World Sustainability Series

Walter Leal Filho
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Handbook of Theory and Practice of Sustainable Development in Higher Education

Volume 4

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Handbook of Theory and Practice of Sustainable Development in Higher Education

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Preface

We are pleased to introduce the fourth volume of the "Handbook of Theory and Practice of Sustainable Development in Higher Education."

This publication, which is the last of a set of four volumes, introduces many of the papers discussed and presented at the World Symposium on Sustainable Development at Universities (WSSD-U-2016), which was held at the Massachusetts Institute of Technology (MIT), in Cambridge, MA, USA, in September 2016.

The aims of WSSD-U-2016, consistent with the goals of the WSSD-U series, were as follows:

i. to provide universities all round the world with an opportunity to display and present their work (i.e., curriculum innovation, research, activities, and practical projects) relating to education for sustainable development at university level;
ii. to foster the exchange of information, ideas, and experiences acquired in the execution of projects, from successful initiatives and good practice;
iii. to discuss the methodological approaches and projects which aim to integrate the topic of sustainable development in the curriculum of universities;
iv. to network the participants and provide a platform, so they can explore the possibilities for cooperation.

Last but not least, a further aim of the event was to document and disseminate the wealth of experiences available today.

To this purpose, the "Handbook of Theory and Practice of Sustainable Development in Higher Education" has been produced.

This volume is structured around three parts.

Part I, titled "Sustainability Education and Training," refers to a wide range of initiatives where attempts have been made to include a sustainable development dimension in the context of education and training programs;

Part II under the heading "National, Regional and Local Initiatives" documents and promotes examples of initiatives where sustainable development schemes led by universities have involved actors at the national, regional, or local level, often beyond the walls of universities;

Part III is about "Engaging Different Stakeholders." As the name implies, it presents a set of papers where a variety of stakeholders have been involved. This

part of the publication demonstrates in practice that much can be gained by involving various groups in support of university-led initiatives.

We thank the authors for their willingness to share their knowledge, know-how, and experiences, as well as the many peer reviewers, which have helped us to ensure the quality of the manuscripts.

Enjoy your reading!

Hamburg, Germany — Walter Leal Filho
Aveiro, Portugal — Ulisses M. Azeiteiro
Coimbra, Porto, Portugal — Fátima Alves
Nottingham, UK — Petra Molthan-Hill
Winter 2016/2017

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Part I
Sustainability Education and Training

Achieving Resiliency Through Sustainable Literacy

Vijaya Deshmukh

Abstract

Some of the holistic approaches to knowledge need to include inter-disciplinarity across subjects, creative and critical thinking and systemic thinking, value explicitness and ethical concerns, solving real world problems, collaborative and participatory approaches, experiential learning, reflexive learning, etc. A sustainably literate person is one who is expected to understand sustainable ways of doing things, individually and collectively, have sufficient knowledge and skills to decide and act in a way that favours sustainability and adaptability with resilience. Academic Institutions need to abandon long-established traditions of academic isolation and become active contributors to sustainability through innovative teaching, research and outreach. Collaborative strategies should be explored as a means to keep pace with accelerated advancement and resource sharing. Integrating actions of conservation and human development, satisfying basic human needs, achieving equality and social justice for all, facilitating social self-determination and cultural diversity, managing legacy for future generations, maintaining ecological integrity, developing new technologies and product manufacturing processes are some of the goals which can lead to sustainability. Value education develops our wisdom, and gives us the power to differentiate between right and wrong. Today, value education is the prime need of the universe for developing of the feeling of universal brotherhood. The scope of value education is wide, and nobody can ignore its importance. We need the education that relates human beings with the feeling that we are one and so we should respect each other. This paper outlines the necessity of networking and alliances of educational institutions to re-orient education towards value-based education, intercultural education, designing integrated curricula, quality

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education, inclusive education, and delivery of effective programs and creative engagement of students. It highlights the need for building sustainable goals and approaches for innovative education. A better connect of students with the society is required so that they can sustain and adapt, while moving along the society on the development path. Value based education and a better connect with other educational institutions and peers are also needed to become resilient and effectively overcome difficulties and disturbances.

Keywords
Sustainability · Resilience · Creativity · Critical thinking · Innovation

1 Introduction

Education and Culture are intimately and integrally connected. Just as culture influences education, much in the same way education also exerts a powerful influence upon the culture. Thus whereas education culturises an individual, it preserves, transmits and develops the culture of a society. Education and culture are mutually interdependent, complementary and supplementary in all their aspects and activities. Technology, globalization, migrations, multiculturalism, and shrinking borders combine to promote a more interdependent future, in which development of a global mindset is necessary in order to live meaningfully and productively in the 21st century. One has to confront to ever-shifting social, cultural, and technological challenges. Successfully communicating with people from other cultures requires learning more than just language. The different thinking and expression patterns cause misunderstanding which leads to problems in intercultural communication. To be competent in intercultural interaction, intercultural awareness is required. This is required for intercultural sensitivity, which in turn leads to intercultural competence (Deardoff 2004). Mostly the teacher is not able to understand and interpret diverse cultures. Also, it can be a problem of structure. Even if the teacher knows the languages and culture, the system does not see the person as contributor to curriculum; instead it tries to develop a curriculum that prioritizes common transactional standards over contextual creative processes.

Networking is essential for pooling and exchange of information, experience and research findings. Networking is crucial for sharing of experiences, resources, theory and inspiration. New information technologies can play an essential role in community-building. Institutions of higher education have a crucial role to play in advancing the goal of a sustainable society, through their roles in both research and education. Successful efforts to increase sustainability at colleges and universities can have a large impact in the conservation of both natural and financial resources and provide an example for the larger community to help shape the values and

behaviors of students. There is a possibility of sharing success stories, networking, and exploring opportunities for collaboration. Also by sharing best practices, provincially, nationally and internationally, we can provide models for adoption at all levels of the education system. Institutions need to move from bureaucratic and disciplinary structures to an organizational context that supports collaboration and foster group and cross-divisional activities. They are structured to support individual performances and hence academic organizations need redesigning.

UNESCO defines **inclusive education** as '*a process of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures and communities, and reducing exclusion within and from education. It involves changes and modifications in content, approaches, structures and strategies, with a common vision which covers all*.'

Inclusive education is not a marginal issue, but is central to the achievement of high-quality education for all learners and the development of more inclusive societies. It also involves a shift in underlying values and beliefs, along with very specific approaches, positions, and solutions. It requires systemic measures and respect for rights within learning environments—right to respect for identity, culture and language and personal and physical integrity. The solutions should be attitudinal and cultural, environmental and organizational, and operate at international, national, regional and school level. Inclusive education is an on-going process and a way of thinking.

The value of self-restraint and simplicity in life and habits need to be stressed upon as part of value-based education. With utmost sincerity with which students adhered to the maxim in simple living and high thinking, the insistence upon self-discipline for the formation of proper habits and repentance develop students into excellent human beings who know how to cherish the positive values of life. These institutions will stand apart because of the democratic principles followed in student management. This, on the one hand, prevents any heart-burning and petty mindedness, on the other, leads to the development of harmony and democratic approach in the personal relationships of the students among themselves. Freedom and liberty will lead to realization of larger synthesis is which the theoretical and conventional differences are reconciled.

This paper outlines the necessity of networking and alliances of educational institutions to re-orient education towards value-based, intercultural education, designing integrated curricula, quality education, inclusive education, delivery of effective programs. It highlights the factors for building sustainable goals and approaches for innovative education. A better connect with peers and the society in large has been highlighted for developing resiliency and overcoming difficulties. The discussion involves broadly on requirement of innovative leadership and institutional reforms involving stakeholders of education, including the educators, researchers, students, parents, employers, social activists, media and government, to help formulate educational policy and programs. It emphasizes that networking and strategic planning in education are essential for sustainable development and capacity building in problem-based research and learning.

The Data for this paper is based on library and online research on topics such as multiculturalism, value-based education, quality practices, inclusive practices, student engagement, and sustainable education practices. It also includes conceptual study, personal observation, experiences and interaction with the stakeholders and making use of the web to build up firsthand information for future analysis. The rationale is to find out approaches and practices that can be adopted by educational institutions to generate resiliency amongst students through innovative practices and education. The study relies on a combination of research methodologies in analyzing the concept of sustainability and resiliency and multiculturalism. Specifically, two phases were included in the research design. The first phase involved a review of what are the issues and how institutions are handling these problems. The second phase involved experts, administrators and stakeholders of institutions in addressing the issues and how they can be assessed. Personal experiences and observations while visiting various institutions were also recorded. Inductive approach was used to describe phenomenon and generate theory grounded on data.

