and transdisciplinary work, positively transform their moral and ethical path in life and research agenda to inform policy and practice. HEIs curriculum reorientation could re-examine learning outcomes, methods, and research to solve great challenges outlined in the SDGs and meet the targets by 2030 and beyond. This would enhance the quality and relevance of HEIs. Institutions may introduce courses (or modules) on sustainability literacy and the process train graduates for sustainability literacy tests (SULITEST) they may encounter in their careers. The use of the Sustainability Literacy Test (SULITEST) results will help identify knowledge gaps, inform curriculum reviews as well compare performance between students worldwide.

The SULITEST provides an online training and assessment tool. This tool is available for higher education institutions and other organizations beyond academia to raise awareness on sustainability and assess sustainability literacy of

students, staff, and other stakeholders (UN 2017). Sustainability literacy refers to the knowledge, skills, and mindsets that help compel an individual to become deeply committed to building a sustainable future, and allow one to make informed and effective decisions to this end (UN 2017). The SULITEST has a core module (general questions), specialized modules (local questions or SDGs framework questions), customized modules (questions created specifically by and for an organization/sector), and finally the surveys (socio-demographic and ESD questions). The adaptation of the SULITEST initiative by HEI would add impetus to SDG4 (quality education) implementation. SDG4 is critical to the achievement of the rest of the UN Goals. At local level, HEI could invest in specialized and customized modules for their students, local communities, and other stakeholders. An approach such as the use of SULITEST may enhance the role and responsibility of HEIs towards achieving Agenda 2030. Pertinent to curriculum innovation at HEI would be recognition of indigenous knowledge and education. This is because UNESCO recognizes indigenous knowledge and is promoting it. SDG 13 on climate change and other SDGs appreciate indigenous knowledge. UNESCO (2018) noted that indigenous knowledge forms part of the knowledge base and is already seen as pivotal in fields such as sustainable development, agroforestry, traditional medicine, applied anthropology, biodiversity conservation, and natural resource management. Research outcomes from these and other field fields could be used to inform policy on indigenous knowledge and contribute to SDGs implementation and success.

The SULITEST questions could be linked to SDGs. The linkage to the SDGs, specialized and customized test questions would help individuals and organizations assess and improve their awareness and knowledge on the SDGs. Specialized and customized test questions could be used by HEIs to measure and assess sustainability literacy in an endeavour to educate future decision-makers. SULITEST can be used by citizens to improve their knowledge on the SDGs process and roadmap as well as their ability to contribute to the 2030 agenda. SULITEST is a unique tool that stakeholders and higher education students can use to measure where they are in terms of understanding the SDGs and to learn how they can improve their knowledge base. The aim is to equip graduates to contribute to addressing the global challenges that the world faces today. This would make HEIs education and training programmes relevant to the economies of the world and achieve sustainability. Translating the SDGs into real action would require change from business as usual to business unusual (Muff et al. 2017, 2018; Muff 2017a, b). It would require both progressive and cooperative learning pedagogies to enhance sustainability competencies. Progressive pedagogy would entail educational theories and learning methods that are used to ground the entire instruction and teaching of Education for Sustainable Development (ESD) while cooperative learning pedagogy would involve the incorporation of ESD-related multi-stakeholder social learning and networking processes (Ofei-Manu and Didham 2018).

10.4 Partnerships

HEIs should start or strengthen their partnership with potential employers of their graduates. Working with industry to support their absorptive capacity would reduce pressure due to 'massification' of education sector and narrowing job market due to technological advancement. A crucial part of successful higher education would be to facilitate the transmission of learning benefit to society by forming partnerships with local and regional communities to help make them socially vibrant, economically secure, and environmentally sustainable in a way that encapsulates the SGDs' 2030 agenda for a sustainable future society. Cortese (2003) states that colleges and universities must support local and regional communities, making every action lead to community improvement. Partnerships with business, public sector, research institutes, earlier education institutions (schools) and other skill providers enhance the collective efforts by all

involved to realize this ideal. Partnerships could be established for the following:

- Collaboration on training the next generation of leaders on sustainable development practices on campuses across the world.
- Establish a network of institutes focusing on large-scale interdisciplinary projects addressing global issues linked to SGDs.
- Initiate and support an annual conference that brings together relevant stakeholders to present best practices and lessons learned in supporting the SDGs. Stakeholders will present their experiences and progress in aligning their strategies with the SDGs.

At local and regional levels, HEIs could establish institution-wide efforts to reduce environmental impact, preserve resources, and show sustainability in action. For instance, the Stanford University has been working with a variety of local stakeholders in the California Bay Area to test SDGs localization strategies, collecting relevant actionable data at the city level to achieve the SDGs (Higher Education Sustainability Initiative Report 2017). Although collaboration and partnership could enhance the role and responsibilities of HEIs and achieve mutual benefit with other stakeholders, it has to avoid issues of power relations and asymmetries that may lead to the collapse of these relations. Local partnership is vital in enhancing effective implementation of the SDGs especially SDG 9. For instance, in 2018, the University of Botswana (UB) and Botswana Open University (BOU) strengthened their relationship and collaborations on different areas of research training to contribute to human capital development and further increase access and the society's participation in higher education (UB Newsletter 2018a). The collaboration and partnership further contributes to the development of the nation and assists in the transformation to the knowledge economy (Milagres and Burkhart 2019). The universities are set to collaborate on distance teaching and learning programmes tapping on each other's experiences. The new BOU staff stand to benefit from the vast experience of the UB staff.

Another partnership is between the UB and the Frankfurt School of Finance and Management on a capacity building project for entrepreneurs. The project aims to equip local entrepreneurs with capabilities to stimulate growth in sustainable businesses. The entrepreneurs were trained on financial literacy, women entrepreneurs, and training for growth. The majority of beneficiaries of this partnership project were women who were empowered with strategic management tools as well as essential skills to enable them to access finance more easily (UB Newsletter 2018b). The partnership could also be forged with the industry. For instance, UB is partnering with Debswana Mining Company. The partnership is on research, innovation, and technology to assist the country transform from minerals-based to knowledge-based economy. The aim of the partnership project is 'to embark on ground-breaking research or project that could be developed into a marketable product or service' (UB Newsletter 2018c: 10). The partnership is across a range of discipline including areas such as ICT, engineering' and others.

It is such partnerships that could assist HEIs show-case their role and responsibility in implementing the SGDs through local and international initiatives. Globalization is pushing HEIs towards greater international involvement while internationalization forces create opportunities for HEIs policies and practices undertaken by academic institutions to cope with the dynamics of the global academic environment. Specific internationalization initiatives would create opportunities for the establishment of branch campuses, cross-border learning arrangements and programmes, setting up degrees on international issues such as global and multicultural studies, peace education, and offering global online programmes and courses (Power et al. 2015). Beneficial partnerships should bring added value and sustainability. Partners should ensure that there are clear roles, responsibilities and accountabilities of each partner right from the beginning. Already the international community is playing a part in providing assistance to HEIs. Table 10.1 shows examples of such assistance that provide opportunities to HEIs to implement the SDGs.

Table 10.1 Assistance by the International Community in Higher Education

Category	Type of assistance	examples
Education and Training	Providing scholarship or fellowship programmes	USAID's merit-based scholarship programme for Pakistani nationals to pursue master's degrees in education at universities in the United States (MESP). The DANIDA Fellowships programme. AFD help universities in Francophone Africa to restructure their staff qualifications to meet international standards. French initiatives include support to the International Institute of Engineering Water and Environment (2IE) in Burkina Faso, AFP, and the creation of the National College of Tourism, Tanzania.
Consortia and networks	Linking individuals and/or departments in HEIs in HICs with individuals and departments in HEIs in LIMCs.	DELPHE (2006–2013) with funding from DFID and its predecessors aimed to promote partnerships between universities and other HEIs working on collaborative activity linked to the MDGs (DELPHE). CIDA University Partnerships in Cooperation and Development Program (UPCDP) (UPCDP).
Institutional development	Projects and programmes aimed at building the capacity of institutions in LIMCs including research capacity. Capacity development within system development, administration and infrastructure, with particular attention to gender balance considerations.	The US$ 90 million external multi-donor support to Makerere University in Uganda for the development of new research strategies and directions and strengthening graduate training and management (University of Makerere). NORHED announced in 2013 that it would fund 46 joint projects between HEIs in DCs and Norway, mostly in eastern parts of Africa. The bulk of the funding will go to institutions in Ethiopia, Uganda, Malawi, and Tanzania (NORAD).
Educational training, consortia, and networks and institutional development	JICA works with Japanese universities to provide support to universities in LMICs specifically selected on account of leading the HE sector in their respective country and region.	JICA support research capabilities through the improvement of teacher quality; facilities, research materials and equipment; the strengthening of university management systems; the promotion of industry-university-community cooperation; and the construction of university networks. Support is mainly provided to engineering, agriculture, and public health sectors. JICA focuses support to the ASEAN University Network/Southeast Asia Engineering Education Development Network (JICA).

Source: Adapted from Power et al. (2015: 34–5)

SDG4 for education includes a target to ensure equal access to affordable quality technical, vocational, and tertiary education, including university by both women and men. Bilateral institutional support is needed in this commitment to attain sustainability through HEIs. However, in low-income countries, the reality of constraints around the relevant resource make it necessary to carefully plan for external assistance to HEI if these institutions are to play and assume their responsibilities and play significant roles in implementing the SDGs. Such assistance should be treated as SDGs implementation package that could be measured for success or failure. The partnership should promote benefits that bridge development and knowledge gaps between stakeholders (British Council 2015) and the learning of good sustainability practices (Africa Unit 2010). Utilizing students to research as an integral part of the learning experience. It helps in identifying gaps in sustainability practices and greatly enhances educations and promotes a strong sense of connection to and caring for the local communities, the general society, and the ecosystems that students are a part of.

HEIs could enhance the quality of the SDGs implementation initiative through collaborative leadership training programmes for and as institutions, as groups of institutions, and through collaboration with other stakeholders both locally and globally. Training could focus on graduates for their careers and for responsible decision-making (UNPRIME 2017). Such leadership training should not only be guided by SDGs but be informed by collaboration with institutions directly supported by UN such as PRIME, Higher Education Sustainability Initiative (HESI), and its stakeholders such as the Global Compact. Of more relevance to enhance HEIs role in the implementation of the SDGs is the HESI which is committed to:

1. Teaching sustainable development across all disciplines of study
2. Encouraging research and dissemination of sustainable development knowledge
3. Campus greening and supporting local sustainability efforts
4. Engaging and share information with international networks

HEIs could provide forums that enable innovation in educating leaders for sustainable development to equip them to help achieve the SDGs. HEIs management also needs to be transformed for SGDs implementation. They require new ways of working, planning, budgeting, decision-making, and monitoring. This calls for strong leadership and effective institutional management to the quality and effectiveness of HEIs. It has been observed that 'due to the limited authority given to institutions in the past, most HEIs in low-income countries suffer from poor, inefficient and highly bureaucratic systems with poorly trained and qualified personnel and inefficient, ineffective and outdated management and administration infrastructure' (Power et al. 2015: 32). The 'human capital flight' from the low-income countries exacerbates this problem and compromises the responsibility of HEIs to implement the SDGs.

10.5 Likely Challenges in Involving HEIs in SDGs

The aims of the SDGs agenda cannot be achieved without active stakeholder involvement and engagement at HEIs. However, scaling up sustainable development growth may face some context-based differences that would impede progress in the implementation of the SDG agenda. Issues such as values, norms, skills, political systems, levels of corruption, legislation, geography in countries, and societies can pose context-specific challenges (UN SDGF 2016). To achieve the SDGs and overcome the challenges posed by the implementation of a universal agenda in a context of country and societal differences, close cooperation between private and public sectors is needed (ibid). If a national plan regarding SDGs is defined, it would be easier for companies to design their sustainability strategies in a way that is both aligned with their corporate objectives and is consistent with national public policies (ibid). HEIs should identify their impact on the SDGs and strategic plans to enhance such impact. Such strategies would include methods and guidelines to assess their impact on sustainable development informed by research and policies and set impact indicators. Measuring and evaluating the HEIs' impact of its actions would show the progress made in achieving the SDGs. It is very important for HEIs to know and take into account the interest of the groups they interact with regarding specific SDGs. Collaborative and interdisciplinary arrangement between and within HEIs could enhance global partnerships in achieving the SDGs agenda. Members of such collaborative endeavours must be self-critical and flexible with partners and work as teams that complement each other's strengths and offset weaknesses.

However, there are inherent risks in HIEs as they stand today. The risks include increased chances of privatization (even of public higher education) due to State withdrawal from HEIs; entrenched and highly stratified systems of HEIs; the focus only on economic purposes of higher education; limited scholarships and bursaries, very attractive loan repayment schemes offered

locally (not only to travel); and importing policies may be challenges to the implementation of the SDGs by HEIs. All the above may be easy, but can have negative impact if not properly contextualized.

Public funding of HE is often inefficient and insufficient. The interactive and reinforcing nature of under-funding, variable quality and relevance, and non-use and non-support of local research presents a bottleneck to research and research capacity development. In addition, the formal employment sector is not able to absorb the increasing numbers of graduates due to slow economic growth in many countries. In most of Southern Africa countries, support for science, technology, engineering, and mathematics (STEM) remains too low to boost technological capability that could contribute to advancement in business and in the process increases in employment creation. Despite a relatively increased enrolment of students in HEIs, certain groups of people such as the indigenous youth remain under-represented. This compromises the achievement of SDG 10 (promoting social, economic, and political inclusion of all, irrespective of race, ethnicity, and origin). Accessing and remaining in HEIs depending on context, gender, family wealth, a region of origin, race/ethnicity, and disability is still a concern in most countries in southern Africa.

10.6 Overcoming the Challenges

In recent years, HEIs have been inundated with highly complex and global forces. These include globalization, internationalization, and massification following the call for education for all (EFA). In this context, societies are looking up to HEIs to provide solutions to some of the challenges impacting on economic growth, social and environmental sustainability. These challenges may serve as catalysts for HEI reforms in southern African and some parts of the world, where HEI structures and systems are weak. Egron-Polak (2016) posits that SDGs are interconnected and comprehensive arguing that we cannot meet one goal without achieving the other goals. Egron-Polak further argues that education and research are essential to all SDGs. As centres of intellectual capital in southern Africa and worldwide HEIs should act as global forums for sharing good practices that promote sustainability regardless of geographical locations. The intellectual capital they produce should be the required capital for poverty reduction, sustainable development, and positive engagement in the global knowledge economy.

In order for HEIs to overcome the anticipated challenges to their roles and responsibilities in the implementation of SDGs, their ability to train essential officials such as teachers, economic managers, and political leaders, all of whom are responsible for ensuring that certain standards of the quality of education are reached, must be financially supported. Curriculum enrichment in higher education must be institution-wide, reconciling and integrating different agendas linked to the 2030 agenda. Some of the challenges could be tackled by granting more autonomy, management, and academic freedom to HEIs, diversifying funding sources, building and maintaining relationships with organizations in the labour market, and supporting a more diversified and complex HE system (Power et al. 2015).

10.7 Conclusion

In conclusion, HEIs are ideal for integrating the SDGs into sustainability strategies in the form of research, teaching, pedagogy, community engagement, and campus practices. Higher education institutions can provide research-based advice and guidance on how to strengthen national educational systems through SDGs. Collaborative partnerships harness collective intelligence to solve shared problems. HEIs can have a great impact in supporting the implementation of SDGs by being conveners for multi-stakeholder engagement, addressing the data gap, informing policy makers through academic research, and developing sustainable solutions in broad collaboration with society. HEIs can contribute to global knowledge through publications and researchers free movement. Global challenges such as poverty and climate change could be met by depending on scientific-based ideas from scholars.

Above all, HEIs' capacities need to be enhanced to be able to play a transformative role and responsibility and contribute to sustainable development. HEIs should integrate the 17 SDGs into their mission, vision, and values, transferring them to the essence of their strategies. Their practice could emphasize sustainability competencies such as knowledge, skills, and values to graduate experts who are reflexive and resilient. Occupying a privileged unique position of the freedom to develop new ideas, they should engage with society, and undertake bold experiments as well as to create new knowledge. HEIs can no longer afford to mainstream and implement SDGs in their curricula through narrowly defined bounded disciplines, but rather as Wals and Jickling (2002: 224) contend, HEIs should produce students whose competences 'enable them to cope with uncertainty, poorly defined situations and conflicting or at least diverging norms, values, interests and reality constructions'. However, HEIs should note that it would be a lost cause to seek to mainstream and implement SDGs within the framework of what does not consider the premise of the full meaning of sustainability. They should avoid merely making attempts to employ conventional measures that delay an inevitable crisis without addressing and completely eliminating the root causes of unsustainability (Kopnina 2016). We conclude that HEIs can play a critical role in the accomplishment of the UN SDGs if fully supported financially and by appropriate policies.

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11 University Environmental Hackathons to Further the Sustainable Development Goals

Sanjana Paul

11.1 Introduction

Hackathons, time-intensive events focused on solving real-world problems, are becoming an increasingly popular approach to rapidly generate solutions to various problems and promote creativity and innovation. Their prevalence among college campuses and corporate settings is increasing, with variation in time frames and participants. While traditional hackathons began in software engineering, recent years have seen a flux in the diversity of students participating. Even with the expansion of hackathons, participants still remain primarily those within or entering the field of software engineering. With some prospective thought and planning, the hackathon concept can be applied to a diversity of problem areas and concurrently attract participation from individuals of diverse backgrounds and expertise to create interdisciplinary solutions to problems from a variety of fields.

This chapter discusses the creation of Earth Hacks, a purpose-driven interdisciplinary hackathon focused on generating innovative, actionable solutions to pressing environmental problems. Earth Hacks was established with two main areas of focus. Firstly, to allow participants to develop and practice existing skills in ingenuity, problem-solving, and critical thinking. Secondly, to expose a diverse group of students to the current and potential impacts technology and interdisciplinary collaboration can have towards environmental issues. It was crucial to balance a positive student experience with the necessary environment to not only promote retention of participants for subsequent events, but also create practical solutions to environmental issues, along with providing resources to continue projects.

We discuss the ideation process and organizational structure of Earth Hacks event, as well as strategies to make the hackathons environmentally friendly events. We also detail the multidisciplinary approach we integrated into Earth Hacks events from the onset of the planning and ideation processes, as well as how we structure judging criteria to be able to take into account the multidisciplinary nature of the projects. We believe that hackathons can be a powerful tool to advance the Sustainable Development Goals (SDGs) and hope to be able to create a global community of student leaders dedicated to breaking down barriers in tech and applying their skills to solving environmental problems.

11.2 Hackathon Background

A hackathon is a defined period of creative problem-solving, ideation, and innovation within a specific theme or discipline. Students with

S. Paul (✉)
The Earth Hacks Foundation, Richmond, VA, USA

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different backgrounds and interests form teams and work together to develop an innovative and feasible solution to a proposed challenge.

Hackathons can be considered similar to many other types of tournaments, including sporting events. In light of this interpretation of hackathons, regulatory organizations such as Major League Hacking (MLH) have sprung up, the college hackathon league recognized worldwide that has hosted events across North America and Europe thus far. One such tournament format that hackathons can be considered similar to are innovation tournaments, such as those hosted by large corporations to innovate their product lines.

While hackathons are well-known in the twenty-first century, they are not the only means of rapid innovation. In "Innovation Tournaments: Creating and Selecting Exceptional Opportunities," authors Terwiesch and Ulrich (2009) of the Wharton School at the University of Pennsylvania define innovation "broadly as a new match between a need and a solution… Our definition of innovation encompasses hardware, software, services, and processes as well as needs that are exhibited anywhere, whether in a factory, a consumer marketplace, or the public arena. The science of innovation tournaments applies across all of these domains. Indeed many of the key ideas apply to tournaments of all kinds, even beyond those used to identify innovations."

This is certainly characteristic of the areas explored within hackathons as well, as indicated by the authors. They continue, "At the most basic level, an innovation tournament is a competition among opportunities, embodying the Darwinian principle of the survival of the fittest. Before the value from an exceptional opportunity is realized, at its inception as a chemical cocktail in a Petri dish or a sketch on a napkin, it competes with many other opportunities to become one of the chosen few… While randomness and serendipity clearly underlie the fate of any particular opportunity, we believe that deliberate management of a system we call an innovation tournament can introduce professional rigor to the innovation process, the same rigor you likely apply in other parts of your business, whether financial budgeting or supply chain management" (Terwiesch and Ulrich 2009).

Terwiesch and Ulrich also note the similarity between innovation tournaments and more traditionally recognized competitions—"An innovation tournament, just like its counterpart in sports, usually consists of multiple rounds of competition. It begins with a large set of opportunities. A filtering process selects a subset to move to subsequent rounds and, from those, picks one or more champions."

Traditionally, only those interested in software engineering or traditional programming participate in hackathons. While the use of the word "hackathon" has only risen to mainstream prevalence in recent years, the first hackathon on record (i.e., being the first event referred to as and using the term) was the 1999 OpenBSD hackathon in Calgary, Canada (Richterich 2017; Openbsd.org 2019). The gathering was extremely informal and consisted mainly of a group of people active in the tech community getting together and working on projects. This simple concept spread like wildfire and soon enough, major companies such as Sun Microsystems were hosting hackathons of their own (Richterich 2017).

The first university hackathon is widely regarded as being PennApps at the University of Pennsylvania. Started in 2009 and with an initial attendance of 17 teams, the event has grown to reach more than 2000 hackers in 2015 (Pennapps.com 2019). University hackathon growth is typical, with events becoming larger each year. Universities may host more than one hackathon, and they are typically annual events that are open to students enrolled in universities anywhere. The exact timing and structure of hackathons hosted by individual campuses may vary significantly.

More nontraditional hackathons, such as those focusing on subject areas outside the traditional scope, tend to maintain this ethos as well, with details about projects being available for reference online, whether or not they are primarily composed of software.

In recent years, hackathons have expanded to encapsulate a wide range of disciplines, including healthcare (D'Ignazio et al. 2016) and civic

innovation (Linnell et al. 2014). Hackathons are particularly popular among universities, where they promote student entrepreneurship, integrative collaboration across disciplines, and school image. Unfortunately, the term "Hack" is still associated exclusively with programming, and in particular illegal activities such as cyber attacks. However, in the context of a hackathon, to "hack" means something completely different. As Major League Hacking, the official hackathon league known worldwide, defines it, "hacking has started to transition into a positive term describing the actions of innovators who are creating prototypes of their ideas" (Mlh.io 2019).

This definition is not limited at all to just software, or even to just hardware. Innovators creating prototypes of their ideas can be from any discipline/background, and especially with something as broad as environmental issues its fine. Because of the unique nature of many issues and the increasingly interdisciplinary nature of projects in various sectors, hackathons are uniquely suited to being adapted to specifics from various fields. One prime example of this is environmental hackathons.

An environmental hackathon is an event that applies the hackathon innovation model to environmental problems (Zapico et al. 2013). The solutions to the problems do not always have to involve technology. They can be an innovative way of approaching a problem that has not been considered before, a reframing of an already existing solution, or a proposal within a non-technical sphere such as public policy.

Environmental hackathons respond to the challenge of allowing young people to take an active role in their future by combatting various aspects of the causes and effects of climate change. The scope and importance of addressing the threat of global climate change are huge, as evidenced by a number of high profile reports in recent months (Unenvironment.org 2018; Ipcc.ch 2018; Nca2018.globalchange.gov 2018) as well as general consensus among the scientific community.

Environmental hackathons have taken place before, notably CleanEarthHack at MIT (Cleanearthhack.mit.edu 2015; Fishackathon.co 2019), initially hosted by the US Department of State, and Green Hackathons, developed by KTH Royal Institute of Technology in Sweden and implemented in major cities throughout Europe (Greenhackathon.com 2017). Some of the hackathons have been more educational in nature and thus have not encouraged their participants to continue their work on their projects after the hackathon ends, while others are focused more on driving innovation and follow up with participants after the event to explore the possibility of continuing their projects.

There are commonalities between all these events that distinguish them as environmental hackathons. The core, most important defining characteristic of these environmental hackathons is that they apply the traditional hackathon model to current environmental problems. Distinctions between environmental hackathons primarily arise in the area of focus as well as their model—that is, whether the event is primarily educational or more focused on the creation of environmental solutions.