The constraints are the varying education policies followed in different countries, regions and universities. It depends on the patterns of particular universities. The policies also change with the change in governments. Hence it is difficult to come to a universal conclusion. But the strategies that can be adopted for resiliency through education have been highlighted. For further research, a comparative study can be carried out between universities in different regions based on the conditions, culture and surroundings.

2 Building Collaborations

In democratic countries the science of associations is the mother science; the progress of all the rest depends upon the progress it has made—Alexis De Tocqueville.

Education for Sustainable Development (*ESD*) is "a dynamic and expansive undertaking that envisions a world where every person has the chance to benefit from educational opportunities and to learn the lifestyles, behaviours and values necessary to create a sustainable future," as stated in UNDESD brochure. ESD is for everyone, at all stages of life and in all possible learning contexts. ESD engages multiple sectors and stakeholders—including media agencies and the private sector—and utilizes all forms and methods of public awareness-raising, education and training to promote a broad understanding of sustainable development. "ESD equally addresses all three pillars of sustainable development, *Society, Environment*, and *Economy*. *Culture*, too, is an essential underlying dimension." The UNESCO is playing a significant role in articulation of sustainable development in the field of education.

As the traditional funding to educational institutions is shrinking, organizations are recognizing addressing common issues jointly so as to comply with the emerging challenges to education in the 21st century. Collaborations reduce duplication of cost and effort. The goal of collaboration is to bring educators, students and the stakeholders together in an atmosphere of support to systematically solve existing and emerging problems in deciphering education. Leaders must understand and develop interconnecting systems for clear communication, trust building and the sharing of human and fiscal resources. Innovations rarely occur in a vacuum. Fostering collaboration and interconnectedness is particularly important for educational institutions, as we all have similar goals that can't be achieved without one another. The constraints are the struggles of people who want to work collaboratively but who are locked into institutional structures and cultures that reinforce individualistic work.

3 Inter-cultural Competency

Taylor defined intercultural competency as a transformative process whereby the "stranger" develops adaptive capacity, altering his or her perspective to understand and accommodate the demands of the host culture effectively. As such, intercultural competency is not a result of something, but an ongoing, individual internal process. An intercultural competent person manifests increased affective, behavioral, and cognitive abilities, such as empathy, adaptive motivation, an ability to tackle alternative perspectives, behavioral flexibility, and person-centered communication. Thus, intercultural competency can be defined as transformation of learning and a growth process where an individual's existing, often implicit, knowledge is diversified to intercultural knowledge, attitude, and behavior (Taylor 1994).

Higher educational institutes are required to provide an environment in which students can learn the nature of global society and skills for effectively communicating with people of diverse cultures. The key to successfully facing the challenge academically is to internationalize the curriculum, understand sensitizing cultural concepts, and adaptability. Tolerance and mutual respect for other cultures and intercultural awareness can only lead to intercultural sensitivity, and both abilities will in turn lead to intercultural competence. The need is to overcome ethnocentrism and adaptability to alter the understanding and meet demands of cultural differences for better obtaining the knowledge and skills required for survival in the 21st century.

Goodwill is essential and one has to go beyond simplistic communication. Obstinate or extremist interpretation of words and behavior do not contribute positively to cross-cultural communication. Only mutual respect for diversities helps reconcile problems and reinforce good communication.

One has to learn how to deal with unexpectedness, ambiguity and otherness as well as the resulting culture bumps or culture shock. The knowledge, skills and attitudes that are necessary for successful intercultural communication have to be

observed, discussed and practiced. The rapid development requires a new way of living and learning together. The terminology used for intercultural competence includes global competence, global citizenship, cross-cultural competence, international competence, intercultural effectiveness, intercultural sensitivity etc. Some have the same general components of intercultural competence such as empathy, flexibility, cross-cultural awareness, and managing stress, while some definitions of intercultural competence specifically note other elements such as technical skills, foreign language proficiency, and situational factors.

4 Overcoming Diversity

Universities provide opportunities for the meeting of artists, scientists, literary figures and scholars which creates internal understanding at a very high level and thus are the most important medium of propagating international education at a very high level and propagating international education. Many institutions of the UNO, particularly UNESCO, are engaged in directly and consciously promoting international understanding and the growth of cross-cultural feeling. Participation in these programs can help achieve the desired goals. There is a need for scrutinizing the ideological basis of higher education, drawing from these ideologies, identifying the cornerstones of intercultural competencies and proposing an adequate model.

Intercultural competitions/festivals bring people into contact. Exhibitions also play an important part in promoting international understanding, because it helps to acquaint people with the art and culture of different regions/countries. Films give a lot of information. Besides, it also encourages the feeling that human beings are the same everywhere in their happiness, pain, pleasure, problems, joys and sorrow. Radio and Television also help understand life in other parts of the world. Literature, which is almost available in every country helps in increasing acquaintance with life as it is lived in different parts. Certain books compile the stories of lives, character, interesting incidents and surprising objects which help.

Inter-culturalism should also indicate student learning and attitudes. “Institutions that are serious about its effect on students should take a closer look at learning goals, course content, pedagogy, campus life, enrollment pattern, and institutional policies and practices to get a more complete picture of their success” (Engberg and Green 2002). Schools and classrooms, generally, are not organized to accommodate diversity. They assume that all children bring a similar socialization, one that corresponds closely to the experiences of dominant groups. Students who enter schools with ways of learning that differ from the expected norm often are seen as deficient. Culturally responsible educators must believe that the students are capable of learning and hold high expectations from each one. Critical thinking and evaluation of one’s own activities in an international perspective and respect for other people, culture and values remain a cardinal element of all education. Humanity is the true religion of human beings, while all the great religions are only

different forms of it. All great religions have placed great stress upon the quality of human beings. Faith in humanity and love for all human beings irrespective of the country is necessary.

The entire climate and culture of departments, schools, or colleges of education as well as the college or university campus and cooperating schools should radiate a consistent, pervasive, and comprehensive appreciation for and promotion of cultural diversity. Multi-culturalism must convey these in the way they relate to students and colleagues and in how they ground the pedagogical concepts, principles, theories, and strategies they teach. This commitment is also conveyed through lecture series, awards for promotion of cultural diversity and educational equality for marginalized ethnic and social groups. Evidence from research and wisdom from best practice points out that students should understand and implement a multicultural perspective in their classes and during their field experiences, such a perspective should permeate the entire curriculum including courses taken outside their schools, departments, and colleges of education.

Academic programs do not operate in isolation and are a part of institutions of higher education which have their own particular histories, policies, and cultures. These policies and procedures include recruitment, support, and retention of faculty, staff, and students of color, a multicultural core curriculum, service to a diverse community, and numerous multicultural experiences for students and educators. The goal of a multicultural education program is to help teachers become change agents who can impact power relationships through curriculum, instructional practices, and individual and collective action towards more than just personal and structural relationships.

5 Students as 'Partners'

The Quality Assurance Agency, Scotland, describes students "as the heart of the system." Student engagement can be conceptualized as individual and collective participation and passionate involvement of students in curricular, co-curricular and extra-curricular activities and interactions. Student engagement needs to be embedded as a part of institutional philosophy and practice. A proper structure to accommodate students at all levels with regular monitoring and review of engagement activities need to be carried out and documented. A student engagement audit is needed to review the activities, professionals and resources and the level of the student participation. Exploring areas for maximum student engagement and improving upon it is the only way forward to ensure high quality of education.

According to the Quality Assurance Agency, UK, students should be 'partner' and 'partnership' needs to be used in a broad sense to indicate joint working between students and staff. In this context partnership working is based on the values of openness; trust and honesty; agreed shared goals and values; and regular communication between the partners. It is not based on the legal conception of equal responsibility and liability; rather partnership working recognizes that all members

in the partnership have legitimate, but different, perceptions and experiences. By working together for a common agreed purpose, steps can be taken that lead to enhancements for all concerned. The terms reflect a mature relationship based on mutual respect between students and staff. Partnership working can occur both in informal and formal arrangements, including representation mechanisms involving a students' association.

Students appreciate engagement opportunities timed so that they experience a direct benefit as a result of their input, in addition to the benefits provided for succeeding cohorts. For this reason, higher education institutes need to develop a framework for eliciting comments from students that employs a range of methods, that is timely, not overly onerous, and of demonstrable direct benefit to the students providing the feedback.

Mechanisms for involving students may include:

- questionnaires; for example, at the end of a module or year
- student representative structures
- research activities; for example, through focus groups
- student membership of committees
- student consultation events
- student involvement in projects
- student dialogue with decision makers
- online discussion forums
- formal quality processes; for example, periodic program review.