11.3 Earth Hacks Background

While a number of environmental hackathons exist already, they are singular events that occur at different, geographically separated universities that usually do not collaborate with each other. In order to create a successful environmental hackathon environment, The Earth Hacks Foundation addresses this gap in the solution space by serving as a centralized body to administer and provide support to environmental hackathons that choose to align themselves with Earth Hacks in some capacity.

Furthermore, most environmental hackathons—and many traditional hackathons—do not currently place emphasis on post-event follow-up and support of students. The Earth Hacks Foundation makes this a core part of our model and focuses on providing resources to students to continue working on their projects and bring them to fruition after the initial hackathon is over.

Earth Hacks harnesses the hackathon innovation model of empowering innovators to work on

prototypes and implementation of their ideas, no matter what the field of discipline they are in. We use the Earth Hacks hackathon events as starting points for environmental innovation, recognizing that while hackathons are extremely useful for generating ideas for solutions to pressing problems, actual sustainable implementation of these ideas in a way that they are able to persist requires a much larger investment of time.

With this in mind, The Earth Hacks Foundation provides support to environmental hackathon organizing teams at various universities while they are in the process of organizing the event, and maintains the partnership on a yearly basis. In the aftermath of the event, we switch our focus to primarily supporting the students who attended the Earth Hacks affiliated event, providing traditional prizes in addition to access to resources such as mentorship or funding opportunities to continue working on their ideas and bring them to fruition. This may be accomplished through direct contact with The Earth Hacks Foundation, or by connecting students to partners of the foundation who would be most beneficial to their particular project.

The Earth Hacks Foundation's Mission Statement is "Empowering hackers to generate innovative, actionable solutions to pressing environmental problems." The ultimate goal of Earth Hacks empowering student hackers is to make a tangible difference in climate change mitigation—if even one cause or effect of global climate change is significantly remediated or solved directly by the work of someone supported by The Earth Hacks foundation, we will have been successful in our mission.

The mission of Earth Hacks is to deliver financial, logistical, and operational support and strategy to students of all academic levels and backgrounds who are organizing environmental hackathons. The work of Earth Hacks includes community organization, engagement, and leadership, as well as providing access to hackathon resources and connections.

Earth Hacks seeks to break down barriers between fields of inquiry and bring together students from all disciplines to rapidly generate solutions to pressing environmental problems using the hackathon innovation model. Earth Hacks aspires to advance the United Nations sustainable development goals while embracing the ethos of the maker movement. We will pursue and advocate for transformative solutions that enable individuals to contribute to the global fight against climate change, demonstrating the potential that curious, motivated students have to change the world.

Our primary goal of empowering hackers to generate innovative, actionable solutions to pressing environmental problems is chiefly accomplished by combatting lack of access to environmental education, opportunities, and funding.

The theoretical framework of The Earth Hacks Foundation harnesses the traditional hackathon innovation model in conjunction with those used by innovation tournaments and educational models. Our approach is to remain as student driven and student led as possible, with The Earth Hacks Foundation simply serving in a support role and central coordination body as the student organizers create their individual events at various universities. The main areas of the theoretical framework include the Pre-Hackathon, During the Hackathon, and After The hackathon.

During the Pre-Hackathon phase, the Earth Hacks Foundation provides logistical and operational support to hackathon organizers. This is primarily in the form of the Earth Hacks kit, which is the core content of The Earth Hacks Foundation. The Earth Hacks kit mainly provides support in the form of:

- Advertising resources
- Timelines
- Social media graphics
- Sponsorship resources
- Earth tracks—environmental hackathon challenge areas
- Judging structure, rubric, and guidelines

During the Hackathon and in its current state, The Earth Hacks Foundation's pre-hackathon resources being used during the Earth Hacks event is how day-of-support from The Earth Hacks Foundation is implemented. However, as

the organization grows, funding for additional resources will become available. After The hackathon, much of the support of The Earth Hacks Foundation that is not to be found elsewhere with regard to the environmental innovation space in particular is after the hackathon. In order to bring students' projects to fruition, post-hackathon support is needed in a myriad of ways, including but not limited to: funding, mentorship, and advertising

The Earth Hacks Foundation creates partnerships and programs to support students work by forming relationships with local partners in the form of accelerators and local programs. Youth and current university students make up the majority of the population that will bear the brunt of the effects of climate change, and are becoming increasingly invested in addressing the climate crisis as it poses a threat to our existence, and are expressing interest in mobilizing more. The youth climate movement is becoming a global one, and as technological spaces are at the forefront of innovation and information movements, it can be assumed that environmental hackathons may become increasingly popular in the coming years.

We propose empowering hackers to generate innovative, actionable solutions to pressing environmental problems. We do this through The Earth Hacks Foundation, a nonprofit organization that works with students at various universities to create environmental hackathons aimed at students from all backgrounds. The Earth Hacks Foundation primarily seeks to drive environmental innovation. It does so by using the environmental hackathon events—Earth Hacks events—as starting points for students to begin working on solutions to environmental problems. To ensure these ideas are able to be brought to fruition, The Earth Hacks Foundation forms partnerships that support students in various ways, whether it be access to funding and mentorship or advertising and exposure.

Secondarily, The Earth Hacks Foundation seeks to break down barriers to entry in tech fields so that the perspectives, ideas, and contributions of those not traditionally included in hacker culture are taken into account. This is in continuation with the ethos of the maker movement, which has been hugely influential in creative and technological spaces in recent years. (Halverson and Sheridan 2014) Environmental problems are not just limited to the technological sphere and as a result cannot be solved by technological solutions alone, which is why Earth Hacks promotes cross-disciplinary collaboration among the arts, humanities, sciences, and all other fields.

Many university students, while aware of climate change and related issues, are not aware of how they can make a meaningful contribution towards mitigation. Hackathons provide a democratization of access to information and opportunity, and environmental hackathons can serve as educational events for:

- Students who were not previously aware of environmental issues to become aware of environmental issues
- Students who were not previously aware of environmental issues to apply their skills from entirely different fields to create solutions to the environmental issues they learn about
- Students who were aware of environmental issues to learn more about them
- Students who were aware of environmental issues to become more actively involved in climate change mitigation activities
- Students who were aware of environmental issues and noticed a gap in the solution space to act on their ideas

In some cases, even if students have concerns, ideas, or solutions they would like to implement, they do not have the capacity to do so, mainly due to a lack of resources such as time, knowledge, or access to more brain power to bring their idea to fruition. Hackathons address all these gaps individually. By setting aside 24 h solely dedicated to defining and developing solutions to problems, students are able to get a considerable amount of work done as evidenced by the quality and quantity of "hacks"—hackathon products—that can be observed from most hackathons.

Hackathons are particularly effective at addressing knowledge gaps. Many environmental hackathons provide well-defined challenge

and problem areas with backgrounds and sources. Furthermore, hackathons, whether traditional or not, provide mentorship for the students attending, usually by asking professors from the university it is being hosted at to attend and provide guidance, as well as asking representatives from any corporate or community sponsors who are providing fiscal or other support to the hackathon, environmental or otherwise, to attend and bring their perspectives and experience to share with students.

In addition to mentors being present, hackathons usually have workshops during which students can explore one particular skill in depth, usually led by a mentor or a representative from a sponsor or by an organizing team member. These workshops can over any subject that is relevant to the hackathon in some way, and may be technical, non-technical, and involve a hands-on activity or be structured more similarly to a traditional presentation.

Hackathon culture, while often touted as innovative, can still sometimes be close-minded when focusing only on traditional problems in software or focusing solely on computer science education. Environmental hackathons and other nontraditional hackathons fill a gap in the cultural sustainability and model of hackathons, and secondarily support the social sustainability as well by bringing in people from different fields, and hence new perspectives. These both allows people who do not have computer science or technical backgrounds to interact with the field in an informal way, possibly lowering barriers to tech education entry in the future, and allows students with technical backgrounds to experience firsthand the value of working on interdisciplinary teams.

Hackathons are breeding grounds for new ideas and hubs of innovation. The quality and quantity of projects produced over the course of what is usually 24 h, for most hackathons, is evidence of this. However, even though hackathons are time-sensitive events, the problems being solved are typically not time-sensitive ones. Because of the short time frame we have to limit global climate change to a manageable level (ipcc.ch 2018), climate-related environmental problems are some of the most time-sensitive and pressing that we face today. The Earth Hacks Foundation seeks to fill that gap with Earth Hacks events at various universities.

There may be other aspects of students' experiences that contribute to bottlenecks in innovation, whether in the environmental field or otherwise. As more hackathon events take place and more data is collected, we will seek to identify and remedy these gaps as well to be able to ensure as many students as possible are able to implement their solutions.

One large assumption that is important to the success of The Earth Hacks Foundation and environmental hackathons elsewhere is that the biggest issue that motivated student face is lack of access to opportunities to implement their solutions, rather than climate change apathy or another personal issue regarding human behavior. As Earth Hacks events progress and the global youth climate movement grows, the solutions will be further monitored to evaluate their progress and the progress of those implementing them.

The intended end users of the Earth Hacks innovation model are university students bringing their ideas to fruition, whether they be technical products, other products, business plans, programs, urban planning initiatives, educational platforms, or anything else. While most hackathons held on university campuses involve professors and administrative staff to a certain extent, the majority of the workload, ideas, and vision for the event, as well as running it on the day or days of, is undertaken by university students. These students are primarily undergraduate, especially in recent years as the popularity of hackathons continues to grow, but can also include graduate students.

We have evaluated past environmental hackathons and used the lessons we learned from all of them to develop The Earth Hacks Foundation's innovation model. The primary difference between The Earth Hacks Foundation and other environmental hackathons are twofold:

Firstly, the continued emphasis on interdisciplinary collaboration while still using the title "hackathon." There are a number of other environmental innovation events, such as Plan-It Earth at Georgetown University

(Georgetownplanitearth.com 2019) or Blueprint at Duke University (Dukeblueprint.com 2019), that emphasize an interdisciplinary approach but do not explicitly harness the hackathon innovation model and hackathon culture.

Secondly, the emphasis on post-event follow-up with students to ensure that their projects can come to fruition. Most hackathons, environmental or not, limit their involvement to the 24 h—or however long the timeline of the individual event is—of the event, after which their involvement with students is minimal until advertising for the next year's hackathon begins. The Earth Hacks Foundation focuses on post-event follow-up primarily with student participants and partners, but secondarily with Earth Hacks organizers.

The financial model for The Earth Hacks Foundation as a nonprofit organization is a hybrid of traditional fundraising strategies employed by nonprofit organizations and those employed by student hackathons.

Intellectual property that students generate at Earth Hacks events is their property, and they can choose whether or not to move forward with their projects and what they would like to do with their creations.

11.4 How Environmental Hackathons Further the Sustainable Development Goals

The sustainable development goals (SDGs) can guide many areas of innovation across the various disciplines to cover and they were created as a result of noticing a lack of action to solve these problems in an effective manner. While various ways to further the SDGs (Patrick et al. 2019; Foody et al. 2019; Mishra 2019) hackathons are a novel approach that have not yet been harnessed at a larger scale. Such ways are important to harness hackathons as tools to further the SDGs for two main reasons: (1) as a youth movement and (2) to harness technology in a timely manner. As a youth movement, these hackathons will include youth in the fight against global climate change is crucial as youth are the ones who will bear the majority of the issues caused by it. By providing venues and opportunities for students to work and share their work and ideas, we are ensuring this is possible. From harnessing technology in a timely manner, hackathons utilize different types of innovation model than have traditionally been used in dealing with the SDGs. Hackathons are becoming super popular and it is also important to ride the wave of momentum, but it is as important to learn from the mistakes that have already been made in the hackathon community and learn from them, as well as adapt environmental hackathons to be more particular to the problem areas we seek to address.

Eventually, environmental hackathons produce tangible solutions to many of the issues that SDGs aim to mitigate, and with proper guidance from subject matter experts, it is possible that the outside perspective students bring could generate extremely valuable intellectual property that could be harnessed and developed further by them to become concrete solutions.

11.5 Post-hackathon Follow-Up for SDG Implementation

By using accelerators in schools and local partnerships within the university to elevate students and their ideas, The Earth Hacks Foundation's approach allows more students to bring their projects to fruition. Earth Hacks events in particular are meant to serve as starting points for environmental innovation and are by no means the final iteration of the projects. This is another difference between traditional and nontraditional hackathons—traditional hackathons tend to end with the presentations, while Earth Hacks events mark the starting point of the innovation process for the students.

There are twin main areas of follow-up that The Earth Hacks Foundation currently supports, with plans to add more as we better understand the nature of the support the students we are working with require. These areas include follow-up on services and websites and follow-up on products, each of which encompass follow-ups on explicitly technical ideas and explicitly non-technical ideas. Follow-up on explicitly technical ideas focuses on explaining how we work with accelerators, labs,

and local partners and organizations dedicated to innovation. Follow-up on explicitly non-technical ideas focuses on explaining how we work with accelerators, labs, and local partners and organizations dedicated to innovation.

Within the confines of The Earth Hacks Foundation post-event support model, both technical and nontechnical ideas are equally valid, and no one type of solution is considered to have more merit than another. For example, public policy is a huge aspect of environmental innovation, and well-researched implementation plans that contribute to this area can win Earth Hacks events. Furthermore, the delineation between technical and nontechnical projects is not entirely binary or straightforward, as there are multiple areas of overlap and interdisciplinary projects are common. The Earth Hacks Foundation plans to continue to assimilate data from projects from hackathon events to inform a more rigorous model for evaluation.

Hector Postigo, a Professor of media at Temple University whose work focuses on digital media and technologically mediated activism, proposed the concept of "technology as resource and opportunity." He suggests "[t]hinking of technology as a resource is to think of it not only as a functional resource, but also as a linguistic resource. Technology speaks a certain kind of language about cultural production" (Postigo 2012: 177). He also expounds on technology as opportunity allowing "particular relationship between consumers and content" (Postigo 2012: 177). This argument is also reflected in Coleman's (2004: 507) examination of the "informal politics" of FOSS. Coleman describes this technology as a "catalyst by which to rethink the assumptions of intellectual property rights through its use and inversion" (Coleman 2004: 508; see also Wark 2013).

11.6 Collaboration with Universities and Students

The Earth Hacks Foundation generally adopts a parent and chapter model to work with teams of university students organizing environmental hackathons, where The Earth Hacks Foundation is the primary governing body and the satellite student chapters at various universities can access support from the central body by registering with us. This allows these chapters to get off the ground more easily as they are given support that student organizations at various universities receive, which may or may not include funding, insurance, and access to other resources. The Earth Hacks Foundation has two main methods of working with universities through chapters that include: Stand-Alone Events and Integrated Events.

Stand-Alone Events are the traditional implementation of both Earth Hacks and any hackathons that operate at multiple universities. With a stand-alone event, The Earth Hacks Foundation provides a greater amount of resources, including the Earth Hacks kit, access to graphics for social media, stickers, logo usage permission, advertising, connections to the Earth Hacks network, support from the Earth Hacks team and access to the Earth Hacks team to ask questions, as well as follow-up support to allow the students to implement their solutions. In Integrated Events, Earth Hacks involve an Earth Hacks "track" that is incorporated into a pre-existing hackathon. The Earth Hacks Foundation still provides a significant amount of support to integrated Earth Hacks events, but primarily in the form of intellectual property such as hackathon challenges ("Earth Tracks") and rubrics and suggestions for judging projects, as well as support for the Earth Hacks track winners. Since the advertising and sponsorship efforts of integrated Earth Hacks events are mainly focused on the main hackathon into which an Earth Hacks track is being integrated, The Earth Hacks Foundation does not provide an excess of advertising, social media, and sponsorship resources.

The Earth Hacks kit for partners is intended for use by student hackathon organizers that The Earth Hacks Foundation partners with at various schools. The kit is distributed after an agreement of some form is created between the Earth Hacks organizing team at a remote university and The Earth Hacks Foundation so that the responsibilities and deliverables of both parties are clearly outlined before any work begins.

The Earth Hacks kit for advertising is meant to be an informational document about the work The Earth Hacks Foundation does and provide up-to -date information for potential partner organizations who see a mutually beneficial relationship in supporting the projects created by students at Earth Hacks events.

For environmental hackathons, as with traditionally software-focused hackathons, it is important to clearly communicate the objectives of the event. Advertising plays a key part for an event like an environmental hackathon, as it is important to communicate the merits of a hackathon rather than something similar, like a design sprint, to non-technical audiences, and the merit of interdisciplinary teamwork and the exposure to environmental issues to more traditional technical audiences.

Universities should take care to support their student hackathon organizing teams because of the value it can bring to a university, including being perceived as innovative. There are also many intangible benefits like the possibility of a successful business or enterprise coming out of a hackathon project which provides additional exposure for the school.

11.7 Conclusion

This chapter provides an overview on the history and development of hackathons to provide a background for environmental hackathons aimed at undergraduate university students and focusing on environmental innovation. Environmental hackathons demonstrate the potential that student-developed technology and ideas have to combat environmental issues. They allow students to apply the hackathon model of innovative problem-solving to problems related to those that fall under SDG 13 dealing with Climate Action. Environmental issues present a challenging obstacle for the twenty-first century, and novel solutions are needed to address them. Moving forward, the objective of Earth Hacks and other environmental hackathons will be to generate these solutions by providing a competitive and collaborative environment for students. Real-world problems require inventive solutions to properly address their complex nature. Hackathons can be a powerful tool to not only foster practical, innovative, and implementable solutions to real-world problems, but also to advance the SDGs. In this context, we are grateful to have the opportunity to assist students in creating environmental hackathons through The Earth Hacks Foundation, because through Earth Hacks events, and through events like them, we can further realize these ideals.

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12 Learning and Teaching Practices Promoting Education for Sustainable Development: Case Studies from Social Studies and Language Education, University of Botswana

Annah A. Molosiwa and Keene Boikhutso

12.1 Introduction

This chapter explores the types of pedagogical approaches and assessment practices in teaching and learning that are more likely to promote education for sustainable development (ESD) in social studies and language education courses at undergraduate level at the University of Botswana. ESD is credited for promoting learning practices that facilitate active engagement and social interaction in higher education (Armstrong 2011). Kevany (2007) and the United Nations Educational, Scientific and Cultural Organization, UNESCO (2005) aver that by its nature, ESD seeks to develop citizens who have knowledge, skills, and values that support sustainable behaviour. The idea is to prepare reflective and flexible learners to meet the social, environmental, and economic challenges. This process requires the reconceptualization of how and what learners should learn (UNESCO 2005). It also resonates with issues of identity and marginality. According to Armstrong (2011) social interaction requires learners to make personal reflections and tackle real-life problems as they interact amongst themselves and the world they live in.

Improved educational quality and lifelong learning opportunities are critical for the twenty-first century knowledge-based economy. Kang and Xu (2018: 339) contend that:

> …higher education is not only an integral part of sustainable development, but also a key enabler for it. Universities, with their social functions of creation and dissemination of knowledge and their unique position within society, have a critical role to play in the achievement of the Sustainable Development Goals.

Specifically, higher education institutions can help improve the quality of learning and teaching. Higher education has a unique role in helping to achieve sustainable development goals (SDGs) in that it is critical for equipping learners with requisite knowledge and skills needed for implementing the goals (Blessinger et al. 2018).

ESD is credited for promoting learning practices which facilitate active engagement and social interaction in higher education (Armstrong 2011). UNESCO (2005: 9) proclaims that there are five elements of ESD: (1) education that allows learners to acquire the skills, capacities, values, and knowledge required to ensure sustainable development; (2) education dispensed at all levels and in all social contexts (family,

A. A. Molosiwa (✉) · K. Boikhutso
Department of Languages and Social Sciences Education, University of Botswana, Gaborone, Botswana
e-mail: molosiwaa@mopipi.ub.bw; Boikhutso@mopipi.ub.bw

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school, workplace, community); (3) education that fosters responsible citizens and promotes democracy by allowing individuals and communities to enjoy their rights and fulfil their responsibilities; (4) education based on the principle of lifelong learning; and (5) education that fosters the individual's balanced development. This chapter adopts the UNESCO definition of ESD:

> Education for Sustainable Development means including key sustainable development issues into teaching and learning; for example, climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption. It also requires participatory teaching and learning methods that motivate and empower learners to change their behaviour and take action for sustainable development. Education for Sustainable Development consequently promotes competencies like critical thinking, imagining future scenarios and making decisions in a collaborative way (UNESCO 2014).

According to this definition, effective learning and teaching under ESD requires strong linkages between content and pedagogy approaches. This definition is applicable to teacher education courses as it encompasses both content and pedagogy. In addition, the chapter draws from Longhurst (2014) who defines education for sustainable development as "the process of equipping students with the knowledge and understanding, skills and attributes needed to work and live in a way that safeguards their environmental, social and economic well-being, both in the present and for future generations". This definition outlines the learning outcomes students need to acquire in order to perform according to demands of sustainable development in the world of work and in society.

Although secondary school teachers are expected to infuse global issues in their respective subjects at the secondary school level, many of them are unable to do so. A common reason for this inability is that teachers lack the knowledge and skills to effectively integrate issues that are pertinent to sustainable development in their classroom settings. An evaluation study conducted to review the senior secondary school curriculum in Botswana revealed that some teachers infused emerging issues in their teaching subjects while others decried lack of knowledge on how to infuse them (Ministry of Education & Skills Development 2009). Generally, teachers felt that there were subjects in which infusion was easier but difficult in others. The 1993 Commission on Education recommended that in order to achieve the goals of the Junior Certificate curriculum, "compartmentalization of subjects should be avoided and every effort should be made to establish linkages between the subjects in a holistic way" (Republic of Botswana 1993: 155–156). At the time, the purposes of junior secondary education were; "firstly, to provide the knowledge and skills upon which further education and training can be built; and, secondly, to provide the competencies and attitudes required for adult life and the world of work" (Ibid: 155). It is evident from these objectives that the Botswana government has long embraced education for sustainable development. Failure by educators to embed ESD into their subjects and disciplines could be due to lack of being capacitated to do so by the then Ministry of Education. This situation is not unique to Botswana as studies conducted in some developed countries also show that ESD is not incorporated in many subjects in higher education. A study carried out at the University of British Columbia in Canada, Moore (2005) revealed that the discipline-focused organisational structure of the university was a barrier to implementing sustainability initiatives. In a study commissioned by the Higher Education Academy in the United Kingdom, Dawe et al. (2005) identified four major barriers to the successful embedding of ESD into many of the subject disciplines in higher education. These were: overcrowded curriculum, perceived irrelevance by academic staff, limited staff awareness and expertise, and limited institutional drive and commitment.

To overcome barriers, Moore (2005) recommends that higher education should put more emphasis on transdisciplinary research and teaching. In response to those who perceive ESD as overcrowding the curriculum, Moore cautions that "sustainability education is transdisciplinary in nature and should not be thought of as a new subject or discipline" Moore further recommends that

"educators should provide collaborative working spaces for learners where they could exchange ideas, feelings and experiences" (Ibid: 551–552).

It is against the foregoing discussion that this chapter explores the pedagogical approaches and assessment practices in teaching and learning that are likely to promote ESD in disciplines such as social studies and language education at undergraduate level at the University of Botswana. The chapter seeks to address these two key questions: (1) which pedagogical approaches can be employed in humanities disciplines to embrace ESD? (2) How can students be assessed to measure the extent to which they have acquired the knowledge, skills, and attributes needed to participate in sustainable development? The chapter shares experiences and attempts that have been made by two instructors in incorporating ESD issues into their courses in the Department of languages and Social Sciences at the University of Botswana (UB). The instructors have participated in ESD workshops since 2013 as part of capacity building targeting higher education institutions in Southern Africa. The section that follows describes how the University of Botswana (UB) has approached ESD and the policies that have been created to support it.

12.2 ESD at the University of Botswana

Education for sustainable development is the critical component of the UNESCO's promotion of United Nation's (UN) efforts to ensure that the education sector play a critical role in the sustainable development drive. This is part of the UN's United Decade of Education for Sustainable Development initiative. ESD is an ambiguous and contested concept which brings about uncertainty. Approaches to ESD also differ substantially from one context to the other. There is also no consensus about how to achieve sustainability given that the concept is complex and its implementation, problematic and contextual (Hensley 2017). Given the complex and ambiguous nature of ESD, discourses and approaches are varied and contested. Consequently, actors in this place make decisions based on their diverse viewpoints.