Higher education institutes should use effective student representation in decision-making processes, including on governing boards and senior committees at institute, faculty and departmental level. This gives a maturity level and ownership to the students and promotes achieving resilience.

6 Value Orientation

Human being is the most evolved creation amongst all the living beings. His/her life possesses meaning beyond self-protection. They have to make their own destiny guided by certain values which are illuminating forces of their life processes. The great centres of learning like Nalanda, Vikramshila, Jagaddala, Nadia, Odantpuri and Vallabhi in India imbued the rising generations with the traditions of a great society who, for centuries sustained on such human values which nurtured free minds and urged them to full and fair enquiry which brought wisdom into human affairs. The unorthodox and liberal approach advocated an all-encompassing spirit of universal brotherhood which knows no boundaries of nationalities, faiths or sects. Other values highly cherished by educationists were self-sacrificing asceticism, self-concentration which developed moral sentiments and character. Acknowledging that the personality of youngsters formed the backbone of the whole value system of society, it was sought to be developed by these universities

by eulogizing the feeling of self-respect, encouraging the sense of self-confidence inculcating the virtue of self-restraint and fostering the powers of judgement.

The entire system was based on the principle of personal touch and warmth. Rules of discipline, that were prescribed for the students were laid down not so much for the purpose of prohibiting from doing undesirable acts as with the object of forming good and valuable habits. Rules were framed which developed them into strong and hard persons and prepared them for the long struggles in life with determined wit and great enduring power. The self-confidence of the students was fostered by regular meetings, discussions and debates between scholars and students at regular intervals. The friction of the best minds was the best possible means of developing and sharpening the wits and self-confidence of the participants. It was an ideal platform for the students to broaden their knowledge base, to correct incorrect orientations and thus move forward towards personal and thereby social betterment.

7 Conclusion and Recommendations

The interlinked strategies proposed for the promotion and implementation of education for sustainable development in many discussion forums are advocacy and vision-building, consultation and ownership, partnership and networks, capacity-building and training, research and innovation, information and communication technologies, monitoring and evaluation. Creating a culture of sustainability, education approaches to fostering sustainable behavior among the community and building systems and awareness for sustainability. While Student and Faculty Exchange is a common practice now a day, a library consortium provides a way for its members to conduct business in a comparative manner. The basic premise of consortia is that its members can collectively achieve more than what they can achieve as individual institutions. The consortium constantly monitors international developments in this area and liaise with agencies to bring the best possible consortium-based solutions to its members.

The syllabi should include painting, literature, music, typical of different countries, overcoming narrow mindedness, include contributions of great leaders of the world, the rights and duties to international community, and encourage pen friendship. Stress on humanity and world citizenship is required. The teaching should not only concentrate upon the differences but also on similarities so that sympathy for all nations and nationals is awakened in the minds. The educator having an international viewpoint can inspire through conversations, ideas, training and examples. International contacts among scientists, scholars, literary figures, teachers, doctors etc., and mutual exchange of scholars and learned people helps. Every national plan of education must make a specific provision for developing international feeling. Effective methods to assess intercultural competence in educational institutions should be developed.

Cultural differences are impossible to avoid. The key to successfully face the challenge academically is to help students understand globalization, sensitizing cultural concepts, have self-perception and emotional and cognitive acquisitions, in

order to reach a high level of empathy, govern their performance and emotions in working and in living with people from other cultures by increasing their adaptability, and adopt a changed way of perceiving and behaving, so that they can improve their social performance. The students should be valued and revered not only in the country but in foreign lands where they become harbingers and torch-bearers of their culture and civilization. They should develop into physically, mentally, emotionally and spiritually sound human beings and work for the emancipation of the society. Celebrating diversity is the key to sustainable literacy. Finally, it is about Retain—what is of value, Revise—what might need modification, Reject—what we need to abandon, Renew—what new ideas, concepts, principles, methodologies, working methods, pedagogies etc. are needed.

The fundamentals of education are to educate the individual as a free individual; to understand and use critical thinking skills and to educate the individual as a part of society. Through education, knowledge must continually be renewed by ceaseless effort, if it is not to be lost. The hands on and practice based education and a multi-disciplinary approach, is must for holistic learning and developing resilience.

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Learning and Teaching for a Sustainable Future

Karola Braun-Wanke

Abstract

Education and continuous learning are one of the keys for sustainable development. A sustainable development not only calls for transformative research, but also for new transformative education that disseminates the values and principles that are the basis of sustainable development. "Schools@University for Sustainability + Climate Protection" is an educational format at Freie Universität Berlin (FUB) that has taken up the call for education for sustainable development (ESD) in 2005 by creating an innovative inter and transdisciplinary program. In this framework, young students and their teachers are invited to FUB twice a year to gain in-depth knowledge on sustainability issues, learn critical thinking skills and be empowered to effect changes within their everyday world and in society at large. The educational format Schools@University has played a pioneering role and its accomplishments have been recognized with prizes from the UN Decade of ESD three times. This chapter reflects the experiences and key challenges of the project's ten year history, the goals, didactic approach as well as topics and methods of the educational format. Moreover, it explains how the Environmental Policy Research Centre (FFU) has met the challenge of developing this innovative approach with Schools@University and how its messages and activities have become a role model, encouraging other universities to adopt these exemplary ideas.

Keywords

Education for sustainable development (ESD) · Transformative education · Outreach · Children´s university

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1 Introduction

A secure, climate-friendly energy supply, protection of biodiversity and the provision of life's basic requirements to all are some of the key global challenges of our time. To deal with them requires critical examination of our way of doing business, as well as consumption and lifestyle practices in Western industrialized countries. Climate change and the nuclear catastrophe in Fukushima have made it clear that these problems cannot be solved without fundamental political and social change. Such a transformation calls for a broad societal awareness of these problems and the magnitude of change required. Sustainability is the one idea that links all of these global problems and connects them to mechanisms of change (Fig. 1).

How can such change take place? In its 2011 report on "the new societal contract for a great transformation", the German Advisory Council of Global Change (WBGU 2011a, b) described the importance of education that contributes to sustainable transformation by promoting societal participation. The report singled out universities' special role in promoting education for sustainable development by better orienting science and policy to the societal goals of the great transformation.

The UN Decade for Education for Sustainable Development (ESD) that ended in 2014 and the follow up of the Global Action Plan ESD (UNESCO Roadmap 2015) seeks to promote important skills necessary to actively contribute to social, economic and environmental change. It teaches students how to work together, resolve conflicts, identify problems and express independent judgement to solve complex problems and shape their world (de Haan 2009, Wiek et al. 2011). The FFU believes the transfer of such skills should be facilitated by civil society, too. That's why the Environmental Policy Research Center (FFU) has taken up the UNESCOs call for education for sustainable development by developing an innovative program that brings young students and their teachers to FUB two weeks a year to gain in-depth knowledge on key issues of sustainability, learn critical thinking skills and become empowered to make change within their everyday world and in society at large (UNESCO Roadmap 2015). By bringing elementary school students to FUB to learn about critical issues relevant to sustainability and climate change, Schools@University[1] intends to educate the younger and next generations to be a key part of the great transformation.

This chapter presents the project "Schools@University" at Freie Universität Berlin's Environmental Policy Research Center (FFU). It looks at the history and structure of the project and presents it as an example to follow for other universities. Among the many merits of the project are its impact on young students aged 10–13 years, their increased knowledge about the environment, sustainability issues and climate change, and the teachers' involvement in trainings and the project itself. Evaluation and surveys are used to show the project's value and the beneficiaries' opinions.

[1]The German title is "SchülerUni Nachhaltigkeit + Klimaschutz".

Fig. 1 Logo of Schools@University (Copyright: Schools@University, Environmental Policy Research Centre)

2 Expanding the Dialog

How do you turn wind, cow dung and tooth paste into energy? What do mobile phones and roast beef have to do with climate change? Can we have a real effect on the climate? How can we make the world fairer for everyone by changing our daily consumption? These and other issues regarding sustainable development are the subjects FFU focuses on at Schools@University (Fig. 2).

With Schools@University, FFU expanded its outreach activities because research in 2005 showed that despite the political importance of climate change, schools have given little attention to the whole issue. FFU didn't want to accept these knowledge gaps and decided to build bridges between the research institute, schools and the community. Since 2008, FFU has been inviting 5th and 6th grade classes and their teachers regularly to programs and training always in spring and autumn.

By opening the green campus of FUB, FFU creates a fascinating "out of school learning place" where kids and teachers can gain practical knowledge about sustainable development and solutions on climate protection. With a one-week

Fig. 2 Establishing a dialogue between school children and experts at university (Copyright: Schools@University)

program consisting of roughly 80 hands-on workshops and lectures, FFU addresses and discusses the social, economic, environmental and cultural aspects of sustainable development in relation to the lives of young students and together we develop solutions for everyday life.