The University of Botswana has put in place policies that enhance mainstreaming of environmental issues in the curricula of all courses offered across its various faculties. The aim is to deepen awareness and ensure that environmental and sustainability issues are incorporated into teaching and learning, research and community engagement. These initiatives are also articulated in the University of Botswana (2001, 2010). For example, the Faculty of Education requires that all Bachelor of Education Secondary teacher education students take environmental education courses as core. This is in response to the recommendations (REC.44 para.5.10.29 b, e, and f) that were passed by the 1994 Revised National Policy on Education. The recommendations read:

(b) Environmental education has a key role in secondary education and should be incorporated into all subjects.
(e) Teachers must be trained in the methodologies, at both pre-service and in-service levels, for environmental education to ensure that learning results in attitudinal changes and citizenship participation.
(f) Educational institutions, starting with the teacher training institutions and the University of Botswana, should develop an environmental ethos and set an example to the rest of the community.

To deliver on these recommendations, in the academic year 2018/2019, the Faculty of Education at UB introduced Master of Education (M. Ed) in Environmental Education programme. This was prompted by various reasons which included providing opportunity for further studies for Bachelor's degree graduates who studied environmental education and those with the Post Graduate Diploma in Education (PGDE) qualification who majored in Environmental Science at Bachelor's degree level. This development is also part of the drive and emphasis to create an educated and informed nation that would be able to participate nationally and globally in issues to deal with environmental protection and conservation in view of climate change and other environmental risks and challenges.

In this context, the Government of Botswana shares the notion that higher education institutions have to lead the implementation of the SDGs. On February 22, 2018, the Ministry of Finance and Economic Development in conjunction with the UN and UB launched the Botswana SDGs roadmap. The president who at the time also was the UB Chancellor highlighted the importance of domesticating and localising SDGs. The alignment of SDGs to National Development Plan 11 provides a strategic tool for tracking, monitoring, and implementation of priority areas. One such priority area is policy research and innovation. It is envisaged that UB and other research institutions will drive research to fully achieve SDGs. This drive includes the development of relevant and quality courses and programmes at UB and other institutions. The government of Botswana has also systematically mapped SDG indicators into the current Vision 2036—the country's development plan (Government of Botswana 2016). This vision has four pillars relating to the SDGs. For example, Pillar 1 focuses on sustainable economic development including issues of affordable and clean energy, inclusive and sustained growth. Pillar 2 focuses on human and social development issues such as poverty reduction, quality education, gender inequality, and issues of health and well-being. Pillar 3 dwells on a sustainable environment and specifically on issues of clean water and sanitation and climate action. Pillar 4 highlights issues of governance, peace and security, promotion of inclusive society, and the development of partnerships (Government of Botswana 2016). The domestication of SDG indicators is an important milestone but requires sustained political will to ensure full and effective implementation.

12.3 Theoretical Framework: Teachers' Reflective Habits to ESD

The constructive discussion of learning and teaching approaches which promote reflective habits and mind-set are better framed through the application of theories that promote reflection and learning from own experiences. According to Fidller and Marienau (2008) and Rogers (2001), there is a close association between reflection inquiry and reflective habits. Rogers (2001: 41) contends that "the intent of reflection is to integrate the understanding gained into one's experience in order to enable better choices or actions in the future as well as enhance one's overall effectiveness". In fact, reflective habits are better understood within the context of reflection as an inquiry. The main idea is to prepare learners who are aware, sensitive, and able to make sense of and connect with the environment in which they live (Shapiro et al. 2006).

The general consensus amongst scholars is that reflection ideally goes hand-in-hand with active participation and the ability for a person to interrogate his/her social context. This resonates with the issue of reflexivity and critical reflection. Fook (1999) avers that the use of reflexivity helps learners to make connections with the broader social, cultural, and structural environment: that is, learners are prepared to understand how their ideas, beliefs, and assumptions are partly influenced by the social contexts. Learners are made to appreciate that "what we see, hear, touch, feel, think, taste, and smell" ideally should be accompanied by non-judging attitude and accommodation of multiple perspectives (Fidller and Marienau 2008). This chapter adopted issues of reflection as inquiry, reflexivity, and reflective habits because these are compatible with the conceptualization of sustainable development (SD), ESD, and SDGs, particularly in the context of promoting critical learning and teaching contexts.

In the context of the growing educational, economic, environmental, and social challenges, issues of sustainability and how they are approached are at the centre of policy development and practice (Hensley 2017). According to Hensley (2017), habits are not simply actions repeated by teachers but are rather deep and a complex set of activities. Reflective actions are habits which provoke teachers to think deeply and critically about their teaching. In doing so, teachers simultaneously think about the purpose and the uncertainty of education outcomes.

Understanding teachers' reflective habits is useful and represents a realistic approach to the reality of pursuing sustainability despite the inherent operational challenges. Teachers' habits are shaped contextually through interaction as part of their daily teaching routine. In addition, teachers' habits are shaped socially through their understanding of the purposes of education and customs which ultimately give rise to collective habit. Teachers also shape their pedagogical practices based on the best way to reach students and encourage active learning. It is also possible that some of the teachers are not able to articulate the deeper meanings of their habits. In the context of ESD, uncertainty and unpredictability of working towards sustainability is often ignored and taken for granted.

In terms of application, Hensley (2017: 23) posits that the "cultivation of reflective habits helps teachers deal with uncertainty and risk, which are an important part of the pursuit of sustainability in ESD". Several approaches can be used to cultivate critical reflection. For example, reflective questioning can help teachers to acknowledge their underlying habits and purposes in education and adjust their approaches appropriately. It is established that teachers' reflective habits and approaches provide some indication of their ideas about ESD; reveal purposes beyond teaching or ultimate goals for student learning and sustainable change. More importantly, the habits help teachers in terms of topic selection and deciding on themes and concepts that are important for student learning and promotion of critical thinking and analytical skills (Hensley 2017).

12.4 Methodology

The chapter is premised on narrative inquiry approach, a component of sociocultural theory. It focuses on examining and understanding how human actions are related to the social context in which they occur (Moen 2006). In spite of its contested nature, narrative inquiry is increasingly used in studies that explore educational practices and experiences. Some scholars see it as a method of inquiry located within qualitative and interpretive research while others portray it as a frame of reference in a research process (Gudmundsdottir 2001; Heikkinen 2002). Narrative inquiry is preferred because of its proximity to sociocultural theory and social constructivism. At the centre of the debates is the idea that individuals are part and parcel of our society. Similarly, the society exerts influence on human thinking and human behaviour and thus impacts society.

The authors have adopted the position taken by Moen (2006: 57) who perceives narrative inquiry as a "frame of reference, a way of reflecting, during the entire inquiry process, a research method, and a mode for representing the research study". Such an approach is informative in that it allowed the authors to explore pedagogical approaches which are associated with ESD particularly with respect to the teaching of social studies and language education courses at undergraduate level in the University of Botswana.

Data for the chapter are based on desktop literature, document analysis, and examples of practices from two courses taught by the authors of this chapter; one from Social Studies and the other one from language education. Having participated in ESD workshops, the two lecturers infuse ESD issues in the courses they teach. The social studies course is used to illustrate ways in which students could be assessed to measure the extent to which they reflect on issues critically, thereby demonstrating achievement of the crucial outcome of social justice in this area of learning. Past examination papers of a course titled "Social studies and nation building" were analysed, employing qualitative research methodology utilising document analysis of primary and secondary sources of data. We acknowledged that document analysis is an important research tool in its own right capable of producing reliable data (O'Leary 2014). It is a process of "evaluating documents in such a way that empirical knowledge is produced and understanding developed" (Bowen 2009: 33). The process entailed three steps. In the first step, we appreciated that the documents we used were the original work of 200 students which constituted part of their summative assessment. Under the second step, we

recognised that the use of student work has implications for ethical and credibility issues—fortunately students' identities have been safe-guarded and their work is purely used for academic purposes. Last, students' answers were interpreted as reflected in examination booklets against the corresponding questions which primarily dealt with issues of identity and marginality.

The language education course is used to illustrate the benefits of incorporating sustainable development issues in the teaching of English language to prospective secondary school teachers. The illustration is based on a particular assignment that was given in the course "Interdisciplinary Approaches to Literacy Education". There were only seventeen (17) students enrolled for the course. The students were divided into four groups and assigned to develop thematic units on indigenous plants that are edible or medicinal. Each group was asked to research on one plant, take notes, and pick a topic from the junior secondary school English syllabus, and demonstrate how they could teach it using the information they have gathered about the plant (the exact question of the assignment is given under the discussions section). The students were given 2 weeks to complete the research assignment and prepare power point notes to present their output on a set date. They were directed to go and research in the Botswana collection section of the university library where they could easily find relevant sources for the assignment. The assignment was to be strictly carried out in groups. Bruner (1996: 84) posits that "learning is best when it is participatory, proactive, communal, collaborative, and given over to constructing meanings rather than receiving them". Before class presentations, each group was asked to give the instructor copies of their research notes. This was meant for the instructor to check if students had grasped note-taking skills; assess the suitability of the selected topic to be taught and the suitability of the planned activities to impart the communication skills of speaking, listening, reading, and writing in a language classroom. During the presentations, attention was paid to how far the students displayed reflection, analysis, and critical thinking skills. The manner in which each group collaborated to respond to questions was also observed. The final task was to find out if the students could relate some of the issues they raised in their deliberations to the SDGs. The SDGs were taught long before this assignment and students had copies of relevant notes.

12.5 ESD and Social Studies Education at the University of Botswana

As outlined earlier, the twenty-first century era requires higher education institutions to prepare reflective and responsive students to meet current, future, and diverse needs. Issues of identity and marginality are not only relevant to SDG 4 but also increasingly occupy centre stage in various platforms: teaching and learning, political and academic debates. The analysis of narratives of identity is important in understanding construction of dominant and subordinate identity categories (Johnson 2005). Further, Johnson (2005: 37) contends that "narratives that foreclose empathy facilitate the denial that discrimination or subordination is taking place. Similarly, privileged narratives of identity facilitate subjects' ability to think well of themselves and their treatment of others".

This section explores how level 200 undergraduate students enrolled in the Social Studies and Nation Building course at the UB construct and/or deconstruct narratives around identity and marginality. Particular attention is paid to ways in which marginalisation experiences and practices are reproduced, normalised, or resisted (if at all) by level 200 undergraduate students coming from different ethnic contexts. The intention is not to go into the formation of identities but how they are shaped and shape wider social, political, economic, and cultural interactions. This is extensively covered in the extant literature on ethnic identities which has long reminded us that "we are entirely made up of bits and pieces, woven together so shapelessly that each of them pulls its own way at every moment. Moreover, there is as much difference between us and ourselves as

between us and others" (cited in Gomzina 2012). Put differently, the role of "othering"/"otherness" that is, us vs. them a form of social categorization is embedded in our daily lived experiences and interactions. What is critical is the analysis of how majority and minority identities are constructed, deconstructed, perceived, represented, or experienced.

In most nation-states, strong socio-political contexts exist where assimilation and suppression of ethnic minorities are justified in favour of the "genuine" members represented by the majority ethnicity (Tanyas 2016). Botswana's nation-building project is premised on the construction of the *Tswana* identity as the privileged and hegemonic over the "other" cultures. Ethnic minorities are historically dominated and assimilated into the dominant culture. This leads to the branding of Setswana, the national language, as the main marker of national "unity"; hence, the nation-state is idealised and packaged as a linguistically "homogeneous entity". The idea of a "homogenous" nation-state pushes minorities to identify with a national identity which is not inclusive of them; that is, one that is founded on processes of marginalisation and "othering" (Tanyas 2016). In the next section, we use the end of semester examination paper and students' scripts to appreciate the extent to which the students embrace issues of inclusiveness which are central to SDG4.

12.5.1 End of Semester Examination Paper: Social Studies and Nation-Building

The rationale behind the use of end of semester examination in social studies and nation-building course is to strengthen sustainable learning using alternative assessment as opposed to typical examination questions. The key focus is on the promotion of critical thinking and application of learning experiences. The intention is to place student learning experiences and reflections at the centre of pedagogical and assessment practices. This is deemed critical for transforming the quality of higher education in general and student's learning outcomes. The assessment processes recognise the complexity of learning, teaching, and integrating skills, knowledge, judgements, and multiple goals (Hammerness et al. 2002).

12.5.2 Sample Examination Question: Social Studies and Nation-Building

Usually, this is a compulsory question and it seeks to equip students with critical thinking skills. The students are presented with a sample narrative extracted from the research work produced by faculty members within UB. Students are then expected to read the narrative and answer the structured questions. An example of a narrative used in the past (Box 12.1).

Below, we present students responses under the sub-headings generated from the structured questions. We have randomly identified three students and looked at how they answered the sampled three questions. The students are identified as ST 1, 2, and 3. Students' responses were picked verbatim from the answer booklets and have not been tempered with. Our critique is presented immediately after each of the students' responses.

12.5.3 Students' Identification of the Narrator

The students were asked to identify the narrator using analytical skills, which they practised during the semester. The student responded as follows:

Box 12.1: Sample Narrative

Most of them are very wild, when you teach you to have to use both Setswana…and English and yet they will say that they don't understand Sekweni…you will be surprised to hear a form 2 or form 3 student reasoning like a standard 3 student!!

—personal communication from Mafela, June 2014

ST 1: "Teacher because he is trying to teach Basarwa children and they fail because they cannot understand the language which is used to relay education to them".

What comes out is that ST 1 has not conceptualised the teachers' identity to help contextualise the narrative. There is also the assumption that the fault lies with the marginalised San children. In others, the children fail due to their poor literacy in Setswana, a language, which is not their mother tongue. The student also falls in the trap of "othering" where San children are referred to as out-groups and the teacher as in-group.

ST 2: "Teacher who teaches children from settlements, who interacts with them… teacher because he/she…forces them 2 speak Setswana…when the narrator talks about them taking a long time to cope and improve their learning achievements, it shows that he has experience associating with them".

In this response, we also see the failure of the student to identify teachers' identity and social background. What also comes out is the persistence of social categorization and poor analytical skills.

ST 3: "*Teacher from the majority group is the narrator…force students to speak Setswana, which is a language of majority groups…the narrator shows signs of despising when he/she calls them children from settlement… they are from a minority the 'them' group"*.

The good thing is that ST 3 was able to qualify teachers' identity and also provide justification of why students are forced to speak Setswana. Furthermore, the student was able to appreciate the fact that social categorisation still permeates our daily life experiences but again falls in the trap of "othering".

12.5.4 Unpacking Attitude of the Narrator

The students were asked to reflect on: what does the statement "you will be surprised to hear…" tell you about the attitude of the narrator?

ST 1: *"Basarwa (San) children keep quite because they do not know…Setswana language is enough to converse. They get frustrated because they keep on failing to speak perfect Setswana and their teachers give up on them. The rejection and frustration from their teachers gives them a fear of failure. They drop out of school because they cannot understand anything they are being taught because of the language that is being forced on them"*.

In contrast to what the question sought, the student was primarily concerned with explaining the issue of "surprise". The expectation was for the student to interrogate the attitude of the narrator. Again, we see that the process of "othering" is still problematic and the student fails to address the following questions: is it really necessary for San children to speak "perfect" Setswana and are teachers justified in giving up? What is the rationale behind the "forced" language in the context of nation-building? These questions are left hanging by the student.

ST 2: *"Since the San do not know or hardly speak the Setswana language, they keep quiet as there is no other way for them to communicate as they are seen as inferior in the society. The San are seen as people who are not modernised therefore they have a fear of failure… seen by other children as outcasts…"*.

The focus of the student was more on providing explanatory factors than interrogating the attitude of the narrator. On a positive note, the student was able to identify modernization as one of the theories of ethnicity. The question that begs the answer: is it really necessary to use the

cultural lenses of the ethnic majority to judge the language competencies of ethnic minorities? This is a rhetorical question which calls for the deconstruction of ethnic identities in Botswana.

ST 3*: "The San children keep quiet, get frustrated and develop a fear of failure, have low self-esteem, drop out because they are taught by someone from the major tribes who despise them. They keep quite because they are not familiar with the language they are being taught and this also brings down their…confidence. The reason why the Basarwa children are afraid of failure is that the teacher/narrator is belittling them…they know that if they fail it will prove the narrator right"*.

The student also focused on explanations than appreciating the attitude of the narrator in terms of construction/deconstruction of identities. On the positive side, the student was able to recognise the significance of self-fulfilling prophecy in the context of nation-building project.

12.5.5 Lessons from Social Studies and Nation Building

It is important to acknowledge contestations around concepts and discussions of "identity" and "marginality"; hence, ELC 202 students' perspectives have to be located within this framework. This is also compounded by the fact that SDGs and ESD are not only contested but also elusive concepts.

Similarly, narratives, discourses, and conversations tend to revolve around issues of inclusion and exclusion, domination and resistance thus giving rise to multiple perspectives. There is also a need to consider students' cultures, identities, prior knowledge, practices, and experiences. Young people's identities tend to have a significant impact on their interpretation of the country's history and teachers' instruction has some but not too much influence on their views (Epstein 2016). This is consistent with Hensley (2017) contention that habits are not simply actions repeated by teachers but rather deep and complex set of activities. It is important to make a clear-cut distinction between reflective action and unreflective habits. The results revealed that students' judgements tended to be subjective and largely influenced by use of own ethnic "lenses" to interrogate issues of identity and marginality. In the next sections, we focus our attention on language education at UB.

12.6 ESD and Language Education at the University of Botswana

Instructional approaches employed in language education at the UB are influenced by the communicative approach. The communicative approach is deemed the most effective as it emphasises that the best way to learn a language is by using it to communicate meaning rather than by learning grammar and vocabulary as isolated bits and pieces. Enhanced communication in language instruction requires full engagement of learners and the use of interactive activities such as group or pair work, debate, dramatisation, and role-plays. The crucial aspect in language teaching and learning is to use language as a vehicle for genuine, meaningful communication (Brown and Lee 2015). Rivers (1976: 96) has long explained that "as language teachers we are the most fortunate of teachers—all subjects are ours. Whatever [the students] want to communicate about, whatever they want to read about, is our subject matter". Put differently, language education plays an important role in assisting learners to apply and transfer knowledge from one context to the other. Based on the UNESCO (2014) definition of ESD, effective learning and teaching of ESD requires strong linkages between content and pedagogy approaches. Thus, in the teaching of language education courses, content is drawn from various disciplines.

In order to engage meaningfully in thematic units, students are usually assigned work in small groups in language education. Mafela et al. (2013: 15) assert that "the adoption of group work in classroom settings is part of the broader

need to engage learners effectively, and acknowledgement of the crucial importance of cooperation and collaboration in knowledge and skills acquisition". Over and above, collaboration is one of the twenty-first century skills learners are expected to have acquired in order to function efficiently in the world of work.

12.6.1 ELL 402: Interdisciplinary Approaches to Literacy Education course

The course *ELL 402: Interdisciplinary Approaches to Literacy Education* is core to all Bachelor of Education students taking language courses as either major or minor in their programmes. This is a seminar course that aims at providing both pre-service and in-service teachers with the foundation for using integrated and interdisciplinary approaches in literacy education. The course enables students to evaluate research on the integration of language and literature with reading, speaking, listening, and writing as well as with other disciplines in the secondary school curriculum. One of the outcomes of the course is for the students to be able to plan and design interdisciplinary thematic units. From a literacy perspective, Burns et al. (1992) define thematic units as a way through which effective teaching of language is organised around a central topic, idea, or theme that uses related activities and experiences to conduct a more in-depth study.

The application of thematic approach allows for the incorporation of language concepts into a selected topic area. This pedagogical approach gives students the opportunity to use and apply language to their daily lived experiences. It is also relevant for integrating teaching and assessment (Burns et al. 1992). The secondary school syllabuses for English and Setswana call for the infusion of "current and emerging issues". These issues include HIV and AIDS, human rights, environmental issues, environmental education, population and family education, and awareness of prejudice and bias (Ministry of Education 1998, 2000). It can be seen that the Ministry of Education in Botswana incorporated these issues long before they were pronounced by UNESCO in the SDGs.

Box 12.2: Sample Group Assignment Question for ELL 402

(a) The theme for the unit is: Indigenous plants and trees. In your groups, research on one indigenous tree or plant found in Botswana that is edible or used for medicinal purposes. Describe ways in which it is used for human consumption or otherwise.
(b) Discuss how you could use the information you have gathered to teach any topic of your choice to a Form 3 class of mixed ability. Mention the kind of activities you would engage your learners in and the communication skills you will be focusing on.

Remember that you are teaching English but also educating your learners about ESD issues. You should therefore mention which sustainable development goals the issues you will be discussing will address.

However, effective implementation has proven to be a challenge. It is against this background that the instructor of this course embarked upon incorporating ESD in its teaching to address the interdisciplinary approach to literacy teaching.

What follows is an illustration of how level 400 students enrolled in ELL 402 (Box 12.2 and Table 12.1) responded to an assignment, which required them to research a given theme and come up with activities they could use in an English classroom setting. Students were asked to research the following question in groups of five and prepare a power point presentation to share with the class.

12.6.2 Source: Lessons from Language Education Students

Although many students are not proficient in English and usually passive in class, the level of class participation was very high during this

Table 12.1 A summary of presentation from the assignment

Group	Indigenous plant/tree researched on	Topic, skills, and activities	SDGs addressed according to the students
1	*Morula* (translated as *Marula by non-native speakers)*	*Debate* *Listening and speaking skills* Small group discussions on the benefits and uses of *morula.* The class divided into two groups to debate the motion: Traditional alcohol "*Khadi",* made out of *morula* should be legalised as it has reduced poverty in many households.	SDG 1 End poverty SDG 12 Responsible production and consumption
2	*Motsintsila* (*Berchemia discolour)*	*Poetry*: Speaking and writing skills The whole class watches a video showing women harvesting and processing *motsintsila* followed by discussion of the video. Activity: compose poems individually on *motsintsila*	SDG 4 Quality education SDG 5 Gender equality SDG 12 Responsible production and consumption
3	*Sengaparile (grapple plant)*	*Report writing* *Reading and writing skills* Reading of an extract on *sengaparile* followed by an explanation of new words, e.g. inflammation, tuber, supplement, arthritis, cartilage. Activity: Write a report to the Minister of Health; tell him about *sengaparile* and what you wish his Ministry could do so that the nation benefits from this plant.	SDG 1: End poverty SDG 3: Good health and well-being SDG 12 Responsible production and consumption
4	*Mogwana (Grewia monticola)*	*Parts of speech* *Listening and speaking* Presentation by a guest about *mogwana* fruit; its benefits and how it is used. An extract on *mogwana* is read and discussed in small groups. Students then identify nouns, adjectives, and adverbs and explain their function in the text.	SDG 4 Quality education

Source: Molosiwa, A. A. (2017). ELL 402 Summary of students' presentations. University of Botswana

particular lecture on the presentation of indigenous plants. The content of the research work was authentic and captured the interests of the students. This resonates with sustainable learning practices. During the debates, students were able to reflect on the information presented and shared their views freely. The government was criticised for not creating employment opportunities by making use of the natural resources that are readily available in the country. They questioned why the government does not support the cultivation of indigenous trees such as *motsintsila* and *sengaparile* for commercial purposes at a large scale and have them processed in Botswana for medicinal purposes. Currently, *sengaparile* is exported raw and processed outside the country, brought back and sold to Botswana at a price.

Paul and Elder (2008: 88) state that "critical thinking is that mode of thinking—about any subject, content, or problem—in which the thinker improves the quality of his or her thinking by skilfully analysing, assessing, and reconstructing it". In the analysis of themes and issues, students were able to realise that one issue could address more than one SDG. For instance, they pointed out that the planting of indigenous plants for medicinal purposes would not only create employment (SDG 1: End poverty) but also avail medicines that the country is badly in need of (SDG 3: Good health and well-being). One of the students who presented on the *motsintsila* fruit came from the area where this plant grows and is harvested for making baskets. This student reported that it is mostly women who do the

harvesting of the plant, and all the weaving-related work. This statement provoked a heated argument. For example, some students felt it was the duty of women to make baskets because they cannot undertake tasks like hunting but others argued that this was not in line with SDG 5 that advocates for equal treatment between men and women. The arguments and views expressed by the students were very impressive. I could not agree more with Moore (2005) who recommends that "educators should provide collaborative working spaces for learners where they could exchange ideas, feelings and experiences". Since incorporating sustainable development issues in my courses, I have had lively lessons.

12.7 Conclusion

Even though higher education institutions have been identified as potential leaders in the implementation of education for sustainable development, literature shows that the incorporation of ESD in their disciplines is not yet fully operational. It has been found that discipline-focused organisational structures of the universities, lack of knowledge by academics to incorporate ESD, and the perceived irrelevance of sustainability issues to some disciplines act as a barrier to their implementation. The twenty-first century era requires higher education institutions to prepare reflective and responsive students to meet current and future diverse needs.

Drawing from a course in social studies, the chapter has demonstrated that narratives could be used to measure or evaluate students' understanding of social issues and the extent to which they reflect on them. The example from the language education course is used to illustrate how incorporation of sustainable development issues in the English curriculum could provoke students to collaborate, be reflective and think critically when analysing issues. Whereas the focus of the English lesson was for the students to demonstrate how they could teach certain topics (Debate, Poetry, Report writing, and Parts of speech) to a junior secondary school classroom, they also acquired knowledge about indigenous plants and their use. Ultimately they learnt about the need to protect and conserve them, which is one of the purposes of education for sustainable development. This chapter has demonstrated that it is possible for higher education instructors to transform their pedagogical and assessment practices to embrace ESD principles. Instructors' readiness and commitment to develop strategies and processes of incorporating ESD content into their disciplines is crucial in producing graduates who understand and embrace this approach. The chapter has also demonstrated that, contrary to the conventional thinking that ESD belongs to certain disciplines, it can be incorporated in any discipline.

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13 Livelihood Support Programmes for Sustainable Development Goals in Rural Nigeria

John Adebayo Oyedepo,
Oluwakemi Titilayo Irekhore,
Kazeem Olajide Bello, Olalekan Jacob Olaoye,
Adebukunola O. Lala, Elizabeth O. A. Oluwalana,
Elizabeth Omolola Oyedepo,
and Akinwumi M. Omotayo

13.1 Introduction

Rural communities in Nigeria like many African countries are characterised by extreme poverty, hunger, illiteracy, gender biases, poor health delivery system, indecent housing, poor management of water sanitation and hygiene, climate change, and underemployment (Egbe 2014; Khan and Cheri 2016). Evidence shows that about 71% of Nigerians live on less than $1 (US) a day and about 92% live on less than $2 a day (Ucha 2010). Only 28% of the 125.4 million rural Nigerians (Agbodike 2010) earn up to $1.9 a day while a lesser percentage have access to decent meal and potable water (Akpor and Muchie 2011). Similarly, 6.2 million of the 16.9 million elementary school-age children in rural Nigeria are either out of school (UNICEF 2012; Haruna and Liman 2015) or must travel for more than 20 min (4 km) to attend one (Kazeem et al. 2010). Thus, Sustainable Development Goals (SDGs) especially goals 1 and 2 and 4 are far from being actualised in rural Nigeria.

One means of eradicating poverty and hunger which incidentally forms the objects of SDGs 1 and 2 is through improved agricultural productivity. Agriculture is noted to account for two-thirds of the means of livelihoods in rural Nigeria (Ojikutu 2018). It has also been affirmed that agricultural production in rural areas has supported household food demands in Nigeria for decades (Ikelegbe and Edokpa 2014; Omotayo 2016). However, rural agriculture in Nigeria is currently constrained by vagaries of factors such as finance, technologies, literacy, and land tenure (Ofana et al. 2016). In recent times, impacts of climate change have added to the problems of agriculture in Nigeria (Enete and Amusa 2010).

J. A. Oyedepo (✉) · K. O. Bello · A. O. Lala
Institute of Food Security, Environmental Resources and Agricultural Resources (IFSERAR),
Federal University of Agriculture,
Abeokuta, Ogun State, Nigeria
e-mail: lalaao@funaab.edu.ng

O. T. Irekhore · O. J. Olaoye · E. O. A. Oluwalana
Agricultural Media Resources and Extension Centre,
Federal University of Agriculture,
Abeokuta, Ogun State, Nigeria
e-mail: olaoyeoj@funaab.edu.ng

E. O. Oyedepo
Department of Agricultural Economics and Farm Management, College of Agricultural Management and Rural Development Studies (COLAMRUDS),
Federal University of Agriculture,
Abeokuta, Ogun State, Nigeria

A. M. Omotayo
Department of Agricultural Extension and Rural Development, College of Agricultural Management and Rural Development Studies (COLAMRUDS),
ederal University of Agriculture,
Abeokuta ogun State, Nigeria

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Meanwhile, a lack of power supply in rural areas is a major constraint to alternative sources of income for the rural dwellers. Jack et al. (2018) reported that the lack of electricity to power machines and equipment needed for other trades in the villages contributes to the poverty and hunger for many people. The implication of this is an increase in poverty depth, rural-urban migration with the associated social vices and possibly non-actualisation of the SDGs by 2030.

Meanwhile, university campuses in Nigeria are commonly situated in rural areas where land spaces are believed to be available in relative abundance. Often, these citadels of higher learning are neighbours of rural communities. The establishment of universities in the rural areas of Nigeria from the foregoing is expected to influence rapid human and economic development of rural areas. However, it has not. Instead, it has seen the displacement of thousands of rural populace from their farmlands and primary homes resulting in worsened developmental issues at the grassroots (Oyedepo et al. 2018).

The case of the Federal University of Agriculture Abeokuta is not different; having dislocated over 80 villages with scores of resource-constrained farm-families from 10,000 hectares of land it presently occupies. The plight of rural folks gets worsened when they are dislodged from their place of enterprise and are not promptly resettled (Vanclay 2017). Often, such involuntary resettlement creates setbacks to decent living and hinders rapid attainment of sustainable development goals. According to Uduji and Okolo-Obasi (2016), it is logical that universities within the neighbourhoods of rural communities take up the task of rural development as part of their corporate social responsibility.

In this light, the Federal University of Agriculture Abeokuta; a land grant university saddled with a tripod mandate of teaching, research and extension adopted several rural communities for livelihood support interventions. In its previous outreach programmes, the university has extended several research products and proven technologies to surrounding communities meeting both successes and failures. Against this background, there is an argument that more goal-specific programmes could be carried out to assist rural communities to actualize the sustainable development goals.

Universities are intrinsic to the actualisation of the SDGs (Levi and Rothstein 2018), conceivably because they are uniquely positioned to assist with the intellectualism involved in location-specific strategy formulation critical for the implementation of a number of SDGs. Universities are known for providing knowledge from research, innovations, and solutions that underpin the implementation of development objectives (SDSN 2017). They are also essential in providing think-tanks for policy formulation (Fraussen and Halpin 2016) and creating implementers (Khan and Khandaker 2017). Universities can provide scientifically sound advice and knowledge on the means of policy implementation that can be useful for meeting the SDG targets (Fourie 2018). They do this by actively discussing, analysing, and presenting some innovative approaches and tools to deal with the challenges of policy implementation.

Many universities in different parts of the world are currently examining ways of contributing to the SDGs objectives and targets. One such goal is SDG 4 which strives to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (Bhowmik et al. 2017). Goal 4 has seven targets and three means of implementation. Many targets within this goal are directly relevant to universities, such as the need for all learners to "acquire the knowledge and skills needed to promote sustainable development". In other sustainable development goals, universities are to provide research findings to illuminate grey areas to foster the achievement of SDGs. With extensive research capabilities, universities can, therefore, play key roles in the successfully implementation of SDGs.

Goal 1 calls for an end to poverty in all its manifestations by 2030 while the second goal calls for total eradication of hunger attainment of food security, improved nutrition, and sustainable agriculture by the same time lapse. The SDG 2 and is subsumed into SDG 1 since the fang of hunger is sharpened by poverty. If today, 815

million of 7.6 billion people are hungry and additional 2 billion people are expected by 2050 (Abegaz 2018), only increased productivity in agriculture, forestry, and fisheries can simultaneously respond to SDGs 1, 2. Improved performance in agriculture will provide nutritious food for all, generate decent employment, increase incomes, and consequently eradicate poverty while supporting people-centred rural development at the same time protect the environment.

The preceding indicates the need for a profound change in the global food system and agricultural productivity. There is an urgent need for experimentation and trials of more pragmatic models to transform the African agricultural system beyond what we are already accustomed to. This chapter illustrates the place of the Agricultural Productivity Programme—a university-led livelihood support research with a primary focus of the transforming rural lives through interventions aiming to increase agricultural productivity.

The University-led Agricultural Productivity Programme (APP) provides an opportunity for universities to help rural communities to gain the capacity to address livelihood issues as entrenched in four SDGs namely: 1, 2, 8, and 13, which are meant to: end poverty in all its forms everywhere; end hunger, achieve food security, improve nutrition and promote sustainable agriculture; promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all; take urgent action to combat climate change and its impacts, respectively. The philosophies of University-led APP align with some of the United Nations SDGs. The APP is a World Bank supported initiative to enhance food security, eradicate hunger and improve nutrition, combat poverty by enhancing the source of livelihood of the rural farmers while also addressing gender imbalance and non-inclusion. The APP in Nigeria at FUNAAB was therefore supposedly catalytic to a part of the sustainable development goals aiming to address the objectives of the first and second goals. The programme gives the university the privilege to further fulfil its obligation in advancing its corporate social responsibility and enhancing economic advancement and livelihoods support of the rural dwellers within the university's immediate environment.

13.2 Methodology

Agricultural Productivity Programme (APP) was a combination of technology dissemination and livelihood support interventions to rural communities. The study targeted communities within 10 km radius from the university. Five villages were selected based on criteria such as acceptability, security, people's interest, existing knowledge, and proximity to input markets. Assessment forms were used as guides to discuss with stakeholders in each community, while each criterion was graded on a scale of 10. The communities were then ranked based on total scores, with five communities selected. A sample size determinant table was used as guide in selecting adult participants within the benefiting communities. This was done in order to secure the commitments of beneficiaries to the intervention programme. One thousand (1000) participants were selected in all. These interventions consisted of three technologies deployed to selected rural communities within 2 years. The result of the project was obtained through an early impacts assessment.

13.2.1 Description of Targeted Communities

The primary beneficiaries of the various agricultural development interventions are from enclaves in the countryside of Abeokuta city. The villages are situated within rain forest area of Ogun State, southwest of Nigeria. They are characterised as secondary forest with dense vegetation cover replete with several wild animal species and seasonal streams. The area is largely agrarian with extensive rain fed agriculture a common practice and limited agricultural produce processing activities. There is a general lack of basic infrastructures such as modern housing (Fig. 13.1), good roads, electricity, health care facilities,

Fig. 13.1 Section of the houses at one of the beneficiary villages

schools, and adequate water supply in the area. These communities characterise typical rural Nigeria like with low population density, underdevelopment, low per capita income, and people living below US$1.90 per day. The main challenges to sustainable development including poverty and exclusion, unemployment, climate change, and humanitarian aid are clearly expressed in all the villages selected for the intervention. Most of the women are resource constrained while the men sometimes resort to labour on other people's farms to earn a living.

13.2.2 Description of Interventions

Four main agricultural technologies namely: (1) Movable Poultry Cage system, (2) Aquaculture from earthen ponds, (3) Beta-carotene cassava, and (4) Quality Protein Maize were introduced to five adopted village in addition to the establishment of Agricultural Research Outreach Centres (AROCs) and Agricultural Innovation Platforms.

Intervention 1 involved the movable poultry cage. The portable cage is an open-sided structure with capacity for 50 egg laying birds and equipped with poultry accessories were stocked with the Black Nera type of chicks (Fig. 13.2). This intervention was aimed at helping rural farmers diversify into egg production in addition or away from maize and cassava they are used to. The diversification intends to deliver sustainable income generation projects as well as the supply of affordable animal protein in the local diets.

Intervention 2 was in the aquaculture space. This essentially is earthen ponds with a holding capacity for 1200 table size fish. Equipped with a hand-dug well and water pump the ponds were stocked with 1000 African sharp tooth catfish, *Clarias gariepinus* and 200 Nile tilapia *Oreochromis niloticus* types of fish to benefit the villages. The objective was also to give rural farmers better-living condition through alternative improved income and means of livelihood and access to quality protein (Fig. 13.3).

Intervention 3 was the β-carotene cassava. The farmers in the area have a lifelong history with growing cassava. The project sought to take

Fig. 13.2 Moveable poultry cage for egg production

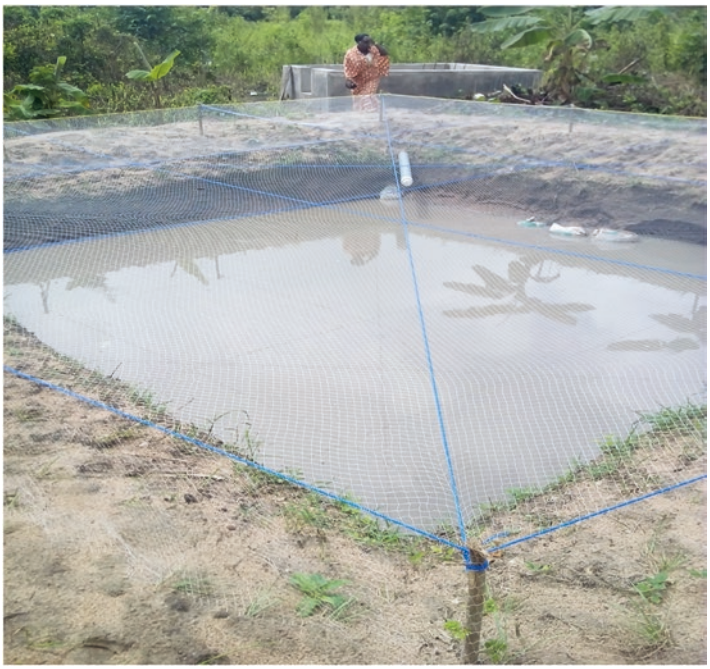

Fig. 13.3 Earthen pond with shallow well for dry season water supply

advantage of this by introducing vitamin A bio-fortified cassava and in the process and improving the nutrition of rural household. Vitamin A deficiency is common in sub-Saharan Africa, specifically, affecting 20% of pregnant women and 30% of children under 5 in Nigeria. The deficiency of vitamin A impairs immune systems and vision, which could sometimes result in death. The high level of β-carotene, which is a precursor to vitamin A, can provide up to 25% of daily-recommended vitamin A intake. Since cassava is a major part of many people's diets, vitamin A bio-fortified with cassava is an appropriate innovation to introduce to the farmers.

Intervention 4 focused on Quality Protein Maize (QPM). Maize (*Zea mays*) of different varieties including sweet corn (saccharata), popcorn (everta), floury corn (amylacea), dent corn (indentata), and flint corn (indurata) is widely cultivated across Africa. Farmers in Nigeria are therefore familiar with its agronomic practices and production. Part of the newest arrivals of maize is the Quality Protein Maize (QPM) variety. The grain of QPM contains nearly twice as much lysine and tryptophan, amino acids that are essential for humans and monogastric animals than other maize varieties. QPM is not genetically modified but has been produced from bio-fortification through conventional plant breeding (Prasanna et al. 2001). The protein deficiency in other common maize varieties informed the inclusion of QPM as part of the technologies introduced to the farmers in the intervention.

Intervention 5 involved Agricultural Research Outreach Centers (AROCs) and Agricultural Innovation Platforms (AIPs). The AROCs are centres where research outcomes are displayed for farmers to learn from. The AROCs latter transformed into the AIPs that seek to develop the breadth and depth of value chain linkages for each of the agricultural commodities under the interventions. Innovation platforms (IP) are windows for show-casing the unregistered or underutilised opportunities in farming. IP emphasises collective problem solving, promotion, and popularisation of agrarian community needs through a participatory approach. Innovation platforms were established as a frantic effort to consolidate the gains of the interventions in the villages. IP also has the objective of expanding frontiers of the interventions and enhancing sustainable livelihoods of farmers through networking of all the stakeholders.

13.2.3 Implementing the University-Led Agricultural Productivity Programme

Technologies and interventions extended to the adopted villages are expected to catalyse actualisation of improved livelihood and other set objectives associated with the development goals. Five villages were adopted by the University employing the four technologies outlined earlier. The adopted village model makes the targeted communities the responsibility of the University. The dissemination of bio-fortified crops was done on demonstration plots in four locations. Similarly, fish culture and poultry interventions were done on demonstration ponds and demonstration pens, respectively. These activities were made possible with the support of the University technical team. The centres were equipped with materials that illustrate modern agricultural technologies and best practices through audio-visual displays. The centres also allowed the farmers to register personal concerns on their farms and get useful feedbacks.

The programme targeted 1000 adult rural dwellers disaggregated into 400 women and 600 men in 2 years. The 60:40 in male-to-female beneficiary ratio is to address part of the focus of SDG 5 which is to "Achieve gender equality and empower all women and girls". A total of 200 adults comprising 120 males and 80 females were targeted in each community.

APP also extended advisory services to interested members of the communities who are not direct beneficiaries of the programme. In the case of innovation platform and research for develop-

ment (R4D), the farmers were organised into commodity groups and interested members of the society were invited to join any of the commodity groups for the introduction of new ideas (innovations) for development of the commodity along its value chain. Invariably, the processors, value addition groups, packagers, and even scientists were encouraged to join any of the four commodity groups namely: Poultry, aquaculture, cassava, and quality protein maize and establish a platform where innovations and novel ideas on how the commodities can be better developed. The innovation platforms were supported with processing technologies such as smoking kilns and other relevant machinery considered basic for the successful take-off of the platform.

13.2.4 Early Impact Assessment

A rapid early impact assessment was conducted to evaluate the effect of the interventions at the end of 2 years. Each of the extended innovations and interventions is regarded as an input which is expected to generate particular outputs. The outputs, in turn, produce effects, and the effects eventually culminate in impacts; thus,

$$\text{Inputs} \gg \text{Outputs} \gg \text{Effects} \gg \text{Impacts}.$$

Since impacts cannot be said to have occurred until about 5 years of applying the inputs, then what is reported in this chapter are, therefore, the results (effects) of the interventions (inputs) of the rural livelihood support project under the Agricultural Productivity Programme.

13.3 Results

The results of the interventions from the early impact assessment of the project as reported in relation to some sustainable development goals revealed some positive effects on the people and their livelihood. In order to have a good basis for reporting, it is important to characterise the targeted beneficiaries in terms of socio-economic status before and after the interventions.

13.3.1 Baseline Report of the Targeted 1000 Rural Farmers

The cross-section of the beneficiaries sampled indicates that 56% of the farmers in the area fall within the 27–55 years age group while about 40% are above 60 years. The majority, 91% are into crop production only 2% are into livestock farming of any kind. The baseline survey also shows that a large percentage of respondents were below the poverty line (1.90 USD per day)

The post-intervention assessment shows that many of the farmers are on their way out of poverty. Average household income from two farm enterprises namely: maize and cassava rose from $1.81 (before intervention) to $3.76 per day (after intervention). This means that most of the direct beneficiaries of the intervention doubled their household income and progressed beyond the $1.90 per day poverty mark.

Table 13.1 summarises the goals set by the various platforms. The goals were premised on felt needs and required a response to such needs.

The interventions were designed based on technologies that are familiar to the beneficiaries. For instance, almost 95% of the rural farmers grow cassava and maize. Most of them are familiar with fish culture and poultry although they had no technical and financial capacities to enhance their activities in these ventures before the interventions. Most encouraging is that the farmers are not strange to the fact that the enterprises are practicable. The interventions, therefore, leverage on this familiarity to introduce the innovations such as yellow flesh cassava, and quality protein maize in addition to aquaculture and egg type poultry. It is therefore understandable that there were a high number of farmers adopting the introduced technologies as shown in Fig. 13.4

The beta-carotene (yellow flesh) cassava variety was fully embraced 100% with only poultry

Table 13.1 Community-driven needs and response (Innovation Platform)

S/no	Commodity	Needs/challenges	Innovation
1	Beta-carotene cassava (BCC)	Availability of stem cuttings and marketing of products	Discussion and multiplication of beta-carotene cassava stems. Sensitising rural household on nutritional potentials of BCC, popularisation, as well as show-casing BCC products for enhanced acceptability and marketing
2	Aquaculture	Additional fish ponds	Production, processing, branding, and marketing (expanding the frontier)
3	Poultry	Quick income venture, finance, and transportation	Promoting meat-type chicken production for fast income generation, processing (to reduce bulkiness and enhance transportation), branding, and marketing (value addition)
4	Quality protein maize	Pilfering of corn and Fulani cattle invasion	Rural socio-economic research to ameliorate pilfering and Fulani cattle invasion

Source: Authors

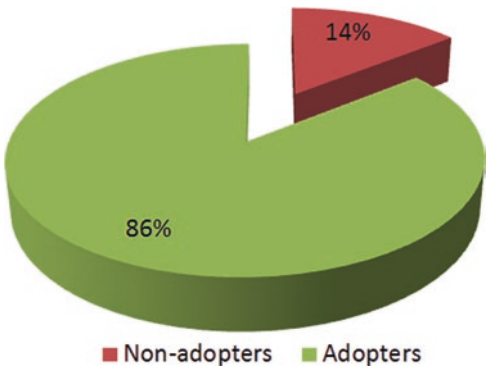

Fig. 13.4 Distribution of farmer adopting and not adopting the availed technologies (*n*=?)

suffering a low level of adoption possibly because of its high capital intensity and high level of risk (Fig. 13.5).

13.4 The Impact of Inventions

The broad objective of APP and related initiative is to improve the welfare of people around the university. This is important given that the construction of the university displaced some people and adversely affected their well-being. This quest addresses the objectives of SDGs.

The productivity of the farmers can only be assessed by comparison of the average commodity yield before and after interventions. Figure 13.6 shows that cassava productivity increased by 40% from previous 7629 kg per farmer to an average 10,688 kg; an increase of 3059 kg per farmer. The increase is attributable to the level of enthusiasm that greeted the introduction of beta-carotene cassava and the training given to the farmers on best agronomic practices. This also explains increased production in maize yield as well. The challenge with further progress in the case of maize is the non-availability of the seeds for introduced type of maize. The programme is campaigning for an increase in the production of QPM seeds as well as beta-carotene cassava stem cuttings.

Culture fishery as against capture fishery has improved the quantity of fish protein available in rural areas from 1310 to 9453 kg per year as depicted in Fig. 13.6. Prior to the intervention, there was no aquaculture in these communities. Instead all the consumed fish were from the local waters—streams and rivers. While this approach did avail fish to the local diet, it was inadequate to meet the dietary protein demand in these localities. The poultry proteins from eggs and spent layers have also improved the diet of many in rural communities. Figure 13.6 shows that the intervention added 1160 kg poultry meat to the protein from poultry in the study area.