The core concept of the project is to build bridges between the university as a research institution, schools as a place of learning and stakeholders and experts with different backgrounds from civil society. The goal is to help children gain in-depth knowledge on sustainability issues, learn critical thinking skills and get empowered to affect changes within their everyday world.

After a first pilot in 2006, Schools@University was established at Freie Universität Berlin in 2008 and has proven to be an accepted and highly recommended learning environment for "Learning and Teaching Sustainability". Regular high attendance rates and excellent evaluation results document the educational relevance of this format. Social innovation in close cooperation with politics, schools, administration and economy can work—this is the conclusion after ten years with a pilot and 14 program cycles and 14 teacher trainings run by FFU. Since 2008 FFU already reached 20,000 young students and 2500 teachers.

The characteristics of Schools@University at a glance:

- Focus on the key topics of sustainable development
- Two one-week programs a year (in spring and autumn)
- One week programs with 80 interactive and hands-on workshops each
- Target groups: 5th and 6th grade students and their teachers
- Two teacher trainings a year
- Learning with a "Head, Heart and Hands" approach
- Inter and transdisciplinary approach
- Different venues on campus
- Lectures and trainers from different backgrounds
- Reaches 2600 students and 140 teachers a year.

3 Building Bridges Between Academia and Community

At the outset of the project a set of hypotheses were taken into consideration:

Children and teenagers are future decision makers and consumers—in other words, potential catalysts for change. They play a key role in implementing sustainable development. Critical analysis of relevant questions and solution designs are crucial elements of school education (UNESCO Roadmap 2015). This requires practical examples and, particularly for young people, models to learn from and emulate, at present and in the future. Schools are important learning places for the personal and educational development of adolescents. They can transfer sustainable thinking and acting and can empower children as catalysts for change. ESD, however is rarely practiced in German and European schools. This makes sharing

proven and applicable knowledge with schools—as the FFU does—the more valuable. The first hypothesis is that the programs and trainings of Schools@University increase teachers' and students' knowledge about sustainability and climate protection. The second hypothesis is that due to the knowledge and practice gaps in schools the programs of Schools@University are key part of the transformation towards sustainable systems. The third hypothesis is, that proven long-term learning environments need to be integrated and institutionalized in the structure of Universities to unfold their transformative potential. The programs educate young students and provide an opportunity for universities to contribute to the sustainable development of their communities and support the necessary change toward sustainable structures. Furthermore they are a viable means to attract the next generation of motivated students:

4 A Ten Years Practical Experience of ESD

The project has a ten year history. Here is an overview of the different project phases:

4.1 2005–2006: The Early Beginning as a Pilot

The FFU initiated the first topic focused "Schoolchildren's University for Climate and Energy" as a pilot project on the 20th anniversary of the Chernobyl nuclear disaster. It was derived from the popular European model of children's universities. Basically, the pilot drew inspiration from the popular term "Children's Universities",[2] a widespread public outreach activity for children aged 7–14 year olds which has become common in many European universities. In 2005, the FFU re-interpreted this idea into an innovative topic focused format: A low barrier tool focusing on 5th and 6th grade classes from all education backgrounds and accessible for schools from all twelve districts of Berlin. The program took place in 2006 as a lecture series. 2600 students participated and their teachers gave very positive feedback.

4.2 2008–2011: From Pilot to European-Wide Educational ESD Format

4.2.1 The European SAUCE Project

The positive response to the pilot program in Berlin inspired the FFU to bring the idea to a wider audience. Thanks to the European program "Intelligent Energy Europe", the Schoolchildren's University model was carried out successfully by

[2]For more information about the European Children's Universities visit: www.eucu.net.

seven European partner universities in Berlin, London, Vienna, Roskilde, Aalborg, Riga, and Twente[3] as SAUCE (Acronym for: Schools@University for Climate + Energy), which was supported by the European Commission from 2008 to 2011. FFU was the coordinator of the EU project. Following the idea of the pilot, each university opened their campus as an extra-curricular out of school learning place for teachers and young students. This facilitated a transfer of knowledge and competencies, deepened the understanding of environmental and climate topics and opened new paths for universities' public outreach Piening, Watts (2011).

All universities chose an interdisciplinary and participatory approach for teaching the young students. Each partner university created their own country-specific version of the format. In three years, a viable ESD education format for a total of 19,000 students was created. 35,000 workshop places were offered and 1250 teachers participated in the accompanying teacher trainings. An intensive, continuous exchange of experiences between all six universities was crucial for this success.[4]

4.3 2011–2015 Transformation with Schools@University in Berlin

Based on the European SAUCE experience, FFU has continued with the format with a modified name in Berlin: Schools@University for Sustainability + Climate Protection. Eight additional one-week programs and eight teacher trainings were offered at Freie Universität from 2011–2015. This was promoted and propelled by the 2011 Climate Protection Agreement between Freie Universität Berlin and Berlin's Government. Freie Universität was Berlin's first university to become a partner of Berlin's climate protection plans, meaning the University needs to lower its CO_2 emissions and its energy use by 10 % compared to 2010. Schools@University's relevance for the energy transition and its positive feedback from target groups ensured the formalized continuation of the format.[5]

[3]London Metropolitan University (UK), University of Latvia (Latvia), Aalborg University (Denmark), Roskilde University (Denmark), University of Twente (Netherlands), Vienna University of Technology (Austria)..

[4]The results of the European SAUCE project are available on the project website: www.schools-at-university.eu/index.html and results are published in the SAUCE published report: http://www.schools-at-university.eu/files/sauce_publishable_rep.pdf; The SAUCE handbook summarizes the most important results and gives interested universities tips and hints about putting on SAUCE programs at their own universities. http://www.schools-at-university.eu/files/sauce_handbook_e.pdf; The SAUCE Resources Guide presents a selection of the SAUCE workshops and lectures held at the SAUCE partner universities>: http://www.schools-at-university.eu/files/sauce_reader_en.pdf.

[5]In addition, Schools@University was supported from 2011–2014 by Berlin's Senate for Education, Youth and Science, by Berlin's climate protection partners, Berliner Stadtreinigungsbetriebe(BSR), GASAG and the Embassy of the United States of America.

4.4 2015–2020 Sustaining the Educational Format in Cooperation with the Climate Protection Partners of Berlin

In 2015 Freie Universität Berlin, Berlin's Government and the climate protection partners of the Berlin Government Berliner Wasserbetriebe, Berliner Stadtreinigungsbetriebe (BSR) and the GASAG signed bilateral cooperation contracts with FFU with the common educational goal to support the ESD format Schools@University for another 5 years. Thanks to the support of these partners, ten program cycles and ten accompanying teacher trainings will run at Freie Universität starting in 2016.

5 Education as Key for Change

The idea for Schools@University is based on the ESD concept, which draws from the guidelines for sustainable development. UNESCO defines the basics of ESD as follows: "ESD promotes sustainable thinking and acting for children, teenagers and adults. It enables people to make decisions for the future, understanding how their own actions will affect future generations and other regions of the world".

Hence, the question is how to offer participatory education formats to convey complex inter-connections and key issues of sustainable development to Berlin's students. Which methods can promote sustainable thinking and acting? Who is best qualified to teach the students?

FFU is dealing with these challenges and has established an open dialogue between academia, schools, politics and the civil society to develop the concept for Schools@University based on the ESD didactic. Following you will find an explanation of the educational format.

6 Didactic Approach of Schools@University

"Learning for a sustainable future" is the slogan of Schools@University. Focusing on a holistic ESD approach and on the key topics of sustainable development distinguishes this educational format from other types of "Children's Universities".

Although content and methods of the format have been modified during the last years in order to meet the needs of the target groups and the results of evaluations the following specifics are characteristic for the didactic approach:

- Interactive and cross-disciplined workshops
- Age-appropriate teaching based on real-life experience
- Participation with a wide range of interactive methods

Fig. 3 Protecting the environment with recycled paper: Hands-on experiment (Copyright: Schools@University)

- Workshop trainers and experts from academic an non-academic backgrounds
- Learning on six different authentic venues on campus (Fig. 3).

With these didactic specifics, FFU transforms the lecture halls, seminar rooms, the weather station and the Botanical Garden into labs where students experiment with renewable energy or discuss about sustainable architecture and future cities. Experience has shown that children are very curious to discover the authentic sites of FUB, which are usually a "place for adults".

6.1 Age-Appropriate Teaching Based on Real-Life Experience

Schools@University's workshops deal with omnipresent key issues of sustainable development by referencing students' everyday environment, their lifestyle and their consumption patterns. Students learn to critically analyze their choice of clothing, transportation, holiday, hobbies, electrical appliances etc. Intriguing questions like how to bring wind or sun inside a socket or how energy can be unjust stimulate discussions.