Although the cassava yield was below the standard value recommended by the International Institute of Tropical Agriculture (IITA), there is an increase in the improvement from yields using old farming practices before the intervention. This suggests greater hope for

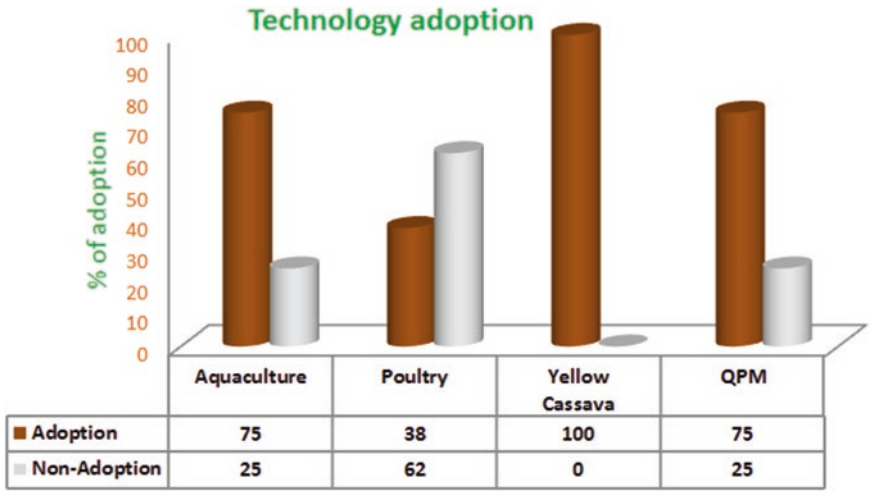

Fig. 13.5 Technology adoption rates for each intervention

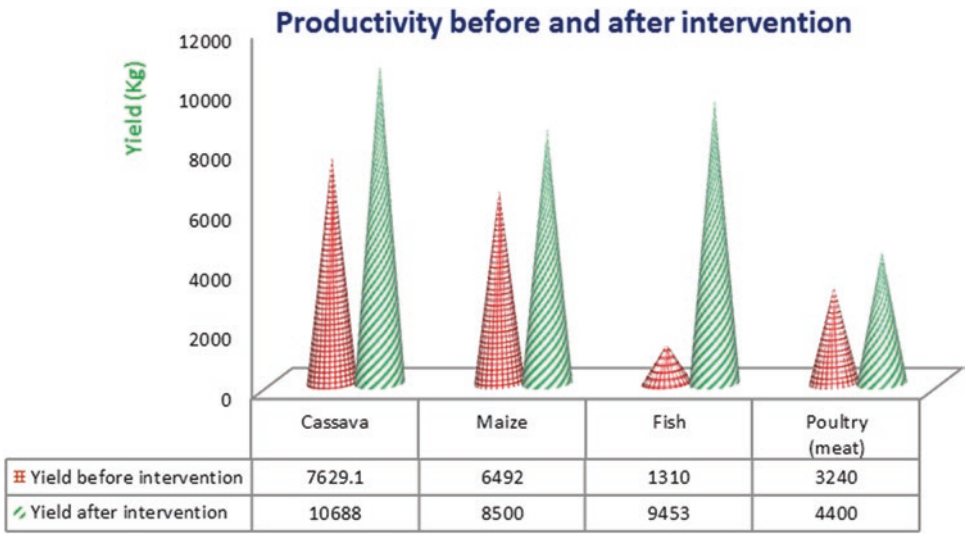

Fig. 13.6 Agricultural productivity before and after intervention

improved income as well as livelihoods of the cassava farm-families in these villages and perhaps beyond should other communities imitate the practices and varieties introduced by the intervention. This is an indication of a possibility of attaining the targets of SDGs 1 and 2 as well the potential for the achievement of the gender equality goal (SDG—Goal 5).

13.4.1 Success Stories

The FUNAAB-led APP appears to be yielding desired results concerning improving livelihoods, income, and nutrition. The programme reached about 1000 adult rural dwellers disaggregated into 400 women and 600 men in 2 years. The project contributed to the sustainable

Fig. 13.7 Laying birds in a personal farm of one of the beneficiaries (Source: Authors)

development goals in several ways. Foremost was an improvement of nutrition due to the availability of eggs, fish, quality protein maize, and beta-carotene cassava in the rural areas. Several women had a hope of earning a living rekindled; many children returned to school while some families made progress towards out of poverty bracket. Narratives for beneficiaries of the intervention attest to the positive effects of this intervention over a 2-year period. For instance, a woman who is an agricultural science teacher in a secondary school 6 km from the university campus transformed her husband's uncompleted building into a big poultry house after being inspired by the APP demonstration plot. She started with 140 birds just a few weeks after the capacity training. She said

> I developed an interest in poultry farming during my college days as an NCE student, but I did not receive encouragement from my parents. Probably I would not have ended up as a college tutor today but a farmer. The arrival of the university-led APP, however, served as a great impetus for me. I started with a few birds in my husband's uncompleted building and today with this success, I think I am a very happy poultry farmer. I have learnt quite a number of lessons and received some technical training ... I say thank you for this programme.

A 70-year-old crop farmer in a remote village called Ajegunle-Adao (about 20 km from the University campus) started with 210 pullet chicks. At the time of this study, he had a total of 783 birds comprising 278 layers and 505 (10 weeks old) pullets (Fig. 13.7). The project team was given the necessary technical support, including inputs sourcing and advisory services on pen construction, purchase of feeders, drinkers, feed, drugs, and vaccines. The man's household, now enjoys the steady income from poultry and fish production.

Two other farmers started their own poultry with 150 and 100 DOC (pullets) each, respectively. They equally made purchases of various utilities and equipment required for production. They were encouraged to brood together to minimise cost, maximise resources, and allow for effective management. One of the farmers from Lagos (the commercial capital of Nigeria) came to the area on the invitation of his late friend in the village. After the death of his friend, he decided to stay in the village cultivating land and taking daily wage as farm labour until the arrival of the APP. Today, he is grateful for the intervention as his livelihood and dignity have improved. He remarked:

Fig. 13.8 Harvest of fish from demonstration pond at Ajegunle-Adao (Source: Authors)

> I left Lagos to this village about fifteen years ago on the invitation of a friend (now late) who was an indigene of this village. The invitation was for me to come and start farming when things were rough economically in the city as a refrigerator technician. I have been growing crops, but the advent of APP interventions has transformed things for me; I now have a new ray of hope in life and in finance.

Fish were successfully reared to table size by the rural dwellers of Ajegunle-Adao and Agbede villages (Fig. 13.8). The practical training on fish culture and the sales of table size fishes tremendously improved the livelihood of the villagers. Their protein intake, as well as technical knowledge on aquaculture, was boosted. The demonstration afforded the project beneficiaries express their gratitude to the University for the interventions.

13.4.2 Interventions and the SDGs

There are clear indications that the activities of the APP in the adopted villages yielded results that relate to a few SDGs. The interventions effect on the people's attitude to agriculture and the outputs are becoming noticeable. Most encouraging is that there also are increases in productivity of some commodities such as yam, pepper which fall outside the targeted commodities. As a result, there is noticeable eagerness by many farmers to adopt the technologies currently being disseminated. Many non-beneficiaries close to communities where demonstrations are done are clamouring for the same type of interventions.

SDG 1 which harps the ending poverty in all its forms, everywhere has seven associated targets namely:

1. Improving access to sustainable livelihoods, entrepreneurial opportunities, and productive resources
2. Providing universal access to basic social services
3. Progressively developing social protection systems to support those who cannot support themselves
4. Empowering people living in poverty and their organisations
5. Addressing the disproportionate impact of poverty on women
6. Working with interested donors and recipients for poverty eradication
7. Intensifying international cooperation for poverty eradication

A careful assessment of the intervention outcomes indicates that four out of the seven targets

(1, 4, 5, and 6) are being addressed by the APP intervention. The project has contributed to the improvement of access to sustainable livelihoods of about 1000 farmers through the poultry and aquaculture projects introduced to the communities. With regular maintenance of ponds and other infrastructure, the benefiting communities can produce 600–1000 tons per annum of fresh fish, which can be taken up by the innovation platform and processed into the smoked form for a longer shelf life. Similarly, the supply of at least one crate of eggs per day is guaranteed in each community from the joint community project. In addition, beta-carotene cassava and quality protein maize are available in greater quantities in the communities. The value chain development by the innovation platform creates entrepreneurial opportunities and productive resources. The development of the value chains can provide more decent employment for the rural dwellers thereby empowering people and in the progress reducing or eradicating poverty.

As mentioned earlier, the project deliberately included 40% of women in the interventions, especially the value addition component which is of greater value in fighting poverty. It is important to note that individual members of the targeted community who adopted the innovations are better off in terms of livelihood; they are even potential employers of labour in rural areas and West Africa Agricultural Productivity Programme is recognised for funding the project.

SDG which aims at ending hunger, achieving food security and improving nutrition while promoting sustainable agriculture, also has five-point strategies namely:

1. Improve income of the most vulnerable in order to raise the purchasing power of the poorest two billion people, which in turn will create incremental demand, generating new jobs and jump-starting local economies. Investing in inclusive development is not just the right thing to do; it makes good business sense
2. Pave the road from farm to market
3. Reduce food waste
4. Encourage the cultivation of sustainable variety of crops
5. Make nutrition a priority, starting with a child's first 1000 days

The APP interventions directly address three out of five of these target strategies. Increased food production is already reducing hunger. Meanwhile, introduction of yellow flesh cassava, quality protein maize, culture of fresh water fish and modest egg type poultry will augment and eventually eradicate poor diet and nutrition issues as more rural people engaged is such activities. Furthermore, poverty is addressed through the improvement of income and provision of decent work directly linked to agriculture. More farmers have received a boost in their income because of the increase in yields.

Concerning attainment of goal number 2, the APP has immensely contributed to the improvement of income among the most vulnerable people in the communities. The project contributed to raising the purchasing power of at least 1000 poorest people in the target areas though daily income from eggs, fish, and products from yellow flesh (beta-carotene) cassava. The multiplier effect of this is incremental demand in processed food items thus generating new jobs thus propelling economic growth in the local economies in these rural areas. If sustainable, increases in agricultural productivity will pave the road from farm to market as consumers move from far and near into the village for the produce and products.

The interventions also touched on SDG 5 by addressing the first and fifth targets; ending all forms of discrimination against all women and girls everywhere and ensuring women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life. The project erased the wall of barrier between genders by the policy of including at least 40% of the women in the interventions.

Meanwhile, SDG 8 whose aim is to promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all was addressed by increased productivity targets. The promotion of the innovation platform is likely to foster the development

and growth of small- and medium-scale enterprises (SMEs) and skills development.

13.5 Conclusion

The outcomes of the 2-year FUNAAB-led APP suggest the entry points for direct participation by universities in the attainment of the sustainable development goals. Village adoption approach is a plausible way of establishing good university–community relationships. In the case of rural universities in developing countries, it breaks barriers between the intellectual communities in the universities and the rural population; giving the rural dwellers sense of attachment to institutions of higher learning. Such agriculture extension of activities directly hinged to specific SDGs and their targets. An enhancement of such activities presents a mean of demolishing development challenges and accelerating attainment of SDGs in the areas. With over 100 universities in Nigeria and 20 out of this 100 situated within rural areas, over 60 million rural Nigerians would be positively affected within a short time. This experience provides a model for other universities across Africa to assist in the push to realise the objectives of SDGs ensuring that these goals avoid the pitfall of the way MDGs.

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14 Transformative Innovation Policy, SDGs, and the Colombian University

Eliana Villa, Daniel Cardona Valencia, Alejandro Valencia-Arias, Karen Hormechea, and Jhonjali García

14.1 Introduction

The university has among its main functions the social impact and the need to be generating and transmitting new knowledge in the community where it is. In addition, the university as a center of knowledge should seek to influence the local context. It must further seek to contribute to the national, regional, and international economic, social, and cultural development bringing up solutions of specific problems on the environment. In the same way, universities have been a fundamental part of the National Innovation System (NIS). This is so because they are the spaces in which science is generated and new knowledge developed including technology and innovation.

Because of the foregoing, universities have played a leading role in the achievement of innovation processes, which, although in some countries has succeeded in impacting economic indicators, unfortunately, have not generated welfare to humanity that was intended. In other words, permanent product innovation has caused problems, such as the excessive and disproportionate use of natural resources as well as inequity in the sharing of wealth in and among countries, resulting in extreme poverty and violence, among other problems associated with these processes. It is for this reason that, these research intended to give a different look to the processes of Science, Technology, and Innovation (STI). For this reason, the TIP is presented as a paradigm shift, to which it must be migrated as a contribution to solving the problems of climate change, inequality, extreme poverty, among others. These problems are defined in the Sustainable Development Goals (SDGs), as a series of goals to be achieved by humanity and that must be addressed by researchers and knowledge in all its spheres. In this sense, in Colombia, a commitment is made

E. Villa (✉)
Instituto Tecnológico Metropolitano ITM, Facultad de Ciencias Económicas y Administrativas, Universidad Nacional de Colombia, Sede Medellín, Antioquia, Colombia
e-mail: elianavilla@itm.edu.co

D. Cardona Valencia
Instituto Tecnológico Metropolitano ITM, Facultad de Ciencias Económicas y Administrativas, Sede Medellín, Antioquia, Colombia
e-mail: danielcardona@itm.edu.com

A. Valencia-Arias
Fundación Universitaria Católica del Norte-FUCN, Sede Medellín, Antioquia, Colombia

K. Hormechea
Facultad de Minas, Universidad Nacional de Colombia, Sede Medellín, Antioquia, Colombia
e-mail: kchormecheat@unal.edu.co

J. García
Universidad Tecnológica del Chocó, Istmina, Chocó, Colombia

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from the national policy of science, technology, and innovation to the incorporation of this transformative approach, as part of the country's commitment to achieving the objectives of sustainable development.

In the following sections, the concept of transformative innovation policy is introduced, and the three innovation frameworks from Colombia explained, showing the objectives of each one, as well as the actors and roles of each framework. In addition, the SDGs are highlighted as part of the goals of humanity and the commitment of the country to the achievement of Agenda 2030. Finally, the chapter introduces the incorporation of the policy of transformative innovation in the National Science and Innovation framework for Colombia (Green Paper 2030), which shelters the university as a fundamental actor in the process.

14.2 Science, Technology, and Innovation in Response to the Problems of Humanity

In the twentieth century, Schumpeter proposed a distinction between innovation, seen as the commercial introduction of a new product or a "new combination," and an invention restricted to the domain of science and technology (Pérez 2010). That division gave birth to the notion of innovation linked to the economic paradigm, which has prevailed in policies and innovation studies since the 1980s. That paradigm is based on two principles: (a) value generation is a term aimed exclusively at the creation of economic value and (b) the agents that perform that function are companies and not people. That dominant paradigm, of Schumpeterian origin, conceived society as a field where innovations were disseminated, but in no case as a potentially innovative agent (Ezponda and Malillos 2011; Villa, Ruiz, Valencia and Picón 2018).

Subsequently, Porter (1996) proposed a new paradigm of competitiveness based on the dynamic innovation processes of companies and industries. According to it, the interrelationships between companies, institutions, and markets support the competitive development of the regions (Platero 2015). Afterward, Freeman and Pérez (2010) suggested the notion of techno-economic paradigms to define, in a synthetic way, the systems of production, innovation, and governance on a macro scale. A techno-economic paradigm is, therefore, the result of a complex collective learning process integrated into a dynamic mental model of optimal economic, technological, and organizational practices for the period during which a specific technological revolution is adopted and assimilated by the socio-economic system (Pérez 2010).

Furthermore, there are important differences in the way the scientific-technical society of the old paradigm of "massive production" and the knowledge society of the current flexible production paradigm conceive the innovative activity (Pérez 2004). Companies already see innovation with a holistic approach; that is, it does not only depend on Research and Development (R&D) departments but it is the result of efforts by all the departments in the organization as well as the interaction with external agents, such as suppliers, partners, and allies. However, the innovation paradigm was not significantly changed: greater competitiveness was required, and innovation was a means to that end.

Adopting an approach different from that of other Organization for Economic Cooperation and Development (OECD) member countries, at the beginning of the new millennium, Quebec (Canada) saw the development of a movement that aims to contribute, from the humanities and social sciences, to an agenda for innovation. These works were based on the study carried out by Taylor (1970), and they aimed to be the first response to the emergence of a paradigm shift in terms of innovation as a means and not as an end, a means for development and social welfare, which could take place not only at companies and companies but in any field, including the community as the first movements of "social innovation" (Echeverría 2008; Echeverría and Merino 2011). These first changes were supported at a prudent pace by European countries and the United States. More specifically, during President Obama's administration in 2009, the US government created the Office of Social Innovation and Civic Participation, which had a budget of

approximately 50 million dollars per year until 2015. Additionally, there is evidence of similar initiatives in Australia and New Zealand (Christensen et al. 2009; House 2014).

Fressoli et al. (2014a, b) emphasize that since innovation models for inclusion and development are designed by academic, governmental, and business actors, there are multiple ways to formalize, abstract, and define variables or principles. According to this thought, the social innovation implies it is better to move away collective spaces for grassroots meetings and, based on that, make commitments in terms of innovation, which will not transcend if marginalized individuals are not included (Thomas and Fressoli 2011). This also includes the acknowledgement of basic innovation, which is produced by and for "the bottom of the pyramid" (Prahalad 2005; Fressoli et al. 2014a, b) and "frugal" innovation models (Bound and Thornton 2012; Fressoli et al. 2014a, b).

14.3 The University as Part of National Innovation Systems

The great demand for education in the twenty-first century resulted in the creation of postsecondary education centers, which, in conjunction with universities, are called Higher Education Institutions (HEIs) (Sebastián and Scharager 2018). HEIs maintain their initial mission (instruction), but they also have two other objectives, conducting research and engaging with the industry and society, which has become a latent evolution (Cesaroni and Piccaluga 2016). Therefore, preserving knowledge and transmitting it, researching and promoting economic development and the welfare of society are the main pillars of HEIs, where science, technology, innovation, entrepreneurship, and social commitment are areas to work on (Beraza Garmendia and Rodríguez Castellanos 2007). HEIs are important knowledge generation centers and the industry depends on them to be competitive (González 2011).

A National Innovation System (NIS) is a network of institutions whose activities favor, import, modify, and disseminate new technologies that provide the framework within which governments develop and implement policies to influence the innovation process (Freeman 1987; Metcalfe 1995; Carayannis et al. 2017). Nevertheless, the type of innovation that has been promoted by the NIS had a competitive component, thus generating inequality, exclusion, unemployment and environmental imbalances, favoring the affluent classes, increasingly segregating low-income communities, and causing greater social, economic, and environmental problems in many impoverished countries (Fressoli et al. 2014b). Drawing from these negative consequences, a paradigm change was necessary, not only about innovating but also about creating adequate conditions so that the economic growth generated by such innovations—instead of impacting the environment or creating inequality—increases the levels of well-being and quality of life and reinforces learning, coordination, and collaboration inside organizations (Hernández 2013; Londoño-Patiño and Acevedo-Álvarez 2018); that is, innovations that contribute to the creation of "an alternative model of growth and development" (Hernández 2013, p. 2). The United Nations set a precedent when it ratified the 17 SDGs as a collective development agenda country must follow to achieve by 2030. To this end, science, technology, and innovation (STI) are widely invoked to face these challenges (Soete 2013; Chataway et al. 2017).

14.4 The Transformative Innovation Policy (TIP): Emergence of a New Paradigm

In the current world scenario, a change of direction and intention in STI processes is necessary. The term innovation for sustainability or "sustainable innovation" is increasingly mentioned, which is in agreement with the change of mentality of the post-modern era in which scientific, economic, and political efforts should be directed at solving structural problems, not only of economic growth but humanity as well (Boons and Lüdeke-Freund 2013). This new current of thought

emerged in developing countries, in which, despite immense efforts to generate economic growth, evident gaps remain in the distribution of wealth and the achievement of human well-being (Gupta 1995; Prahalad 2005; Prahalad and Hamel 1994; Prahalad and Ramaswamy 2004).

One difficulty that arises, nevertheless, is that public policy organizations make proposals only in order to create prototypes and/or innovations that can be marketed. Gupta and Prahalad suggest that, instead of contributing to the generation of "apparently innovative objects," policies should be focused on the *generation of different processes* (Smith et al. 2016). For some decades now, in different places of the world, movements and organizations have been producing this type of developments, called grassroots innovation (Smith et al. 2016). Grassroots innovation is developed through different processes in public institutions, universities, and Research and Development centers, as well as innovation departments at companies that have traditionally networked with formally organized research institutions (Smith et al. 2016). For that reason, new "frameworks" of STI policy are proposed to encourage, support, and leverage those processes, taking into account that the current model must be transformed to achieve humanity's objectives. In the following section, two existing STI policy frameworks are presented along with their actors and relationships; subsequently, this new Transformative Innovation Policy Frame is described.

14.4.1 Framing 1: Research and Development (1960–1980)

Three key actors interact in this model namely: the Government, the University, and the private sector. Additionally, their work and responsibilities are clearly defined. The government regulates and funds R&D expenditures, universities focus on generating knowledge, and the private sector seeks to transform scientific discoveries into innovations to support sustained economic growth (Schot and Steinmueller 2016a, b; Chataway et al. 2017) as shown in Fig. 14.1.

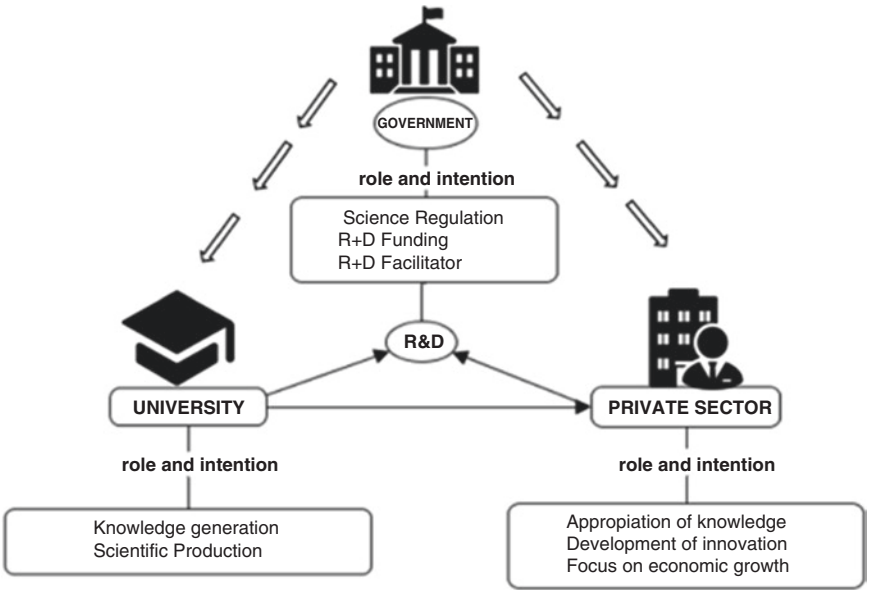

Fig. 14.1 Roles and intentions of the actors in Framing 1: RESEARCH AND DEVELOPMENT. Source: Own elaboration based on Schot and Steinmueller (2016a, b) and Chataway et al. (2017)

14.4.2 Framing 2: National Innovation System (1990 to Date)

Traditionally, Innovation Systems (IS) have been focused on actors, institutions, and their relationships (Dutrénit 2013). One of the central characteristics of this innovation approach is that it has paid less attention to development problems, social inclusion in particular, thus generating greater inequality and strongly influencing the social imbalance (Dutrénit 2013; Kaplinsky 2013; Fressoli 2015). This second frame is focused on describing the structure of actors and their relationships for competitiveness and economic development (Dutrénit 2013; Schot and Steinmueller 2016a, b; Chataway et al. 2017), leaving aside society as a nonessential part of the innovation processes (Dutrénit 2013; Schot and Steinmueller 2016a, b; Chataway et al. 2017). It is important to highlight that, in this frame, universities act as entrepreneurs, the private sector conducts basic research, and the government maintains its traditional role (Schot and Steinmueller 2016a, b; Chataway et al. 2017). The roles and intentions of key actors are reflected in Fig. 14.2.

14.4.3 Framing 3: Transformative Innovation Policy (TIP)

In order to respond to the prevailing need for transformative innovation, some authors propose what has been called the third frame for Innovation Policy. Such frame will allow a world in transition to contribute to the achievement of the SDGs as well as the generation of worldwide public policies that enable the articulation of STI initiatives, actors, and infrastructure to consolidate those processes of innovation. The third frame was studied by the Scientific Policy Research Unit (SPRU) of the University of Sussex in England, based on discussions held at

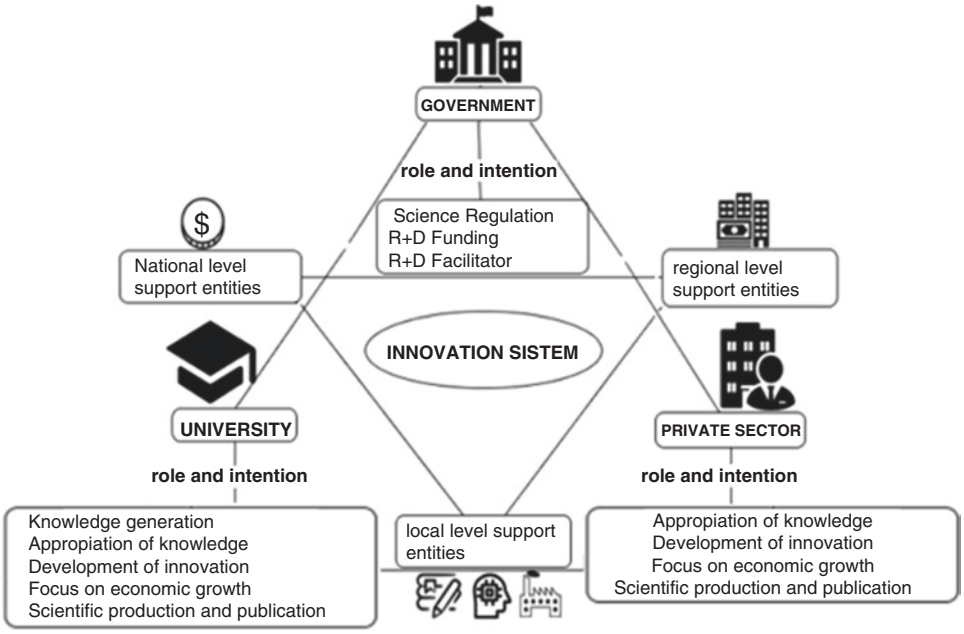

Fig. 14.2 Roles and intentions of key actors in Framing 2: National Innovation System. Source: Own elaboration based on, Dutrénit (2013), Schot and Steinmueller (2016a, b), and Chataway et al. (2017)

the OECD between June and July 2016 in Paris and Seoul; it draws on academic work on transformative innovation policies. Besides, it highlights the need to design policies for innovation that allows transformative change (Schot and Steinmueller 2016a, b).

From the third STI framing, the conception of innovation in the terms mentioned above should change because, under Framing 2, innovation is part of the cause and not the solution to the problems humanity faces. In general, this happens because innovation policy stimulates industrial activities, economic growth, and consumption, which have been the root of environmental problems, social tensions, inequality, and the widening social gap, among others. For that reason, the evolution of public STI policy could contribute to the construction of transformative change (SPRU 2016). In that regard, Thomas et al. (2015) emphasize that systems focused on transformative innovation are those that address problems linked to poverty. Therefore, their articulation with social policies (as elements that demand innovations and define innovation policies) should be more fluid in order to generate virtuous circles of knowledge, innovation, and lower inequality.

This framework recognizes that most innovations have "mixed effects", and it focuses on developing socio-technical changes, interactively linking system actors to find specific solutions. Likewise, policies become more inclusive; they find pathways for alternative development and acknowledge the fundamental role of civil society (Schot and Steinmueller 2016a, b; Chataway et al. 2017). Further details regarding the roles and intentions of the actors are presented in Fig. 14.3.

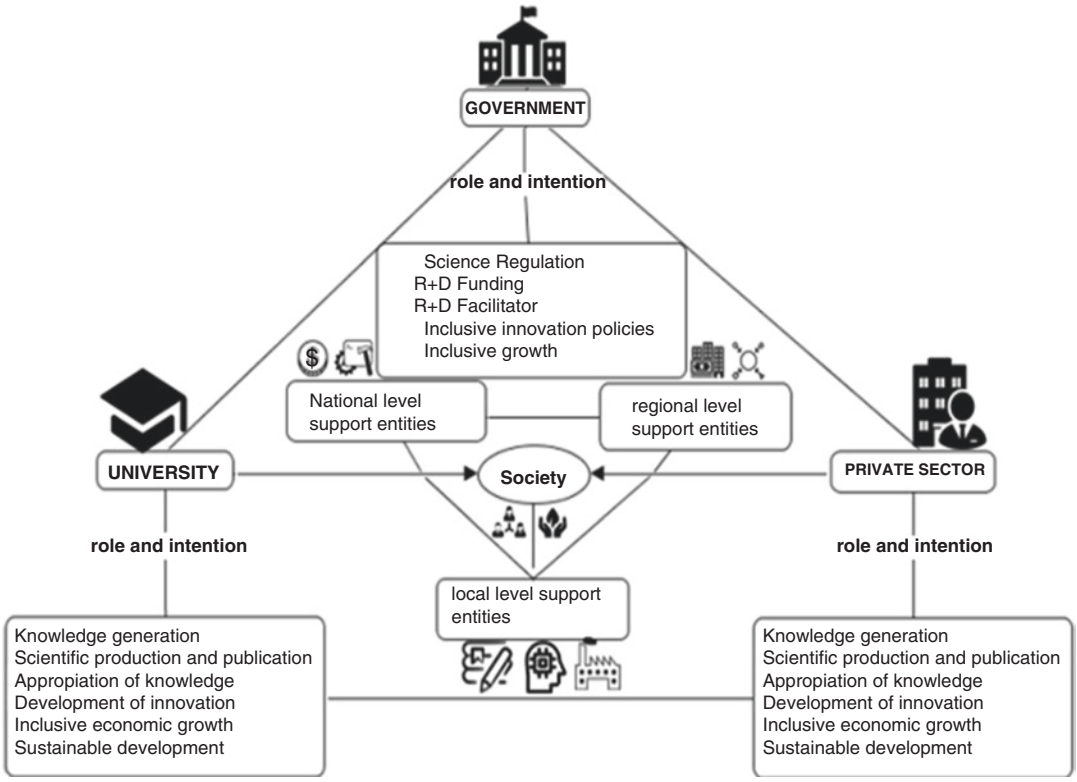

Fig. 14.3 Roles and intentions of the actors in Framing 3: Transformative Innovation Policy. Source: Own elaboration based on, Dutrénit (2013), Schot and Steinmueller (2016a, b), and Chataway et al. (2017)

From Fig. 14.3, it follows that Transformative Innovation (TI) stems from a different conception of the direction and intention of innovation processes. Such paradigm shift is a response to a need for a new structure to meet the real and urgent problems of humanity. In that regard, Schot and Steinmueller (2016a, b) point out the need to adopt the paradigm since the world is changing fast and profoundly. Fressoli et al. (2014a) also claim that the current economic development model is not oriented toward sustainability and, as a result, many scientific policies do not focus on this problem either. Every human should get involved and contribute in a synergic manner to the achievement of the SDGs (ONU 2015a).

14.5 Sustainable Development Goals (SDGs)

The SDGs are an agenda comprising 17 goals focused on eradicating poverty, protecting the planet, and ensuring prosperity for all. They were established for the period between 2015 and 2030. Among the objectives, some are a continuation of the Millennium Development Goals (MDGs) agenda and others mark a global concern for environmental issues. The discourse of sustainable development is used to justify the idea that economic growth helps to reduce social and environmental problems but, in fact, it increases the levels of inequality and environmental problems are evident. Therefore, the goal of this discourse is to maintain the approval of agendas that benefit the capitalist system without effecting a change in the concept of development. According to Fukuda-parr (2016), if the 2030 Agenda is not oriented toward inclusive development, the mistakes of the Millennium Agenda will be made again because the MDGs did not recognize human rights as a priority. They simply focused on the reduction of poverty without looking beyond the causes of the problem; that is, inequality and the economic model were not analyzed. The MDGs stressed economic growth, which prioritizes the profits of companies.

A more optimistic view of the 2030 Agenda is that of Gupta and Vegelin (2016), according to whom the SDGs can mobilize civil society, scholarly communities and communities of practice to demand change. In addition, the academic community and NGOs should monitor the commitment of countries and companies to the objectives of the agenda. The SDGs, compared to the Millennium Goals, are very closely related to each other, as demonstrated by Le Blanc (2015) using network analysis, a characteristic that will facilitate the implementation of policies derived from SDGs. Nevertheless, research, innovation, and sustainable education should be an instrument to achieve the success of the agenda and enable all actors in the quadruple helix model to put research results into practice (Lange et al. 2019).

In addition to the above, a key factor for the success of the SDGs are local conditions and aspirations since they determine how individual countries or other entities wish to respond to the agenda; this is a bottom-up element that generates the local appropriation of the solutions as local expressions of those general objectives (Griggs et al. 2014). In that line of work, Lange et al. (2019) highlight that countries are deciding to study local priorities in order to find their relationship to the SDGs. The goal of climate action and climate change issues constitute a global line of research (Lange et al. 2019). Finally, Sachs (2012) stresses that the success of sustainable development depends on economic development, environmental sustainability, and social inclusion; the three of them should exist in addition to governability. Below is a summary of the main characteristics of development agendas established by the UN until 2030. The evolution of the SDGs agenda is shown in Table 14.1.

In Latin America, interesting initiatives have been developed toward the global pact. Drawing from the second annual report on the progress and regional challenges of the 2030 Agenda by the ECLAC (Economic Commission for Latin America and the Caribbean), more and more companies, institutions, and directed initiatives in Latin America and the Caribbean are voluntarily embracing the vision of sustainable development. The report also mentions stagnation in the reduction of inequality and an uncertain

Table 14.1 Evolution of UN's sustainable development agendas

Characteristics	MGDs	SDGs
Time frame	2000–2015	2015–2030
Focus area	Applied in developing countries	All countries
Goals		
Concept of development	Focused on how economic growth could help increase human development	The evolution of sustainable development, which requires economic, social, and environmental dimensions
Funding	Donation from developed countries	All countries, and even civil society, are expected to bear a cost

Source: Own elaboration based on several works (Le Blanc 2015; Fukuda-parr 2016; Griggs 2013; Griggs et al. 2014; J. Gupta and Vegelin 2016; Kopnina 2016; Lange et al. 2019; ONU 2015b; Sachs 2012)

political landscape that are addressed toward protectionism and less international cooperation. However, the forecast of economic growth and improvements in education in coming years are expected to boost employment and academic training, drivers of equality and development (CEPAL 2018).

The Latin American university has contributed to the SDGs with significant advances in terms of infrastructure and digital skills to use and access telecommunications (widely recognized drivers of human progress, productivity, and the solution to social and educational problems). According to Cisco Systems (2016), in said region, the flow of data over the Internet will reach 11.6 exabytes/month in 2020, compared to 4.5 exabytes/month in 2015, approximately a 50% increase. This growth in digital infrastructure is aimed at promoting new industries, processes, and products, and it is directly connected to the scope of STI in educational projects in rural and urban areas as an effort to reduce educational barriers imposed by physical infrastructure and the administrative-political scope. This immersion in the digital era is decisively influencing higher education in this geographically and culturally vast region, where learning opportunities are required to transform and have an impact on Latin American realities (Cardona Valencia et al. 2018).

ICTs and internet connectivity have been the channels through which universities have launched activities about the global compact and the scope of its objectives. This is the case of Triada, an alliance created to share knowledge, generate social mobility, and create synergies in education by Universidad de los Andes (Colombia), Tecnológico de Monterrey (Mexico), and Pontificia Universidad Católica (Chile). This alliance has developed projects related to common challenges such as corruption, migration, heritage, ethnic groups, the creative industry, and online education. Regarding the latter, the alliance already offers 100 free courses on the platform Coursera, which could potentially reach more than 150,000 users.

Universities are thinking about equality, personal and family growth, and developing initiatives in that sense. For instance, the UNAM Foundation of the Autonomous University of Mexico has included financial education in vulnerable communities as part of its sustainability program—a policy for social outreach. They work in partnership with Mexican companies adhering to the strategy Making Global Goals Local Business (United Nations 2018). Other universities have had similar intentions, such as the University of Sao Paulo and Unicamp in Brazil with the project "Pé de meia" a program that is dedicated to the strengthening of financial

knowledge as a strategy to overcome poverty, aimed at young people, schools, NGOs, and private institutions. Another point that the 2030 Agenda and universities in Latin American have both addressed is migrations, as well as understanding their complexities from economic, social, and cultural standpoints. For that reason, the International Organization for Migration and the UN Agency for Refugees, hand in hand with institutions such as Universidad Nacional, Universidad de los Andes, Javeriana University, Sergio Arboleda University (Colombia), and the Latin American Faculty of Social Sciences (Guatemala, Ecuador, Mexico, and Dominican Republic) are working on reports on migration trends and migration challenges.

Finally, universities are playing an important role as promoters of alliances and validators of a country's commitment to the SDGs and the 2030 Agenda. For example, the University of Panama (Panama) created an observatory for monitoring the implementation of the SDGs that seeks to support the national government, civil society, the private sector, and the academic community to fulfill the commitments acquired in Panama. Brazilian HEIs such as the State University of Goiás, the State University of Piauí, the University of Paraiba, the Methodist University, the Tabosa de Almeida University Center, and the International Institute for Citizen Development jointly created an SDGs network. The latter aims at introducing the SDGs into instruction and extension and supporting their implementation in the country.

14.6 Methodology

The methodology that was carried out for the incorporation of the policy of transformative innovation in the public policy of science, technology, and innovation in Colombia was executed from the policy unit of the Administrative Department of Science, Technology and Innovation (Colciencias). This process was carried out in the framework of an agreement of accession by Colombia to the PIT consortium, which was created with the creation of a group of public policy managers in CTI from different countries of the world. Subsequently, a methodological approach was developed, made up of several processes that allowed the identification of strategies to achieve the OSD from the CTI processes. The processes included:

- Conversations and trainings for stakeholders
- Mentoring network
- Conversations
- Citizen consultation regarding ODS
- Interviews
- Identification of scientific and technological capacities

Based on this methodological design, a consensus was reached, which allowed the theoretical incorporation of these concepts for the incorporation of strategies, addressing and proposals for the incorporation of the policy of transformative innovation, as one way to respond to sustainable development goals in the country, with the support of science, technology, and innovation.

14.7 Results: The 2030 Agenda in Colombia

Colombia, as a member of the United Nations Organization, adopted the Millennium Agenda (2000–2015). Nevertheless, taking into account the achievements and obstacles that arose during its implementation that country expressed (in the United Nations Conference for Sustainable Development Rio + 20 in 2012) the need to expand the definition of development and the MDGs by structuring a new global development agenda (CONPES 2018b). Based on that initiative and the support of several countries, governmental and non-governmental entities, the 2030 Agenda was created, and the SDGs were set. It was adopted worldwide in 2015 and, as expected, Colombia committed itself to implement it (Gobierno de Colombia 2016).

One of the strategies that the country adopted to facilitate the implementation of the 2030 Agenda was the creation of the High Level Inter-Institutional Commission for the

Enlistment and Effective Implementation of the SDGs through Decree 280 of 2015. This commission was established to facilitate intersectoral work for the implementation of the 2030 Agenda, that is, to create a space for several ministries and departments that compose the national government to discuss public policies, programs, actions, and the monitoring of said goals in Colombia (DNP 2018). Additionally, the National Council of Economic and Social Policy (CONPES in Spanish), which advises the government on issues of public policy, published two CONPES documents regarding the 2030 Agenda. First, CONPES 3918 outlines a strategy for the implementation of the SDGs in the country, and it details a route that includes a list of indicators and goals to follow up on said implementation (CONPES 2018b). Second, CONPES 3934, the Green Growth Policy, defines strategic actions to achieve sustained and sustainable economic growth (CONPES 2018c). Although the implementation of the SDGs depends on the national, departmental, and municipal governments, CONPES documents are a point of reference in terms of policies for the adoption of the SDGs in Colombia. Figure 14.4 presents the most relevant events regarding the SDGs in Colombia.

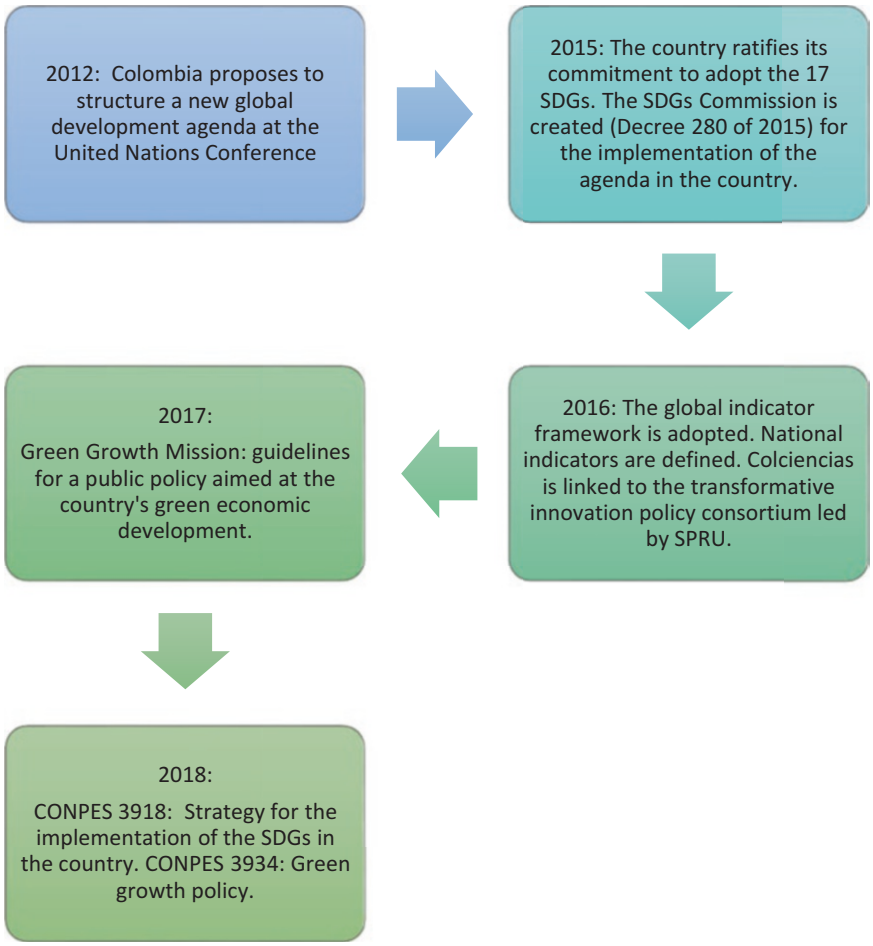

Fig. 14.4 Timeline of the 2030 Agenda in Colombia. Source: Own elaboration based on, (Colciencias 2018b; CONPES 2018b, c; Departamento Nacional de Planeación DNP 2018)

14.7.1 Main Strategies of the STI Policy in Colombia to Adopt the 2030 Agenda

The 2030 Agenda was implemented as a strategy for the sustainable and equitable progress of developing countries (United Nations 2016) and, as a result, Colombia faces major challenges that involve the reformulation of current STI policies to positively impact the social, environmental, and economic context (Colciencias 2018a, b, c, d). One of the challenges STI policies pose is the creation of an educated, prosperous, fair and equitable, society with high quality of life. In that context, development is not only driven by economic growth but also by the most local problems, the environment is taken into account, and all the actors that are part of the National Innovation System actively participate to effect a transformative and inclusive change (Colciencias 2018a, b, c, d; CONPES 2018).

Currently, Colombia has a variety of STI programs and public policies for social and environmental benefits at the national, regional, and local level promoted by different government agencies that have found support in HEIs, private companies, and the social sector. In fact, Colombia is one of the few countries in the world that has a Center for Social Innovation within a public institution and an advanced project of national public policy on innovation that addresses social and environmental problems (Thiele et al. 2010; Villa and Melo 2015). This demonstrates that the need to connect economic and social purposes has been explicit in the Colombian STI policy, and it is no wonder, given the great complexity and diversity of the country, as well as the dimension of the challenges it faces to have a more equitable and prosperous society (Colciencias 2018a, b, c, d).

14.7.2 Colombian University, Incorporation and Achievement of the SDGs

In recent years, Colombian HEIs have developed different studies and conducted research that have contributed to the reconfiguration of public STI policies for the most vulnerable sectors. They have sought to improve their living conditions and support sustainable development. Therefore, the main guidelines of the National Development Plan 2014–2018 "All for a new country" propose to train human capital in STI, research and development, innovation and entrepreneurship, transfer of knowledge and technology for economic development, and the generation of regional social and environmental welfare.

In order to generate a different STI policy and respond to the country's commitment to achieving the SDGs, Colciencias joined the Transformative Innovation Policy Consortium (TIPC), coordinated by the Science Policy Research Unit (SPRU) of the University of Sussex in the United Kingdom and ministries of and participation of funding agencies in countries such as Finland (National Research Council), Mexico (National Council of Science and Technology of Mexico, CONACYT), Norway (Research Council of Norway), South Africa (The South African National Research Foundation, NRF), and Sweden (Swedish Governmental Agency for Innovation Systems—VINNOVA). More recently, other countries have participated with similar initiatives, such as China, Panama, and Brazil. The TIPC has provided guidelines for a new STI policy framework whose objective is to contribute to the solution of the global challenges summarized in the SDGs proposed by the UN (Colciencias 2018a, b, c, d).

Since 2016, a different methodological approach has been developed by Colciencias' STI Policy Unit, which created the National Policy on Science and Innovation for Sustainable Development, known as the Green Book 2030 (Colciencias 2018a, b, c, d). Such book is the result of Colombia's participation in the TIPC and the need to align its STI policy with this global trend. Adopted through resolution 0674 of July 9, 2018, said public policy on science and innovation was developed and proposed adopting a transformative approach in order to contribute to the solution of the most important social, environmental, and economic challenges expressed in the SDGs (Colciencias a, b, c, d). The Green Book promotes changes at the socio-technical

level, considering the complexity and existing interrelation between the problems to be solved. Additionally, it promotes actions in five fronts defined by the STI policy with a transformative approach (Colciencias 2018a, b, c, d):

1. Learning and experimentation: creation of spaces and practical actions that generate processes of reflection, transmission, and acquisition of knowledge and experiences that allow to adjust the public policy and support the necessary changes.
2. Steering: collective process in which different alternatives are considered and actions are oriented toward necessary and desirable changes for sustainable development.
3. Engagement: active involvement and discussion of different actors to generate, use, and access knowledge and innovation that contribute to sustainable development.
4. Interdisciplinarity: collaboration between different disciplines to solve complex problems such as those in the 2030 Agenda.
5. Forecasting of results and effects: open and critical assessment of the purposes, motivations, and intentions in the processes of research and innovation that enable to establish the impacts and ethical limits that compromise sustainable development.

14.8 Conclusions

The current innovation system worldwide has worked on the basis of a clear division of roles and interactions of several actors to respond specifically to macroeconomic demands and market failures; nevertheless, it does not aim at generating social welfare and reducing social and environmental. This trend has only allowed the emergence of innovation approaches focused on solving economic problems and obtaining wealth. Moreover, it has deepened an exclusionary model and is unable to address the new challenges society is handling. For that reason, some nations have expressed the need for different innovation dynamics that can respond to the plurality of current social and environmental requirements (Coenen et al. 2015; Hernández and Pérez 2016; Andoni et al. 2017). As a result of that urgent need to incorporate new intervention dynamics based on innovation processes, Colombia has designed strategies that imply changes in the design of STI policies to face those challenges and achieve the SDGs in the 2030 Agenda.

In particular, the production of the Green Book 2030 revealed six challenges that STI initiatives meet to achieve the SDGs. First, low government investment in this field is a persisting situation in developing countries. Second, STI is a marginal field in people's perception; that is, society in general does not know about or value its processes. Third, STI policies and other national, departmental, and regional policies exhibit limited articulation. Fourth, research agendas are, in general, mono-disciplinary and they do not include inter- or transdisciplinary or ancestral or empirical knowledge, which can contribute to effectively create innovative solutions that are appropriate for the communities. Fifth, technology transfer is usually based on knowing how to do something rather than why, which produces unsustainable, inappropriate, and ineffective innovations. Sixth, although technology absorption capacities are necessary for peer collaboration, low levels were identified.

By contributing as an actor of the National Innovation System to the construction of the new Science and Innovation Policy for Transformation, the university in Colombia becomes as a validator of the achievement of three Sustainable Development Goals. (a) SDG 4: "Ensure inclusive and equitable high-quality education and the promotion of lifelong learning opportunities for all." (b) SDG 16: "Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, responsible and inclusive institutions at all levels." (c) SDG 17: "Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development" at the local and global level.

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15 Adoption of the SDGs as a Reporting Framework at the Alma Mater Studiorum (University of Bologna) in Italy

Angelo Paletta, Pietro Fochi, Tullia Gallina Toschi, and Francesco Ubertini

15.1 The Context of the Alma Mater Studiorum: University of Bologna

Sustainable development is the pathway to the future we want for all. It offers a framework to generate economic growth, achieve social justice, exercise environmental stewardship and strengthen governance
(Ban Ki-moon during the G20 working dinner on Sustainable Development September 2013).