These are the key topics of the workshops and lectures:

- Climate change, transition of energy, energy efficiency and savings
- Consumption and lifestyle patterns, product design
- Mobility and transportation
- Architecture, building, future cities
- Nutrition and agriculture
- Maintenance of biodiversity, resource protection

All workshops and lectures intend to convey a sense of empowerment and engagement with the natural and social world in order to discuss complex issues with fun. All components are designed in an interdisciplinary and participatory manner. For example, climate change is discussed with an eye to its social, economic, ecological and cultural aspects. Practitioners present climate change as a solvable challenge and emphasize its potential for creating jobs in the field of renewable energies.

6.2 Building up an Educational ESD Network: Imparting Critical ESD Skills

A multidisciplinary team of experts is continuously optimizing content and methods of Schools@University together with FFU, resulting in high quality workshops and diversity in topics and methods. Among the experts are renowned scientists, technical experts, artists, photographers, directors, members of environmental NGOs and businesses, peers and students. Over the years, a regional ESD network of about 30 institutions and 60 individual stakeholders has been established under the umbrella of Schools@University.

6.3 Learning with Students and Peers

Having students teach some of the workshops has proven to be particularly successful. Children enjoy these peer interactions at the same level and assess them very positively, as do their teachers. Existing workshop modules are adapted and new designs are explored in a collaborative process to match the format of Schools@University. "Sharing and networking knowledge" is the motto of Schools@University's expert network.[6]

6.4 Learning Sustainability with Head, Heart and Hands[7]

Another characteristic of Schools@University is its diversity of its methods. In order to reach out to students on an emotional level, the format links all senses to theoretical knowledge, thus enabling students to understand and act out topics on a deeper level (Sipos et al. 2008). Story-writing, experimenting and handcrafting are only a few examples of the many engaging methods engaged to encourage children and teenagers to search for practical everyday solutions by themselves (Fig. 4).

The following participatory methods and techniques have proven to be particularly popular[8]:

[6]Schools@University's network with portraits of all stakeholders can be found at: http://www.fu-berlin.de/sites/schueleruni/netzwerk/partner_faq/index.html.

[7]Sipos et al. (2008).

[8]A list of all past workshops with short descriptions can be found here: www.fu-berlin.de/sites/schueleruni/programm/programmbausteine/index.html.

Fig. 4 Two students practicing a stop-motion film about the topic "Water is life" (Copyright: Schools@University)

- Scientific experiments with renewable energies
- Energy tours of the campus
- Tours of the weather tower, the canteen
- or the Botanical Garden
- Art and theater workshops
- Stop Motion Film labs
- Creative writing classes
- Simulations and role plays
- Science slams
- Design thinking workshops
- Breakfast, quizzes and games
- Taste discovery games
- Bike-powered cinema

6.5 Integrating Art and Culture to Re-Design the Future

Creative engagement with topics of sustainable development is especially important to FFU. Topics such as future cities, energy transition and other complex issues are taught in close cooperation with artists, authors, stage directors, and actors without any fixed expectations or outcomes. These artistic workshops usually last for four hours (Fig. 5).

Fig. 5 Using dried plants and flowers to make paint (Copyright: Schools@University)

Other employed methods include art, photography, design thinking,[9] performances and creative writing. These creative workshops make up the highlights of Schools@University. The FFU´s experience shows that cultural education can open up the mind for thinking and discovering. A dialogue between students and artists is established, stimulating self-reflexive actions and aesthetic interpretations of the issue at hand.

6.6 Target Groups: Young Students and Teachers

Schools@University is aimed at both students and teachers. Teachers are encouraged to apply their newly learned methods and ideas of the cross-sectoral topic sustainability and climate protection to their classes in a holistic ESD approach. Considering the gaps in environmental education at schools, FFU focuses on educating teachers. Teachers as crucial disseminators need support. Therefore, since 2009 FFU have been offering with the format Schools@University accompanying four hours teacher trainings.[10] Teachers are equipped with insights into the topics and relevant methods and competencies. Experienced local stakeholders present successful methods, teaching units and material. ESD background knowledge and insights into current scientific debates are also part of the teacher trainings (Figs. 6 and 7).

[9]Design Thinking is an innovative method to describe, design and solve problems. It draws from the idea that innovation can only bring about viable solutions in multi-disciplinary groups. (http://www.hpi.uni-potsdam.de/d_school/designthinking.html).

[10]Teacher trainings are carried out in cooperation with the Senate for Education, Youth and Science and the project "Zukunft gestaltet Schule, Bildung für nachhaltige Entwicklung". Participating trainers receive state-approved statements of participation.

Fig. 6 A school class with their teachers and Schools@University staff (Copyright: Schools@University)

Fig. 7 Workshop during teachers training (Copyright: Schools@University)

Methods like "World Café"inspire the teachers to train other teachers. This constructive exchange of ideas results in an authentic dialogue called "teachers train the teacher". Project ideas, strategies and concepts can be discussed. New inspirations for teaching modules are also presented among colleagues with the support of Schools@University.

Schools@University focuses on students aged 10–13 years who are already able to process and abstract complex ESD topics. Some of the students may have started to think about going to university and a certain curiosity exists. Experience shows that this target group is especially interested in socio-ecological issues and causes and consequences of climate change. Other popular topics include biodiversity conservation and preservation of natural livelihood.

In addition, students of this age group are already able to develop solution strategies in role plays and group works. Simulated games of energy, climate and biodiversity politics are very popular. Young students enjoy taking different roles in simulated international conferences or meetings. Political science students of FUB acts as instructors for the "ministers", "farmers" and "lobbyists".

Students are encouraged to change their perspective and to think about potential issues for discussion. Depending on their individual roles, they later take their respective stand in the simulation, thus getting a good impression of the difficulties and opportunities connected to societal and political processes regarding climate change and biodiversity conservation. 11-year old Zora reports: "It is really difficult to convince everybody and to find my own opinion. I think it's impossible to meet everyone's expectations."[11]

7 Facts and Figures—Evaluation Results

Schools@University formats and the accompanying teacher trainings are booked out regularly. Each year, about 2600 students visit campus and ca. 140 teachers attend the teacher trainings. In 2008, Schools@University offered 40 workshops per week, a number which has now risen to 80. Since 2009, a total of 20,000 students in 14 program cycles participated in 750 individual events. 860 teachers and disseminators attended the teacher trainings. All program cycles are evaluated and each single event receives feedback from two to three students and their teachers.

FFU forwards the feedback to participating experts in order to customize and improve future workshops. Content, methods and administrative procedures are improved continually. About 80 % of the feedback forms, an impressively high number, are returned and provide a good overview. Feedback is positive throughout. Good to very good grades are given, judging the topic selection, methods, experts, atmosphere on campus and overall organization.

According to the feedback forms of 2014 and 2015, teachers especially valued the diversity of key issues and the different perspectives cast upon them by experts from various backgrounds. They also praised the participatory methods. On average, 65 % of teachers assessed the quality of content and methods as well as the overall intention of the education format with very good grades, and 30 % of them gave good grades.

[11]Source: Interviews with students, in: Kiek Mal - Die Berliner Kinder- und Familienzeitung (2013): Mit Schuhkartons das Klima verstehen, 1-2/2013, 17.

A female teacher who repeatedly attended Schools@University workshops with her 5th-graders summed up her experience: "Once again, I am thrilled and inspired by the offer. We cannot teach this wealth of ideas with so many different methods and material at school. I now feel confident to apply the Schools@University ideas to my science classes. The students have seen real life examples and can relate better to topics like renewable energies because they had so much fun in the workshops."[12]

The evaluation of the teacher trainings was very positive as well. Organization, implementation, structure, content, supervision, and atmosphere were praised. 40 % of teachers rated the taught methods and content modules as "very good" and 50 % as "good".

These results show that the format meets the needs and interests of teachers as well as students. Teachers emphasize that they are more motivated to integrated Schools@University's topics into their lessons. The network of experts, regional education stakeholders and other teachers is considered to be very valuable to exchange ideas and experiences.

8 Conclusion: Example to Follow

The reported experience from Freie Universität of Berlin shows that the ESD format of Schools@University represents for the involved parties a valuable and rewarding endeavor. Its achievements in education policy and for meeting all standards of ESD have been acknowledged by three awards of the UN Decade and Schools@University has advanced from pilot to role model for ESD. The realization and continuity of Schools@University still depends on effective management, positive evaluation and constant improvement of the workshops´ design, successful fund-raising, a continuous and reliable support from the FUB and the Berlin Government, an efficient regional partner.

network, and—most of all—the passionate involvement of individual scientists. Needless to say, the prerequisite for a sustainable impact of this approach is to consolidate the project's structural, financial and human resources requirements. The major challenge for future work will be to convince Politics and University to institutionalize this exemplary educational format in the structure of FUB.

The evaluation results are very positive and the attendance and acceptance of the programs is high; a qualitative empirical scientific survey is still to come. Depending on the availability of additional financing, a thorough reflection will follow and we will examine the limits and risks of this exemplary, practical approach. A qualitative empirical survey about the real learning effects and outcomes of the programs and trainings is planned. To operationalize the real learning outcomes and effects on motivation, skills and competencies by the target groups we plan an interview based survey.

[12]Interview from „Kraftwerk im Klassenzimmer", in: Campus.leben, Freie Universität Berlin (02.04.2012); http://www.fu-berlin.de/campusleben/lernen-und-lehren/2012/120402_schueleruni/.

A further challenge—after implementing the theoretical idea of ESD in a concrete practical long-term experience—is to derive lessons for future policy. These should provide useful feedback loops also to the theoretical groundwork of our approach, and deliver new food for thought for testing the hypothesis that young students by addressing and better understanding the complex connections between humans and environment and by "practising" sustainability in everyday life feel less overwhelmed by the multiple global crisis.

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Training Sustainability Change Agents: Lessons from International Water Education

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Abstract

Unsustainable socio-economic practices manifest prominently in water crises and water-related disasters. This turns water managers into prototypical sustainability professionals, and important change agents in a broader societal transformation towards sustainability. Water education is, de facto, sustainability education. By bridging the gap between a pedagogical and a professional view on required sustainability competencies, experiences with water education offer valuable insights in the context of Education for Sustainable Development (ESD). The paper reports on recent experiences with increasing the sustainability

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orientation of water education programmes, and explores key issues that require attention in ESD programmes in general. The experience of three international degree and capacity development programmes at the UNESCO-IHE Institute for Water Education and the National Autonomous University of Mexico (UNAM) reveals lessons on learning environments and capacities essential to the design and implementation of training programmes in, for and about sustainable development. To guide ESD programme development in higher education, it proposes adopting a 'learning and applying what we teach' approach, with particular attention to: skill development for meaningful stakeholder engagement; normative and value-based aspects of sustainability education; and necessary organizational capacities and professional skills of educational providers.

Keywords
ESD · Sustainability · Competencies · Higher education

1 Water Education as Sustainability Education

The 1992 Rio conference on Environment and Development made the case for sustainability education, to empower *"people of all ages to assume responsibility for creating a sustainable future"* (UNESCO 2002). Further encouraged by the UN Decade of Education for Sustainable Development 2005–14, and target 4.7 of the Sustainable Development Goals (SDGs) (United Nations 2015), universities around the world started programmes providing knowledge and skills needed for sustainable development. Nevertheless, Education for Sustainable Development (ESD) is far from accepted as mainstream. Even within the ESD community, common principles for curriculum design and didactics are still debated (Figueiró and Raufflet 2015; Lozano et al. 2013).

Water education is inherently connected with ESD. The principles of Integrated Water Resource Management (IWRM) are, de facto, sustainability principles. Moreover, climate change and commonplace unsustainable practices increasingly manifest in water-related disasters, making water management failures highly visible and politically relevant. This mandate gives water education a distinct perspective in the context of ESD. For future water professionals, sustainability education is a matter of professional skill development. Re-focusing the education of water managers to prepare for complex real-life water problems requires increasing attention to interdisciplinary research, consideration of political and ethical dimensions, as well as social and reflexive competencies that make knowledge actionable (Irvine et al. 2016). Recent efforts to incorporate the necessary level of sustainability orientation into water education programmes yielded valuable insights regarding learning environments and capacities needed to develop

the complex competency sets required. The purpose of this paper is to share key lessons learned in water education, and explore critical issue areas that require attention in ESD programme design in general.

The following sections present experiences collected in three different types of water-related higher education programmes: an interdisciplinary graduate programme; a set of joint master programmes offered by collaborating universities; and a range of capacity development programmes for working professionals at the UNESCO-IHE Institute for Water Education in the Netherlands and the National Autonomous University of Mexico (UNAM). After short summaries of the research approach and case studies in Sect. 2 and 3, Sect. 4 discusses critical issues encountered across the programmes and reflects emerging lessons for ESD research. Section 5 proposes resulting implications for ESD programme development in higher education.

2 Research Methodology

In the tradition of Grounded Theory, the analysis is based on empirical observation, review and evaluation of existing water education programmes and their development process. The ESD analyses presented in the case studies were triggered by routine reviews related to institutional strategy, curriculum development or didactics, which revealed a need for more substantive analysis of sustainability-oriented programme activities in the respective institutions. Despite the differences in programme format, the experience of the programme coordinators shared sufficient similarities to stimulate a structured search for common critical issues and common principles suitable to inform broader ESD research. Independent but coinciding formal evaluations of the three programmes provided the data and opportunity for this study, as elaborated below.

In the case of UNAM, the introduction of an interdisciplinary graduate programme in sustainability science represented a new programmatic approach for the university. A theory-based collaborative programme design process was developed, with in-built continuous evaluation of the process itself, and a systematic summary evaluation of its impacts. Methodically, the process had the characteristics of a design-experiment. The curriculum development approach built on theory of collaborative processes (Margerum 2002), embedding elements reflective of sustainability science, including collaborative design, active participation, social learning, shared visioning, and backwards design of program learning outcomes by strategic partners from academia and the public sector. The case study draws on an evaluation performed by an independent specialist over a two-year period, which examined project activities and implementation through a series of surveys, key informant interviews, direct observations, and review of secondary project sources (Charli-Joseph et al. 2016).

Review of the UNESCO-IHE joint degree programmes was initiated by an informal reflection on alignment of programmatic activities with didactic principles and external accreditation criteria. The responses led to a comprehensive structural review of content and didactics of the Environmental Science programme, and triggered collaborative revision of the programme in a series of workshops and working groups. The process resulted in the overhaul of several modules, and the establishment of academic principles to guide further programme reform. Building on the lessons learned, a formal evaluation of the joint programme in Limnology and Wetland Management was conducted in 2014 by an independent external reviewer familiar with the subject, and the ecology and institutional structures of sub-Sahara Africa. The evaluation considered content, grading and administrative arrangements based on interviews with staff and students at the three institutes involved, a review of documentation and course materials, and observation of oral thesis defences at UNESCO-IHE. The case study draws on the results of the reviews and programme development workshops, as well as on formal module evaluations by the students and 'reflection reports' prepared by module coordinators since 2013.

During 2014–2015, UNESCO-IHE undertook an assessment of its capacity development (CD) programme as part of the review of its strategic direction. The review was conducted by a multidisciplinary task force spanning social science to engineering; through a series of internal workshops with CD project leaders and experts; an international stakeholder event; and an international survey among its stakeholders (Wehn et al. 2015). At the time of the review, some 200 CD projects were ongoing and more than 750 had been completed over the previous 25 years. The international stakeholder survey (with 117 valid responses) contained questions on the role of the institute in CD, on alliances with southern partners to strengthen the relevance of outputs, and on actions to increase the impact of CD projects. The international stakeholder event gathered about 80 participants from various backgrounds and organisations, many of whom had participated in the institute's projects. Specifically, this included partners from southern and transition countries, Dutch and international partners from education and knowledge education institutes, water sector organisations including government, donors, the private sector and NGOs. The survey results, workshop and event reports inform the third case study on UNESCO-IHE's capacity development activities.

The three ESD initiatives reported in this paper are works in progress; curricula and didactics continue to evolve in response to results of continuous evaluation and reflection. The issues and lessons presented in this paper are, therefore, neither complete nor conclusive. Furthermore, the context-specific participatory approaches to programme design and the independent design of programme evaluations limit comparative analysis of the three cases. Both aspects restrict the ability to draw generalized conclusions. At the same time, the independent empirical observation of the three critical issue areas explored in this study recommends them as conceptual categories for ESD research, open to further investigation.

3 ESD: Three Experiences

3.1 UNAM Sustainability Science Programme

Mexico lacks trained professionals with the knowledge and skills required for sustainable development, reflecting an absence of higher education programmes focused on complex socio-ecological issues across Latin America. In response to the demand for more sustainability-based curricula, courses were added ad hoc to a number of disciplinary programmes at UNAM over the years, but there was no successful degree-programme focused solely on sustainability. A sustainability science programme, by definition, integrates multiple disciplines and complex issues (Kates et al. 2001), but neither aspect was explicitly addressed until the university established an interdisciplinary Sustainability Science MSc and PhD graduate programme in 2015, after five years of intensive programme development.