With 86,509 enrolled students, and personnel over 5500 units (University of Bologna 2018), the University of Bologna, one of the most ancient Western higher education institutions was established in 1088 A.D. (University of Bologna 2017a) and, located in a middle-sized town of Northern Italy, faces daily challenges in a constantly evolving society with continuously changing paradigms. At Alma Mater, a multi-campus structure with over 1,162,506 m^2 of facilities only in Europe placing the University as the first European university for international mobility with 2787 outbound students and 1970 inbound students in 2018 (INDIRE 2019). This geographic spread and other factors require a broad and long-term vision of the governance strategy, which goes side by side with the central activities of researching and training in full respect of the freedoms of science and teaching, as it is stated at Art. 3.1 of the University Statute (Italian Republic 2011).

The considerable human and physical of the University system lead to both the need and the duty to harmonize the relationship within people, between people and the environment—that is, between the University and all its stakeholders. Recognizing its role in the society and willing to be a positive actor of change, combining innovation with the history that it has consolidated over time, the Alma Mater Studiorum is fully aware that its activities can produce a significant impact, both direct and indirect, on the community and in the region.

As a large public university conscious of its social responsibility, the Bologna University has invested, in the past three academic years, ener-

A. Paletta
Department of Management and Delegate on Finance, Strategic Planning and Innovation, University of Bologna, Bologna, Italy
e-mail: angelo.paletta@unibo.it

P. Fochi (✉)
University of Bologna, Bologna, Italy
e-mail: pietro.fochi@studio.unibo.it

T. Gallina Toschi
Department of Agricultural and Food Sciences and Delegate on Welfare at Work, University of Bologna, Bologna, Italy
e-mail: tullia.gallinatoschi@unibo.it

F. Ubertini
Rector of the University of Bologna, Department of Civil, Chemical, Environmental, and Materials Engineering, University of Bologna, Bologna, Italy
e-mail: francesco.ubertini@unibo.it

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gies and resources to embrace a new approach in measuring its performance. This consists of an innovative path based on the careful classification and reporting of its activities in a framework that considers its contribution to the achievement of the United Nations Sustainable Development Goals as of 2016. This chapter will start from the investigation of the reasons that led to this new approach in the governance of the University system, focusing on the inner relationship between Higher Education and the 2030 Agenda in the case of the University of Bologna. It will then provide an overview of the pathway that brought the comprehensive tool of the Report on the United Nations Sustainable Development Goals (SDGs) through a variety of previously existing projects and documents. The core point of the chapter is the novelty of the approach to the 2030 Agenda, which will be scrutinized through the reasons behind the choice of conducting such a research, the analysis of its methodology, and the implementation and assessment of the effectiveness of the strategy towards the SDGs of objectives. The conclusions will point out the two main challenges raised by the reporting framework.

15.2 Higher Education and the 2030 Agenda: Perspectives and Actions of the University of Bologna

Even before the adoption of the 2030 Agenda (United Nations 2015) in late 2015, higher education and more broadly academia, has been included in the discussion on sustainable development. This evidence in the reading of United Nations General Assembly Resolution A/RES/66/288, well known as "The Future We Want," which set the basis for the creation of today's development trajectory (United Nations 2012). Paragraph 235 of this resolution explicitly calls for support of educational institutions, especially of higher education institutions (HEIs) to conduct research and innovation for sustainable development "geared to bridging skills gaps for advancing national sustainable development objectives" (United Nations 2012).

A significant role of educational institutions and scholars also emerged from the following debate that gave birth to the 17 SDGs (Dodds et al. 2016). Arguably, the linkage between higher education and the 2030 Agenda has become closer with the shift from the 2000 Millennium Development Goals—MDGs (United Nations 2000) to the 2015 Sustainable Development Goals. While in the MDGs, higher education was feebly mentioned in goal number 3 aimed to achieve gender parity, the SDGs in contrast offer a more extensive reference at goal number 4 titled "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." More specifically, higher education finds place in five targets under Goal 4. Direct tackling of this objective is in target 4.3 which states "equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university," and 4.B "substantially expand globally the number of scholarships available […] for enrolment in higher education…," while indirect references are in target 4.4 "number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship," 4.5 "eliminate gender disparities in education and ensure equal access to all levels of education," and 4.7 "ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development."

Following the adoption of the Agenda 2030, educational institutions have been engaging in a variety of actions and initiatives one hand and on the other have provided inputs to or been tackled by international tools for further exploring the relationship between them and sustainable development. To this extent, it is relevant to consider the Higher Education Sustainability Initiative (HESI) for the first set of actions and the FFA—Education 2030 Framework for Action (UNESCO et al. 2015) for the latter. HESI consists in a partnership between UNDESA, UNESCO, UNEP, UN PRME initiative, UNU, UN-HABITAT, UNCTAD, and UNITAR and collects commitments from over 300 universities

from around the world and provides higher education institutions with a unique interface between higher education, science, and policy-making (United Nations 2016).

Moreover, linking higher education with Goal 4 would offer a very limited and an insufficient picture of the topic in the interconnected world of the twenty-first century. Hence, higher education plays a significant direct role in many other fields inter alia, good health and well-being (Goal 3), gender equality (Goal 5), decent work and economic growth (Goal 8), industry, innovation and infrastructures (Goal 9), reduced inequalities (Goal 10), sustainable cities and communities (Goal 11), and partnerships for the goals (Goal 17). The choice of this set of goals is not accidental, as they, together with Goal 4 have been included in the 2016–2018 Strategic Plan of the University of Bologna. As the 2030 Agenda is not merely a set of 17 goals, rather a harmonic plan of action, Bologna University has therefore taken action by merging the SDGs with its vision, mission, positioning analysis, and community goals. The plan of action in this regard has initiated from three main considerations.

First, a complex range of teaching activities conducted throughout a multi-campus system requires a synergy that increasingly generates interaction between the cities, departments, and schools where the courses are set. Therefore, it is pivotal to improve and to expand facilities and spaces where teaching and research activities are carried out. Second, Bologna University feels the need to increasingly become a major laboratory of ideas for sharing with other players active in its local area in the fields of industry, business, and cultural investment. A multi-stakeholders net of partnerships is one of the answers to understand the present and to face the challenges that tomorrow will bring. Third, the University is aware of the importance of consolidating the already existing dense web of relationships with HEIs all over the world to make the many forms of knowledge locally developed interact with those of other realities and cultures. All these, together with the recognition of the value that education has in the development of every country led to a progressively wider line of reasoning on the real function of the Alma Mater Studiorum in the achievement of the 17 SDGs. Considering that the University of Bologna is a leading academic institution in Europe and worldwide, the discussion soon questioned the broader role of HE broadly asking the questions: Where and how the University set itself in the demanding path towards sustainability? What is its role both internally and externally? How can the University meaningfully benefit from the full embracement of the SDGs in its strategy and the implementation of this strategy?

These questions are pressing universities to confirm their accountability to society under conditions of constantly changing and reorienting paradigms. Driven by these questions, a debate was conducted within the University of Bologna. This debate assisted in identifying the rationale behind the reporting framework this chapter present. While the focus on teaching and research remains primary, the aim to set sustainability as a propulsive push for the betterment of the institution and its communities, goes further and beyond this traditional mandate of the University. Indeed, the Alma Mater has significantly broadened the sphere of application of the sustainable perspective by incorporating it in all its governance actions. Therefore, not just the highest strategic plan has been shaped around the 2030 Agenda, but other areas have been touched by its mandate. Accordingly, the embodiment of the Sustainable Development Agenda starts from the institutional mission of Bologna University, which chiefly consists in the twin pillars of the vocation for teaching and that for research and extends to the international vocation of the University. Vital and dynamic relations with society and with the labor market complete this frame together with the passion for culture united with a deep ethical conscience, and the enhancement of the pluralities of its intellectual disciplines. In this context, the resources allocation mechanism has taken the 2030 Agenda into account at the stage of budgeting and at that of final balancing, the first for foreseeing the impact of the University actions on the goals, and the latter for the impact assessment.

These perspectives and actions, mentioned by way of examples, facilitate the understanding of the mutual link connecting higher education with

the SDGs. Thus, it is simple to explain why the SDGs need universities for their achievement. By providing the knowledge and scientific solutions, universities support the implementation of the goals, combining research with innovation and carrying out experiments and gathering relevant data. Second, the embodiment of the SDG values in all of the university operations, ensures a higher level of completion of the goals due the institutions' significant social, economic, and environmental footmark. Third, universities are mainly credible and impartial stakeholders of either a local or a broader society. This allows them to play a leading role in guiding the response to the SDG implementation strategies at different levels. Leadership can therefore be cross-sectoral, thanks to the gravitas universities assume. Hence, the teaching duty of the HEIs goes beyond its first mission of educating younger generations: advocacy for a more sustainable future, through a change of policies and behaviors, might positively impact but also the public and the private sector, the public opinion, and civil society movements. These considerations have been fully incorporated in the perspective of the Bologna University and complemented with two main driving reasons for the insertion of the SDGs in the University life and one simple and effective way of doing so.

A university holds the paramount responsibility of shaping the current and the future generations of implementers of the 2030 Agenda. This social duty operates in two directions: on one side there is the necessity to forge the right mindsets, on the other there is the chance to provide people with the proper knowledge, skills, and abilities towards sustainability. The expression of such a burden can be directed not only to the students' community, but also to the international network of alumni and campuses. The University of Bologna has deep roots in the world of academia making is a recognized center of knowledge and innovation. Only by translating its very same name "Alma Mater—Studiorum," the University of Bologna feels the extra responsibility of acting as mothers of all other universities, in constituting the best role model of the harmonic integration of the SDGs in the university system.

Finally, the answer to the "how" to reach such results has been put in practice within the Alma Mater long before it has been codified in words: only by finalizing the entirety of the institution's activities in a conscious way towards the SDGs, the University can turn into a living lab for a sustainable future. In a society of fast-changing paradigms, universities must not only respond to needs that come from the outside, but also anticipate, needs from within, the fundamental questions on which they will orient their institutional missions: education, research, and Third Mission which deals with the engagement of the University in the socio-economic context it is part of.

The Strategic Plan of the University of Bologna is the programming document that anticipates and directs change, tracing the development vision, the objectives and the institutional strategies, also setting the indicators to evaluate any improvements achieved. It represents the synthesis of a shared planning process that directly engages university governance, departments, and other academic and administrative structures, as well as external stakeholders.

In Italy, universities are now required to adopt a strategic plan as a consequence of the implementation of the legislative decree 150/2009 (Italian Republic 2009) which provides that all public administrations prepare annually Performance Plans as part of tools in performance management cycles. The University of Bologna Plan is a 3-year planning document in which, consistent with the resources assigned, the objectives, indicators, and targets are explained. In November 2016, the University of Bologna adopted the new 2016–2018 Strategic Plan, a program document that outlines the University's mission, strategic guidelines, and objectives based on the General Guidelines for Planning of Universities defined with the Ministerial Decree 635/2016 (Ministry of Education of the Italian Republic 2016).

For the first time, the new strategic plan introduces Sustainable Development (SD) as a transversal dimension that intersects both the strategic objectives related to the three institutional missions (research, teaching, and third mission) and the operational objectives related to the adminis-

tration, which are the direct responsibility of the University's management structure.

In order to carry out a strategic planning that puts issues related to sustainable development at the center of the University's governance action, the Alma Mater developed the Strategic Plan with an articulating its objectives and strategies according to the 17 SDGs and the related 169 targets. In the first experimentation of the new strategic planning methodology, each basic objective of the Strategic Plan was associated with one or more objectives identified in the 2030 Agenda. This association was represented through the inclusion of the icon related to the associated SDG with which the University of Bologna intended to contribute. The weak point is that when the University started this new approach it had incomplete and non-systematic quantitative data relating to the strategic and operational objectives on the 17 goals of 2030 Agenda. Lacking a historical basis for measuring sustainability performance presented a limitation of the 2016–2018 strategic plan since it was difficult to define indicators and objectives directly linked to the 2030 Agenda except for a limited number of SDGs. In 2017, using data from 2016 and previous years, the Alma Mater prepared the first reporting document measuring the impact of the University on each SDG. In 2018, the second report was compiled, and the compilation of the third edition report was in progress at the time of writing this chapter. The acquisition of a historical database and the learning on how to measure the impact of the University to the 2030 Agenda, is an indispensable condition to improving the planning process pertaining to the University's sustainability strategy. The new planning process involves a diagnosis phase important to fully understand the reality within which the University operates and the resources at its disposal to operate at the desired level. From the process, it was decided to develop an internal analysis of the strengths and weaknesses of the University's sustainability and an external analysis of the risks and opportunities given by the context in which the University of Bologna operates.

The strengths have been identified as the characteristics for which the University stands out in a positive sense. While the weaknesses are the features that present room for improvement. Opportunities were then identified as the external factors that the University can grasp to improve its sustainability positioning. Finally, the risks are external factors that constitute a constraint in the University's operations or events that can negatively influence sustainability performance.

On the light of these findings, the next section will develop the precise methodology on which the University's report on SDGs is built upon.

15.3 Methodology and Report's Picture

As earlier reported, the University of Bologna Report on United Nations Sustainable Development Goals to date has been published twice, for 2016 and 2017. For the purpose of this explanation, reference will be mainly made to the latest edition of the Report (University of Bologna 2017b), which was prepared from April 2018 to July 2018. The data presented refer to 2017, as well as academic year 2017/2018 for training data.

The Scientific and Technical Committee for Social Reporting—appointed by the University Board of Directors has formulated the report with the support of the ARAG—Evaluation and Strategic Planning Unit, and the ARTEC—Communication Unit. In order to fully comprehend the cross-sector nature of the study, it is relevant to catch the diversity of the Committee which comprises: the Rector; the Deputy Rector and the National Coordinator for Italy for the UI GreenMetric Network; Delegates on Budget, on Occupational well-being, and on Building and Sustainability; the coordinator of the Alma Mater Technical Group for H2020; Chair of the Guarantee Committee for Equal Opportunities, Employee Wellbeing and Non-Discrimination at Work—CUG; Pro Rectors on International Relations and on Digital Technologies; the Member of Network of Universities for Sustainable Development (RUS) for University

of Bologna; Director General; Head of Administrative Division—ARAG—Finance and Subsidiaries Division; Head of Administrative Division—APOS—Personnel Division; Head of Administrative Division—AUTC—Buildings and Sustainability Division.

The report presents the key figures of the University of Bologna, followed by 17 sections dedicated to each SDG. The sections define the direct and indirect impact of the University's activities in their four dimensions—training, research, Third Mission and institution—in order to measure their contribution to the advancement of the 2030 Agenda. A single goal is reported using a set of metrics specifically formulated to match and integrate with the institutional documents adapted by the University of Bologna.

First, under the dimension of training three items are measured: course units, students and collaborations. Course units indicate the link between the single course unit of a study program and the 17 SDGs. The relevant data come from a survey conducted through an on-line procedure asking to all teachers to identify the links. Up to 95% of the course units have been found a link with at least one SDG. The number of students who could chose a course unit linked with the taken SDG is then reported, together with the number of collaborations, teaching and mobility projects active in 2017 and listed by continent of implementation. Some SDG sheet is also integrated with further data, such as Goal 8 (Decent work and economic growth) reporting the percentage of graduates employed, at 69.7% in 2017 (University of Bologna 2017b). Second, the dimension of research presents six items: publications in Scopus, "cited by" in Scopus, H-index, publications per capita (international and national benchmark), and the number of FP7 (EU Parliament and Council 2006) and H2020 (EU Parliament and Council 2013) research projects active on 2017.

In order to extract the number of publications from the Scopus database, a research has been conducted considering all articles from 2007 to 2017 containing a specific sequence of keywords chosen for each SDG (considering all its targets) and an author affiliated with the University of Bologna. The "cited by" in Scopus derives from the number of documents that have cited the author for a document's publication in the database. The H-index, developed by the physician Jorge Eduardo Hirsh, counts the highest number of papers having at least the same number of citations. It expresses an easy to read 1:1 relationship between publishing articles and citations, useful in the medium-long term of a career, for example, to define the level of global citation, in terms of scientific production of an author. In the report, it is used to measure the scientific output of the University of Bologna, using the keywords' clusters, extracted from each SDG, to contain, cross and limit its topics and objectives. The procedure has the advantage that, once the keywords selected and the Boolean operators applied are fixed, it can be repeated year by year giving the same results (or updated in case of new citations) and gives comparable results when different Institutions are taken into consideration. The main limit of the use of this procedure is that it excludes the non-bibliometric sectors. After a long discussion and the consideration of different proposals and databases to rate the non-bibliometric sectors, none of the possible methods actually available to measure the contribution of the non-bibliometric sectors was agreed to be universally used as a valid and sufficiently updated national or international reference and the Scientific and Technical Committee agreed, till a solution will be found, by to accept and declare this limit.

The international benchmarking standards includes universities within the top 10 European Universities ranked in QS World Universities Ranking 2017/2018 (which are UCL (University College London) UK; The University of Manchester UK; Ludwig-Maximilians-Universität München—DE; Sorbonne University—FR; University of Copenhagen—DK; Katholieke Universiteit Leuven—BE; University of Leeds—UK; Utrecht University—NL; University of Ghent—BE; Rheinisch-Westfälische Technische Hochschule Aachen—DE) (QS 2018) comparable to the University of Bologna in terms of: size (XL—more than 30,000 students), focus (FC—all five

QS faculty areas, including the school of medicine), Research Intensity (Very High—more than 13,000 publications in the last 5 years), and Status (Public). The total number of articles was determined as described in the item publications in Scopus. The total number of articles for each university and each goal was scaled against the number of academic staffs as listed by QS for the World University Ranking 2016/2017 (QS 2018). By doing so, we eliminated any dimensional effect caused by simply considering the total number of publications. Finally, for each goal we compared the University of Bologna's ratio with the average of the ratios for the ten universities in the benchmark group. The result is the index number "benchmark = 100"; an index number higher than 100 means that "per capita publications" by the University of Bologna academics is higher than the average of the universities in the international benchmark group. If the index is lower than 100, academic productivity of the University of Bologna is lower than the benchmark.

The national benchmarking follows the parameters used for the selection of the international one: three Italian universities (Sapienza—Università di Roma UNIROMA1; Università degli Studi di Padova UNIPD; Università degli Studi di Milano UNIMI) were selected from the first 400 in the same ranking (QS 2018).

The dimension of the Third Mission, referring to the role of the University in knowledge society, mainly indicates the numerical level of cooperation and social engagement research projects that are active worldwide, but also—as a non-exhaustive list—students and teachers on lifelong learning programs (SDG 4), spin off and start-ups born by academic entrepreneurship (SDG 8), and events with public engagement (SDG 11). The fourth dimension intended to measure the institution's overall performance, displays concrete results (e.g. the reduction of water consumption in a 3-year period—SDG 6; the solar energy produced—SDG 7) or data connected to a topic (e.g. institutional accountability and transparency—SDG 16). Further elements of harder classification are reported under the last two dimensions. Among these are the patents (the number of active patents and vegetal varieties registered in 2017 by the University—both ownership and co-ownership-, and their various international extensions) including new plant varieties, and other projects the University is involved in (such as the participation into the Magna Charta Observatory) or has created, e.g., AlmaEngage or Unibo4Refugees.

The Report is presented in a very attractive layout for reading and comprehension of data making the tool accessible to all readers. This presentation style affords quick reading given the difficulties that non-expert readers sometimes encounter with such reports which are sometimes extremely long, detailed, and confusing. However, these quick read reports should give enough information and pointers to move towards stated objectives annually. For a deeper understanding, a reading of the full document is recommended.

15.4 Pathway Towards the Report on UN Sustainable Development Goals

In the past decade, the University of Bologna has been paying holistic and particular attention to the harmonization of its governance. The managing structure of the Alma Mater has indeed prepared and implemented a variety of researches, documents, and tools meant to both analyze the functioning of the institution and its impact on the community, and to provide a solid ground to the future research activity that might deal with the topic or issue each instrument tackles.

A short overview of some of the most significant actions in this regard intends to demonstrate the evolutionary pattern existing within the University of Bologna prior to the adoption of the 2030 Agenda for Sustainable Development to show the vocational push that led to the creation of the reports on the UN SDGs. Indeed, a broad and cross-disciplinary vision has been driving the governance bodies and units in the scrutiny of the University's status quo while not forgetting to read in depth the relationship between the institution and all its stakeholders. This section will

provide an overview on the Alma2021 portal, the Social Responsibility Report, the Gender Equality Annual Report, and the Gender Equality Plan.

The first tool to consider in this framework is the Alma2021 online portal (University of Bologna 2016) which sets out the actions that are intended to implement the Strategic Plan and essentially summarizes the planning processes followed by the University's governing bodies and departments. The website (University of Bologna 2016) reports on the policy decisions made, the processes of governance implemented within the academic community and outside, the commitments made, and the results achieved. Thus, Alma2021 has a dynamic shape deriving from the continuous inputs provided throughout the University, the adoption of new ideas and the adaption of institutional policies and strategies along the way. This dynamism is expressed through a regular update and a live interaction with all the parties involved. Actions listed in the Alma2021 platform are organized in major categories that are easy to understand, e.g., international, public, and social engagement and digital agenda among others. With a zoom-in path, while accessing a content the user finds the related SDGs highlighted through the display of each goal's icon. The icons link directly to the UN information box on the SDGs, which is useful for offering the user a better understanding on the goal. However, this linkage does not simply show a relationship, it proofs the University aim of achieving the goal itself.

Finally, the Alma2021 platform, keenly wanted by the Rector Professor Francesco Ubertini at the beginning of its mandate, seeks to be a transparent and systemic tool for communicating the progress made by the governors towards achieving—at the same pace—the objectives of the Strategic Plan and those of the Sustainable Development Agenda.

A second tool deserving attention in this treatise is the Social Responsibility Report, which has been published annually since 2012. The report has become a flagship document for the University management, and it reached its 6th edition subtitled "Value of the use of knowledge for the community and the territory" (University of Bologna 2017c).

The Social Responsibility Report consists of an extensive publication covering the economic, social, and environmental effects of the entirety of the University fields of action: identity, strategy, and governance structure; accounting, asset, and properties; activities and results (including research and teaching); procurement policies and impact on the environment. The editing of the report follows a meticulous methodology made of precise data and time references. Hence, its completion gets sharpened year by year thanks to a tenacious investment of time and resources, and to the feedback of the increasing number of readers, from inside and outside the University environment. In the same way, the report precisely sums up the annual life of the University. It also generates an active debate and stimulates a critical discussion on the direction the institution should take in the future, i.e., the next review year. This virtuous circle indicates the transparency end of the document that has been validated to an even stronger extent by the recent sharing of data sets the report is grounded on in the University open data portal. This way, not just a policy of open science is fostered, but also that of open government. It is significant to point out that the Scientific Committee in charge of the work on the Social Responsibility Report, coordinated by Professor Angelo Paletta, Delegate on Budget is the same Committee that manages the editing of the Report on the UN SDGs this chapter focuses on. The complex activity of reporting has gradually involved all university entities at different levels (principle of inclusivity), which consented to identify the most relevant activities and data (principle of materiality) in order to allow an evaluation of the full performance of the institution (principle of completeness). These principles, together with that of a balanced reporting, have been and are the driving standards of all the analysis carried out by the University of Bologna regarding its own actions that are taken in the context of the Report on the UN SDGs.

The University's stand for gender equality has been translated into two meaningful tools: the

Gender Equality Annual Report and the Gender Equality Plan. The Gender Equality Annual Report (University of Bologna 2017d), started with reference to the year 2015, is a voluntarily published document that gives account of the studying, researching, and working opportunities within the Alma Mater from a gender perspective. Conceived under the aegis of the CUG—Guarantee Committee for Equal Opportunities, Work Wellbeing and Non-Discrimination at Work initiative is today (2019) chaired by Professor Benedetta Siboni. The last edition of the Report used, for the first time, the UGII—University Gender Inequality Index (Mignoli et al. 2018) expresses, through a single value, the distance between gender balance at the University and hypothetical perfect equality. The report is organized in the following four sections: (1) Regulations and bodies in charge for the promotion of equal opportunities; (2) Positive Actions Plan and initiatives implemented; (3) Gender composition at the University of Bologna; and (4) Investments made for the promotion of equal opportunities. The third section presents an analysis of the context through disaggregates data of all the universities components—students, teaching staff, technical and administrative staff—and the women representation in university bodies and top positions in research and teaching. Moving to the Gender Equality Plan (GEP), it becomes clear how the University of Bologna's adhesion to the 2030 Agenda is shaped by global goals that go far beyond the boundaries of the University itself.

The GEP is a fundamental action of the PLOTINA Project "Promoting Gender Balance and Inclusion in Research, Innovation and Training," granted under the Horizon 2020 financial program of the European Commission (Grant Agreement No. 666008), coordinated by Professor Tullia Gallina Toschi and named after the Roman empress Pompeia Plotina (Birley 2015). The project consists of a consortium of nine partners representing the diversity of European Research Performing Organisations (RPOs) as well as the diversity of European social and cultural environments. Partners include the following: University of Bologna (Italy), University of Warwick (UK), Mondragon Unibertsitatea (Spain), Instituto Superior de Economia e Gestao (Portugal), Kemijski Institut (Slovenia), Ozyegin Universitesi (Turkey), Zentrum fur Soziale Innovation GMBH (Austria), Jump Forum (Belgium), Centro Studi Progetto Donna e Diversity MGMT (Italy), and Elhuyar—Zubize SL (Spain) (PLOTINA 2015).

PLOTINA aims to promote career development of both female and male researchers to prevent the waste of talents, particularly for women who are more likely to drop out their careers because of a variety of reasons. The project aims to improve decision-making processes in addressing gender imbalances to meet new opportunities for excellence, to incorporate the gender dimension variable in research especially where it is traditionally not applied, to ensure diversification of views and methodologies in research and teaching, and to stimulate a gender aware culture change. Towards those aims, the GEP is shaped on each partner institution's specific context and it is divided into five key areas: governance bodies, key actors, and decision-makers; recruitment, career progression, and retention; work and personal life integration; researchers and research: gender equality and sex and gender perspective; integration of sex and gender dimension in teaching curricula. Each key area extensively articulates its objectives and indicators directly linked with one or more targets of the SDGs.

This brief outline evidently captures the preexisting vocation of the University to the approach to Sustainability as it is required by the 2030 Agenda.

Given this inner setting, as integral part of the Alma Mater's identity and spread through its governance, the time push that brought to the production Report on the UN SDGs has been the Environment Ministerial Meeting of the G7 held in Bologna in June 2017. The Report was launched ahead of the gathering of the Ministers of Environment of the seven most industrialized countries: the presentation aimed to highlight not only the value of the HE's commitment for sustainability, but also the novelty of Bologna approach.

15.5 The Novelty of Bologna Approach

The innovation in adopting the United Nations Sustainable Development Goals as a reporting framework carries two main elements. First is the political choice behind the full inclusion of the 2030 Agenda in the University strategy; and second the setting of the SDGs as driving standards, rather than mere parameters of analysis. These positions are the product of a long process of reflection directed to answer the overriding question: how to measure the status of compliance of such a complex institution to push the community to commit to sustainability and how to harmonize the implementing actions?

The answer came with reversing the usual paradigm. Instead of identifying the SDGs' targets and indicators that would fall into the University actions, the alternative was to consider the actions that could deliver on the SDGs and to redesign the University strategy to conform accordingly. This approach of not turning the narrative but the operations upside down required a strong push form the highest levels of governance in the University, and a deep process of reforming the conventional measurement criteria. Although complex, the process was smooth and the measurement of social, environmental, and economic impact of the University read through the 17 SDGs, the University of Bologna has started a new Strategic Plan for 2019–2021 developing initiatives and projects described in a website entirely dedicated to the 2030 Agenda called "AlmaGoals" (University of Bologna 2017e). "AlmaGoals" establishes actions and measures both at the wide-campus level and also at the single-campus level with 3-year objectives. All these measure contributed to create living-labs of sustainability, places where to experiment sustainability by the adoption of appropriate technologies and best practices, particularly related with environmental issues as energy-efficiency, water improving reuse and recycling, solid waste management and recycling, eco-buildings, climate mitigating and adapting technology as green infrastructures, implementation of strategies to reduce consumption, pollution, and carbon footprint.

The organizational structure that allows the implementation of the actions is guaranteed by the Management Plan and its operational objectives (management objectives) contained in the Integrated University Plan and borrowed from the Strategic Plan. In countries with a high degree of administrative bureaucracy as in Italy, there is the risk that the operational objectives are defined in a manner that is detached from the academic objectives, therefore creating an obstacle to the sustainability performance. Sometimes the resulting reaction consists of isolating sustainability actions, delegated only to the administrative component of the University, which interprets its role by managing sustainability in a confined way and hence minimizing interactions with the scientific part. The great challenge that has placed the integration of the 2030 Agenda in the University's strategic planning has established a broad and long horizon to sustainability, focusing the attention of the whole community towards the achievement of the SDG aims. The objective of the initiative is therefore to supplement the strategies (Strategic Plan) and the reporting of activities (primarily the Social Responsibility Report) with the SDGs, by analyzing the positioning of the University via the definition of indicators and metrics for measuring impact in terms of sustainable development.

In actualizing this approach, the Report on UN SDGs confronted some difficult issues. The main one is that of data management. First, data had to be chosen and a collection strategy planned. Second, availability and certainty of data requested a process of optimization and adjustment *in itinere* which drove to the creation of the University Data warehouse (DW). Indeed, the innovation of the approach and of the Report itself led to the need to develop new scientific skills for an advanced measurement of the University activities which would go over what was previously needed. If the University is a hotbed of knowledge, for surely developing such an expertise necessitates an investment of energies and resources.

Once the data management issue has been settled, the next challenge in query is the sharing of data.

Organized in three Data Mart (on students, staff, and teaching activities), the DW contains a big quantity of sensitive data. While this informative heritage became essential to carry out any monitoring research, its circulation among outsiders can easily lead to improper use or misinterpretations. On the other hand, the collection of data from different stakeholders could avail positive results in the path towards sustainability through a more effective and integrated monitoring of a community. While the University has moved some steps forward in providing open data, a number of questions remain open. However, in this light, the AlmaGoals initiative is accompanied by a new model for communicating the "Social Responsibility and Sustainability" (RSS) strategy and for promoting discussion and dialogue with all interested parties.

15.6 Conclusions

This chapter intended to showcase the evolving approach of the Alma Mater Studiorum to sustainability, and its interconnection with the United Nations 2030 Agenda. Recognizing the impact the University has on the region where it was established more than nine centuries ago, the University of Bologna acknowledges its role as international player towards sustainable development, in terms of research, teaching and Third Mission, which refers to its engagement in the socio-economic context. The definition of this role cannot avoid a reflection on the relationship between Higher Education and the 17 Global Goals. In the case of the University of Bologna, the pillars of the 2030 Agenda have shown to be an inherent part of the institution. After the second edition of the Report, the experience of the reporting on the UN SDGs has emphasized some findings. The Reports are used as a summary catalog of the directions and levers assumed by the Institution, both as a tool for the external dissemination and an information abstract for internal use.

First, conducting such a research contributes to raising awareness on the broad sphere of application of the SDGs and its targets within the higher education institution. It starts with a process of basic literacy on sustainability and develops in a political action of inner dissemination of the culture of sustainability. The entire University system therefore becomes the subject through which sustainability permeates in the activities of research and teaching and in the Third Mission. Before the Report, the University units were not measuring themselves on sustainability at all. Second, the experience generates an external interest bringing a competitive push that impacts other universities in turn giving birth to new partnerships at an international level. The interest emerges from the number of downloads: the 2016 edition of the Report on UN SDGs of the University of Bologna has been downloaded 4719 times from 20 Oct 2017, the 2017 edition has been downloaded 3730 times from 3 Aug 2018 for a total number of 8449 downloads (University of Bologna 2019).

This has brought the University of Bologna closer to the global community in terms of dissemination of the SDGs.

In the third place, the publishing of the Reports on the UN SDGs, clearly demonstrates how there is a real need of applicable indicators that are functional to offer comparable results. The University of Bologna has used these indicators in an original way, touching all aspects of its structure. While well aware of the fact that a Report of such a broad application cannot fully represent in detail all the shades of research or of every single discipline taught in the University, it is understandable how proposing it over the years leads to the definition of a more reliable measure. The indexing by goals has two values: on the one hand, to report what has been done, on the other to push—and this has been fundamental above all for the first publication—to undertake actions of research, teaching, and Third Mission strongly oriented to social, economic, and environmental levers of sustainability.

Even a quick comparative reading of the two editions is sufficient to highlight the strengths

and the room for improvement the University system needs today. A more careful comparative reading certainly leads to a useful means of guidance for the tracking of development of the university strategies. Moreover, the reporting manifests itself as a great accountability instrument of the institution towards for all of its stakeholders. Recently, the University of Bologna was ranked in the Top 10 Universities in the world for positive impact based on the UN SDGs by Times Higher Education (26 Red Lion Square 2019). With a ninth place sitting in the overall ranking, the Alma Mater earned a fourth place on a global scale for SDGs 4, quality education, and 5, gender equality, even if the path, this should be underlined, to reach a better gender equality and to approach other goals is always long.

However, the novelty of the Bologna approach consists in a full and rooted embracement of the SDGs under a solid political will of the University governance. Nevertheless, this approach raises an internal and an external challenge for the Alma Mater itself.

The internal one is the capability of the University decision-making processes to adjust the governance according to the outcomes of such a reporting, keeping pace with the fast-changing society of today. The external challenge tackles the University stakeholders. Hence, a greater engagement of the local social fabric is necessary: private sector, public sector institutions, and civil society communities shall start reporting their activities through the lens of the SDGs with no further due since a one-only element contribution is not enough to ensure positive results for all.

Finally, the Bologna experience can be summed up in the answer to the following question: to which extent are higher education institutions truly willing to invest in contributing to the achievement of the 2030 Agenda even through an internal process of paradigm shifting? The critique that might emerge from the Bologna approach is the mere formality of the reporting. We can reply that a measuring system truly matters. It forces us to deal with the SDGs and their most intrinsic aim of building a more sustainable and fairer world today and tomorrow. It does so in the planning and in the teaching, which compels concrete exchanges and comparisons broadly. In the full consciousness of the perfectible nature of such an approach, it has shown to be the right start of the route towards the University of Bologna's contribution to the achievement of the Sustainable Development Goals.

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16 Conclusion: Moving on with SDGs in Institutions of Higher Education

Vuyo Mjimba and Godwell Nhamo

16.1 Introduction

For those reading this chapter, we assume that you have some interest in issues of the sustainable development-education nexus or the separate subjects and the related concepts and concerns of managing climate change, building climate resilient communities, delivering low carbon economies, and driving the green economy agenda. Sustainable development remains a relatively simple concept to understand. However, sustainable development remains difficult to practise and deliver. This set-up arises from the fact that the core of the subject is both a means and an end to global desires of preserving the well-being of current and future generations of humans as well as those of flora and fauna. Although the 2030 Agenda for Sustainable Development (AfSD) and its accompanying 17 sustainable development goals (SDGs) somehow clarify the sustainable development agenda, there still are gaps in implementation.

V. Mjimba (✉)
African Institute of South Africa (AISA), Human Sciences Research Council (HSRC), Pretoria, South Africa
e-mail: vmjimba@hsrc.ac.za

G. Nhamo
Institute for Corporate Citizenship, University of South Africa, Pretoria, South Africa
e-mail: nhamog@unisa.ac.za

A notable component of the 2030 AfSD is its quest to deliver discernible positive changes to the economic, social, and environmental well-being of all global citizens. To this end, Institutions of Higher Education (IHE) are part of such a future and desired pathway. This is emphasised in the 2030 AfSDs leaving no one behind clarion call (United Nations 2018). From this perspective, if no one is left behind then it is sensible to expect everyone to contribute to the attainment of the stated goals and objectives. This is important to ensure that there is a sense of ownership in the attainment and consequently the maintenance of attained improvements. A point of convergence in the quest to deliver the goals of the 2030 AfSD is the need to innovate out of old practices and technologies that hinder progress towards the desired outcomes of an inclusive world. The desired innovations are both in the processes and in the hardware (technology in machinery) that drive modern economic and social activities. Therefore, IHE remain key stakeholders and at the core of this innovation thrust. The institutions play two roles in this regard. First, through their teaching mandate, they impart 'basic' knowledge without which, some innovators may not advance their novel ideas. Second, they are innovators themselves through their research mandates.

The preceding 15 chapters have emphasised the importance of IHE in the 2030 AfSD and the realisation of its 17 indivisible SDGs. A central

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theme of the chapters is the succinct articulation of the fact that IHE are part of the communities, governments, private and public corporation they expressly and implicitly seek to inform, educate, and/or assist. In addition, these IHE will remain part of this set-up in the future. To this end, these institutions should teach and learn from all sources, including their own practices to benefit themselves in as much as they seek to teach and learn from the perspective of the communities they serve or seek to serve. Under the SDGs drive, this means IHE need not only inform on good practices, but should also be seen implementing the good practices they preach.

16.2 Practise What You Teach

An interesting thread in this book is that in all the chapters, IHE have not procrastinated in getting their hands dirty regarding the implementation of the 2030 AfSD and its SDGs. In all the cases presented, for example, Chaps. 2, 3, 9, 11, and 14 there is praxis in delivering on the various SDGs. The contributions fall into three broad categories.

The first category focuses on ensuring that universities do what they recommend to others, i.e., they practise what they teach and research. Often, research by IHE point to government and private sector failures to deliver specific outcomes in failed endeavours to address dire economic, social and environmental conditions, thus the core of sustainable development. The University of Helsinki (Chap. 2) is part of a number of universities that are re-organising seeking to redefine their strategies and organisation in order to deliver on demands of sustainability within and outside their premises. The drastic nature of some of the components of the re-organising demand novel and radical policy shifts resulting in the abandonment of entrenched and familiar practices, technologies and procedures. The policy shift is demonstrated in the Unisa Chapter (Chap. 3) through a deliberate effort by the university formulating its own sustainability policies drawing from the national policy space. This policy is set to guide practice and will *ceteris paribus,* deliver a university that contributes to South Africa's and indeed global efforts in the SDGs space. The case of installing solar energy facilities in some buildings at this university is a practical demonstration of an IHE practising what it preaches. Similarly, Colombia University (Chap. 14) realises the importance of drawing from the national policy pool to formulate its own policy and practice issues concerning the SDGs. Chapter 15 further shows a university that is changing its reporting formats to accommodate sustainability concerns. Such organisation-level policy shifts may have minute impact as individual cases but collectively they are critical to delivering on 2030 AfSD and the SDGs. These and other examples show institutions that are aware of the policy spaces in their immediate environs and beyond.

The second category concerns the 'products' of IHE, the graduates. Teaching and research are the two key methods of delivering and producing knowledge that can deliver the desired outcomes concerning the SDGs. Through learning and teaching, students and researchers get to understand the linkages in and the inherent complexities around policies, legislation, and practices that impact on local, national, and supra-national abilities to deliver the desired SDGs outcomes. This makes it imperative for IHE to deliver the appropriate material to impart relevant and current knowledge and knowledge systems before graduates leave these institutions. Chapters 4, 7, and 12 examine the issue of teaching important concept around the 2030 AfSD and its intertwined 17 SDGs. Most encouraging is that the book's 15 preceding chapters address the issue of changing the pedagogy of imparting and generating knowledge to a form that could deliver the targets specified under each SDG. Chapters 6, 8, and 10 allude to this requirement.

In addressing the pedagogy issues, authors realise that one of the key objectives of IHE is to ensure that the knowledge they teach in classrooms and they generate through research finds its way to policy and practice for larger societal benefits (Engel-Hills et al. 2013). This is the essence of creating knowledge economies that will dominate an economically, environmentally,

and socially sustainable twenty-first century world and beyond. Under this paradigm, it will be inadequate to simply memorise facts and procedures. Instead, a desirable outcome would be a position where graduates from institutions of higher education become workers with the capacity and capability to understand complex matters and present simple solutions to the identified problems. In fact, the SDGs conceptual framework presents itself as a pre-loaded systems thinking model. What then IHE need to do is to equip the graduates and present several models that excite thinking abilities. Graduates should have the ability to solve societal problems through both product and process innovation, which in the processes generate new theories and knowledge (Organisation for Economic Co-operation and Development 2009). The graduates need to be able to critically evaluate what they read, be able to express themselves clearly both verbally and in writing, and understand the science and technology as well social impacts of their innovative solutions and proposals. Furthermore, graduates must be able to experiment and explore, make mistakes, rectify them, and produce refined and sustainable products of tomorrow. This means that the twenty-first century graduates and workers need to learn integrated and usable knowledge, rather than the sets of compartmentalised and de-contextualised facts. They need to be able to take responsibility for their own continuing, life-long learning. This theme runs throughout this book.

This demand on the twenty-first century graduate is the essence of the third category of contributions that emerge from the book. The 2030 AfSD calls for an all hands on deck approach. Against this demand, it is appropriate for IHE to develop internal capacity to both teach and practise cooperation across the traditional academic disciplines. This is important for a systemic change in human thinking and practice that can maintain the courses of action that can deliver the desired SDGs outcomes. To this end, the notion of delivering the agenda as a science and technology discipline concern needs to be dispelled. In fact, the SDGs space demands that both the art and science of engaging the 2030 AfSD be embraced. This is important because the agenda is as good and true concern of both science and technology as it is for economics, social sciences, and humanities and related activities that have led to present day challenges that include environmental degradation. Such a pathway has further resulted in social and economic inequalities and injustices across the globe. It is therefore, only fair that the same be involved in reversing the status quo. Several authors, again, amply demonstrate this all hands on deck approach. For example in Unisa (Chap. 3), senior management is involved hence a local policy regime that drives a specific sustainability agenda and Chap. 4 outlines an approach to gradually build a team of sustainability focused academics and staff member in an IHE. This approach is critical for buy-in that ensures commitment and the sustenance of efforts from a range of stakeholders, key among them, top management. The same is demonstrated in the cases of the Technical University of Madrid, in Spain (Chap. 9) and the Alma Mater Studiorum—University of Bologna (Chap. 15).

While these cases show internal re-organisation, what is important in Chaps. 5, 9, and 13 is the extended concept of working across disciplines and into the communities where universities are hosted. Community engagement is important because it is the communities that either adopt or reject processes and/or products from innovations that can deliver or halt the charge towards realising the objectives of SDGs. The case of the Technical University of Madrid shows how working with communities through the local authority, the municipality of Madrid assisted in solving problems. In contrast, is the case of the Federal University of Agriculture, Abeokuta (FUNAAB) in Nigeria (Chap. 13) engagement is with local farming communities. In all the cases of universities engaging the local communities, context is important for defining the nature of engagement or intervention.

Looking at all cases presented in the book it is clear that there are a number of programmes, initiatives, and interventions seeking to advance the ideals of the SDGs from and within IHE. In this concluding chapter, we only highlighted what the chapters emphasised under three identified broad

categories. The boundaries around these categories are not absolute. The 14 core chapters of this book discuss crosscutting issues that readers may find falling within and outside our three define categories. Such is the nature of discourse around the 2030 AfSD and the SDGs. All solutions that hasten the pace of reducing poverty and inequality, without affecting environmental sustainability are desired and encouraged. In 2018, the United Nations reported that progress on the SDGs was uneven and slow, particularly, on addressing poverty, health, and inequality by the year 2030. Noting this concern, the United Nations Secretary General, António Guterres, stated a need to 'inject a sense of urgency' if the aims of the 2030 development agenda were to be met (Lieberman 2018). This calls for a change of thinking in developing the human capital that will accelerate the process and inject the required sense of urgency. The IHE are and must be at the core of developing such a base whether *de novo* or through retraining or re-orientating an experienced human capital base. It is our view that the traditional call for transdisciplinary, interdisciplinary, or multidisciplinary pedagogy as separate entities is in adequate. Consequently, we proposed a trans-, inter-, and multidisciplinary (TIM) approach to teaching, thinking learning as well as for research, innovation, and development.

16.3 The TIM Approach in SDGs: A New Way to Teach, Learn, Think, and Research

It is established that delivering the 2030 AfSD requires a plethora of insight and skills. Against this background, it is common for policymakers, researchers, academics, civic leaders, and others to call for either trans-, inter-, or multidisciplinary (TIM) approach to examining contemporary challenges as means of advancing plausible holistic solutions. Our view is that individually, the approaches only allow for a partial understanding of the challenges and that advance equally partial solution to economic, social, and environmental challenges of this century. To this end, we advance the notion of TIM research and most urgently for curricula that advance this notion promptly.

The TIM approach to curriculum integration seeks to erase the boundaries between the conventional disciplines by organising teaching, learning, and research around the construction of a common meaning in the context of real-world problems or themes. The approach achieves this through moving beyond the bridging of divides within academia to engaging directly with the production and use of knowledge outside of the disciplines. Its advantage is that it locates societal impacts as a central aim of the research, teaching, learning, and thinking. Solutions from such an approach are applied through action-oriented processes premised on direct collaboration with the groups involved (Klein 2004). The approach is also referred to as post-normal science or Mode-2 thinking, or co-produced knowledge, and can be linked to theories and methods defining a wider participation and determination in the production of knowledge in the interest of social change (Stokols 2006).

The TIM approach pursues the setting up of new concepts, methods, and theoretical frameworks through a process of relationships between several disciplines where concepts, methodologies, or epistemologies are explicitly integrated with the end result of a mutual enrichment (Tucci 2004). This is important for the twenty-first century research, teaching and thinking approaches. The approach allows for the development of concepts and models that benefit from a variety of interpretations from different traditional disciplines. For example, a plausible engineering solution may benefit from a humanities view from culture studies that may reveal the social acceptance or undesirability of the solution. Engineering is key to delivering some SDGs like clean water and sanitation facilities (SDG 6) that are critical for health (SDG 3). A TIM approach considers the social angle concurrently with technical development. This ensures greater acceptance of advanced solutions. In addition, the TIM approach pursues an epistemological path of supporting established concepts, methods, and theoretical frameworks within a discipline and not outside it. However, it intermittently

plagiarises ideas from other disciplines. In TIM research, teaching, learning, and thinking; a diversity of disciplines may join forces in one research programme without necessarily integrating the concepts, epistemologies, or methodologies of the different disciplines. This TIM approach therefore allows for bilateral discussions between concurring disciplines in the process of understanding phenomena but maintains the plurality of views and awareness of the different dimensions of the topic examined (Tucci 2004). Such an approach is needed in dealing with SDGs that are understood to be all in one and one for all (Nhamo et al. 2018, 2019). The objectives of TIM approaches in resolving complex real world are simply to provide different perspectives on problems, to create comprehensive research questions, to develop consensus on definitions and guidelines, and to provide comprehensive solutions services (Tang and Hsiao 2013). While this is appropriate for a wider understanding of problems, the approach suffers draws backs that include the time and effort it takes to reach consensus to allow projects to proceed as well as the difficulty of cooperation across disciplines that start from differing views of phenomena, interpretation of causes, and solution of challenges and approaches to dealing with challenges. For instance, the challenge of merging positivism of natural sciences with constructivism in social sciences and humanities. However, IHE should continue addressing this. The essence of the TIM approach as displayed in many chapters in this book (with a number of chapters written by more than three authors) is that the real world transcends disciplines that some scholars elevate over others in some research works. Consequently, research formulation and findings sometimes do not holistically explore issues, and policy and practice from such research are often inappropriate and inadequate.

16.4 Conclusion

Examining the discourse around the broader concept of sustainability and with the 2030 AfSD and the related concepts and initiatives, the centrality of institutions of higher education in this space cannot be overemphasised. Mistakes will be made. However, what is important is learning from these mistakes and emerge stronger and better focused to deliver a world that improves overall well-being for humans and other fauna and flora. Noting the scarcity of resources, it is important to adjust the curricula of IHE to allow for greater experimenting, the management of risks associated with calculated or educated guesses instead of the current risk averse approaches. The IHE need the SDGs and the SDGs need the IHE. The future remains brighter with the involvement of IHE in the SDGs space.

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