The experience offers valuable lessons for institutes that share similar challenges. Curriculum development for the interdisciplinary degree encountered some barriers found in universities all over the world, such as an emphasis on maintaining disciplinary boundaries and a focus on academic careers over those outside academia (Miller et al. 2011). Other obstacles were more context-specific, including integration of local development priorities and the absence of regional approaches to sustainability science. With regards to the former, the process benefited from guidance and collaboration by the School of Sustainability of Arizona State University, a pioneer of sustainability science in the USA. With regards to the latter, UNAM will explore adaptation of sustainability science approaches originating from the global north, and adjust concepts to emerging economies and developing countries. In this regard, the Sustainability Science graduate programme serves as a pilot and model for other institutions in the region.

A collaborative approach was the key element of programme development, beginning with 18 months of intensive collaborative workshops (Margerum 2002). The intentionally slow and deliberate process proved successful in distilling agreed curricula from the visions of 18 academic entities, ten disciplines across the university, and important public sector agencies such as the Secretary of Environment and Natural Resources (Charli-Joseph et al. 2016). It necessitated flexibility, but ensured that sufficient attention was paid to differing needs of academically oriented PhDs and competency-based MSc degrees. Involving the public sector ensured that the programme specifically addressed local priorities, including poverty reduction, inequality, and vulnerability to global change, as well as themes such as water systems management. However, the competency-based structure of the MSc programme presented a major challenge in the development of the PhD curriculum. Competencies tailored to serve local professional demands proved restrictive for a PhD and research track, which requires stronger theoretical grounding, academic rigour, and advanced research skills, as well as inclusion of cross-cutting themes such as complex socio-ecological systems and collaborative planning.

The participatory process and collaborative visioning in workshops reflect the principles of sustainability science itself. Applying ambitions of the field to the programme development process revealed core lessons, as well as remaining barriers. Buy-in from a variety of disciplines was the most important benefit, with all participants developing a sense of ownership over the programme. Previous attempts to create interdisciplinary programmes at UNAM failed to attract commitment across disciplines, but the Sustainability Science programme reached critical mass and broad support from actors across the university. The interaction with the public sector created strong awareness for the sustainable development needs of Mexico. Involving relevant agencies ensured that skills gained in the UNAM Sustainability Science graduate programme reflect national priorities, and values necessary for achieving the SDGs, while maintaining academic standards. Close monitoring and continued communication among academic disciplines will be needed, however, to sustain institutional support, maintain disciplinary cohesion and promote evolution of the programme.

3.2 UNESCO-IHE International Joint Masters Programmes

UNESCO-IHE's mission is the education, training and capacity development of professionals and sector organisations for sustainable water use; its MSc and PhD programmes target students from developing countries and emerging economies (UNESCO-IHE 2015). Increasing international collaboration, reflected in double or joint degree programmes with several partner institutes, puts UNESCO-IHE at the front of a broader trend. A recent survey of 245 higher education institutions in 28 countries reported that almost all had plans to develop more joint programmes (Chevallier 2013). Three of UNESCO-IHE's programmes particularly embody the principles of sustainability education. The joint masters in Limnology and Wetland Management (LWM) offered with partners in Kenya and Austria, as well as joint specializations in the International Master of Science in Environmental Technology and Engineering (IMETE), and the Environmental Technology for Sustainable Development (ETSuD) masters, train working professionals in sustainable water resource management, addressing a range of technical, procedural and relational aspects of complex environmental management challenges.

Core challenge in the design and implementation of joint programmes is coherence in content, quality and examinations. In contrast to double degree programmes, in which partners award separate degrees in line with their own examination regulations, joint degrees award a single diploma based on examination regulations agreed by all partners. Standards set by intergovernmental or national accreditation authorities are an important tool for quality assurance in such programmes. For example, the European Bologna process promotes comparable and compatible education systems by describing qualifications in terms of workload, learning outcomes, and competencies (Froment et al. 2006). To support international collaboration, UNESCO-IHE MSc programmes are both nationally accredited and designed to meet Bologna Level 7 criteria.

Sustainability education has to confront students with the uncertainties and diversity of perspectives associated with complex problems (Lansu et al. 2013). To this end, UNESCO-IHE's didactic design is rooted in the educational theory of Blooms Taxonomy,[1] using a mix of knowledge, theory and methods training to develop analytical and academic skills. The results of an internal review in 2012 suggested a need for improvements in developing critical thinking, communication skills, and quantitative analysis; a subsequent programme revision aligned knowledge content with these dimensions. As the review covered students enrolled in both single and joint degree programmes, it uncovered challenging questions about the progression of skill development in the joint programmes. Specifically, LWM students complete training in Austria and Kenya before joining UNESCO-IHE, and the resulting skill profile has to be accommodated within the didactic frame of the overall Environmental Sciences programme.

In 2014, the partner institutions involved in the joint degree initiated an independent review of the LWM programme, examining syllabus and learning objectives, assignments, examination and administrative arrangements. The review attested a generally good fit between the course objectives and design, as well as high relevance of the programme especially in the developing world. But it noted the high amount of teaching materials and observed that "*knowing details is sometimes encouraged at the expense of critical thinking*". Striking the right balance between content and critical thinking is a general challenge of academic programming, but requires particular vigilance in joint programmes and sustainability education. Overlaps and inconsistencies between partner institutions can aggravate content overload of students who already have to adjust to several learning environments. Skills and competencies central to ESD (Wiek et al. 2011) require systematic development and, therefore, close collaboration among partners. Not last, moving between different environments in itself develops skills for multi-stakeholder environments typical for sustainability professions, but this opportunity is explored best if complemented with effective reflection.

The review highlighted that the organisational and logistical demands of joint programmes, the need for highly efficient administrative structures and sufficient human and financial resources, are frequently overlooked. Success depends on clearly defined operational agreements and exam regulations that should be developed and governed by joint management committees. Considerable effort was required to align marking ranges and credits for the LWM programme, even between European partners. Negotiating agreements with non-EU partners added further challenges in understanding and matching standards. Implementation of joint and double degrees need on-going attention to programme quality (Froment et al. 2006). The enthusiasm of a few dedicated individuals, a frequent starting point for joint programmes, is not a basis for long-term success. In a telling remark the LWM reviewer noted that the smooth functioning of the programme "*says a great deal for the determination of both academic and administrative staff*".

[1] http://www.nwlink.com/~donclark/hrd/bloom.html.

3.3 UNESCO-IHE Capacity Development Activities

UNESCO-IHE's track record in capacity development within the water sector spans six decades, and amounts to over 40 % of its recent annual revenue (UNESCO-IHE 2015). Capacity development programmes and projects focus on individual, organisational and institutional capacity in IWRM and sustainability. Project modalities typically comprise combinations of education and training, joined research, advisory services, e-learning, knowledge networks and partnerships (Wehn et al. 2015). Experiences across a range of projects reveal a number of common challenges and key issues.

Contemporary capacity development emphasizes locally-driven approaches (OECD 2011), reflected in project designed around training-of-trainers and local change agents. The approach requires local beneficiaries eager to learn and stimulate change. Motivation cannot be taken for granted in any learning environment, but in capacity development there are a number of specific challenges. Training-of-trainer courses for water supply experts or tailor-made trainings for ministry staff frequently suffer from poor attendance and participant selection based on favouritism or availability rather than suitability. Even the best designed training will fail to stimulate change if participants refuse to engage in 'active' learning or to take responsibility for implementing changes afterwards.

Sustainable water management and IWRM build on multi-stakeholder processes, requiring multi-disciplinary and transdisciplinary skills, creative problem solving and critical thinking, as well as interpersonal skills that foster collaborative learning (Sahlberg and Oldroyd 2010; Weatherly et al. 2003). Such skills are inherently difficult to 'teach'; cultural and ethical aspects of international collaboration increase the challenge. Local norms might discourage critical thinking, both in training and workplace environments. Norms and custom might demand behaviour diametrically opposed to the ideas of sustainability education, prescribing a passive role for participants, imposing restrictions based on gender or other characteristics, stipulating that 'the trainer knows best', and discouraging or even prohibiting critical questioning of local practice, institutions or power dynamics. In such contexts, 'integrated' approaches to sustainable resource management require skills beyond theoretical concepts, and beyond critical thinking, to include cultural sensitisation, strategic positioning and social learning.

Sustainable development requires systemic organizational changes in water agencies and utilities (Lozano et al. 2014), but many capacity development projects remain limited to training individuals, focus exclusively on technical expertise, or impose inflexible restrictions conceived by funders (Vallejo and Wehn 2016). Consequently, newly trained staff, equipped with multi-disciplinary skills, face opposition and difficulties effecting change at the organisational level, as innovative and creative solutions might challenge existing routines, procedures, and hierarchies. The importance of the receiving environment for successful capacity development interventions is acknowledged in principle. But our own projections, methods and mind-sets to training and capacity development are often complicit in retaining the *status quo.*

Strengthening the institutional aspect of capacity development requires more attention to the training approach itself. To make sustainability education of working professionals effective, we need to stop teaching, and start facilitating context-specific learning processes. The most successful projects in the review addressed individual and organisational capacity at the same time, and connected what participants learn with the purpose they learn for. Action learning approaches, particularly workplace related exercises based on real-life problems, have proven valuable for a wide range of organisations and fields of expertise. Course designs should see trainees return to their workplaces and engage colleagues as part of the process. However, interactions of working professionals with actual peers follow a different dynamic than exposure visits of students to companies. Action learning requires a safe learning environment; workplace-based action learning needs careful balancing of group work and organizational engagement.

To improve capacity development for sustainability, we need to invest more in the engagement of higher level stakeholders to improve the selection and availability of participants, which requires high political and cultural sensitivity. Donor agencies need to allow and enable more flexible project designs and evaluation, based on systems thinking and theories of change (Lozano et al. 2014). Educators themselves have to be flexible, open minded, and prepared to throw out 'off the shelf' trainings, and instead design and implement meaningful combinations of face-to-face and workplace learning that are adaptable and responsive to the training context. Composition and motivation of training participants will remain unpredictable, so content, tempo, activities and learning styles have to be adjusted as needed. However, flexible and adaptive project designs effectively co-designed with participants risk losing focus. Dynamic training programmes depend, therefore, on experienced project coordinators, capable of balancing continuous adjustment and evolution of activities, while keeping the process on track towards intended outcomes.

4 Training Sustainability Change Agents: Key Issues

The educational and capacity development programmes outlined above encountered three shared challenges in curriculum design: skill development for meaningful stakeholder engagement; integrating the normative and value-based aspects of sustainability; and securing sufficient organizational capacities and professional skills of educational providers. The following sections reflect the relevance of these experiences for ESD programme curricula in general. Table 1 summarizes the findings per issue area.

Table 1 Summary of curriculum-related findings per issue area

Case study	Findings related to curriculum and programme content per issue area		
	Build relational skills relevant for…	Integrate normative aspects to…	Institutional capacities critical to…
Sustainability Sciences MSc and PhD Programme, UNAM	• Facilitating multi-stakeholder processes related to implementation of public policies or national sustainability agendas • Collaborative planning processes	• Address local development priorities such as poverty reduction or inequality • Establish (professional) values necessary for achieving the SDG	• Initiate dedicated inter-disciplinary programmes focused on complex socio-ecological issues • Offer more competency-based programmes tailored to local professional demand
Environmental Sciences Joint MSc Programme, UNESCO-IHE	• Facilitating multi-stakeholder processes at different scales • Collaborative planning and decision-making in complex socio-ecological systems • Building trust and maintaining relationships	• Lay the groundwork for professional identity of future water managers • Reflect ethical dimensions of water management	• Develop systematic, coordinated competency development trajectories across multiple organizations • Ensure positive learning experience with coherence in content, didactics and exams
CD Programmes for Water Professionals, UNESCO-IHE	• Facilitating multi-stakeholder processes • Initiating and stimulating organizational change • Securing commitment from leaders, buy-in from staff and support from relevant external groups	• Address local norms and customs in the target region • Strengthen cultural sensitisation and strategic positioning	• Move contents beyond technical expertise towards action learning embedded in the work environment • Offer trainings that are adaptable and responsive to the local context

4.1 The Importance of Building 'Relational' Competencies in ESD

Stakeholder engagement is a cornerstone of sustainable development. MSc programmes in environmental and water management teach the importance of collaborative planning and decision-making, building trust, maintaining relationships and valuing the contributions of diverse actors. Similarly, transformative change in water utilities and ministries starts with securing commitment from leaders, buy-in from staff, and support from relevant external groups. Translated into competency needs for sustainability professionals, stakeholder engagement requires

combinations of interpersonal and communication skills, process (management) competencies, open-mindedness and a willingness to learn and adapt (hereafter summarized as 'relational skills'). In water management, the need for relational skills is widely documented in competency frameworks, educational reviews and case studies (Irvine et al. 2016; Lansu et al. 2013), policy analyses (OECD 2015), as well as IWRM guidelines and training materials (Global Water Partnership 2009; Kranz and Mostert 2010). Empirical case studies imply a similar priority for relational competencies in other sectors. Wesselink et al. (2015) identify a similar mix of interpersonal skills, open-mindedness and active engagement as crucial for corporate social responsibility. Stakeholder engagement skills are also increasingly acknowledged as core competency in urban planning and other engineering curricula (Halbe et al. 2015; Pijawka et al. 2013). A review of general sustainability competency frameworks (Barth et al. 2007; De Kraker et al. 2007; Hesselbarth and Schaltegger 2014; Wiek et al. 2011) reveals, however, that relational skills are neither understood as one integrated set of competencies, nor given the priority that their empirical importance suggests.

One reason for missing links between theoretical and workplace-specific competency frameworks might be that the term 'competencies' in education reflects two separate schools of thought. In educational philosophy, they serve to envision 'competent' citizens shaped by the educational system (Cheetham and Chivers 2005). In industrial human resource practice, competencies are technical descriptors that allow disaggregation of personal qualifications for recruiting and staff planning (Guerrero and De los Ríos 2012). Educational policy increasingly uses the latter concept, as exemplified by the European Bologna process (Danish Ministry of Science Technology and Innovation 2005). In contrast, the discourse on sustainability competencies originates from the philosophical question of skills enlightened citizens need to invent new sustainable lifestyles (UNESCO 2002).

Competencies are notoriously difficult to conceptualize and evaluate within a higher education curriculum (Allais 2007; Chabeli 2006). For example, it is not sufficient for sustainability professionals to understand or design participatory processes; they have to be able to *participate* and *facilitate* them. The simple term 'stakeholder engagement' describes highly complex social learning processes influenced by culture, attitudes and power (Latour 2004; Pahl-Wostl et al. 2011). Competencies include, therefore, the ability to account for tacit knowledge, social identities, and motivations of participants in reflexive dialogues. The UNAM experience shows that a competency-based approach can uncover inherent conflicts between professional and academic teaching objectives. In the literature, discussions of pedagogical approaches for sustainability frequently mention collaborative learning methods, but problem-based, active or 'action' learning is usually recommended to empower students and capture the complexity and interdisciplinarity of sustainability issues (Halbe et al. 2015; Hesselbarth and Schaltegger 2014), not to develop interpersonal and process facilitation skills. Much closer attention on cooperative teaching approaches that emulate social learning processes and systematically foster relational skills is recommended (Johnson and Johnson 2009; Pijawka et al. 2013; Weatherly et al. 2003).

4.2 Integrating the Normative Aspect of Sustainability Education

All three programmes explicitly or implicitly faced normative question during programme design, related to local development priorities, training paradigms, social norms, integrity and the priority of sustainability education as such. The arguments reflect that sustainable development has an inherent normative dimension; it is often described as 'moral precept', 'ethical consensus' or a 'dialogue of values' (Pijawka et al. 2013; UNESCO 2002). Consequently, offering ESD entails that universities actively and consciously participate in a socio-political transformation, which might cause controversy (Papanagnou 2010). Staff involved in new or specialized degree programmes will often share related values, but suggesting a normative sustainability agenda for existing disciplinary degrees might face outright rejection (Grindsted 2015). In terms of programme content, many supposedly 'technical' sustainability topics contain normative dimensions. Civil engineering has to accommodate value-based arguments of local communities, a demand that expert-led planning models struggle to fulfil (Halbe et al. 2015). In management education, ethics are subject to increasing debate (Sidiropoulos 2014) and behaviour-based approaches to policy making (The World Bank 2014) are based on awareness for mental models and value systems, but current understanding is limited. For example, aruments rarely acknowledge that the term sustainability itself carries different connotations in different languages and religious traditions (Jie and Moris 2012; Kwang-Hoon and Ko 2015). Addressing such normative questions in ESD curricula does not mean to follow a norm-based approach to teaching (Grindsted 2015); it means to *acknowledge* the role of values and norms in the future workplace of sustainability professionals.

These findings identify three different norm-related tasks important to ESD programme development:

Build a shared understanding of sustainability: Difficulty in defining sustainability leads to calls for unified definitions to avoid lengthy clarifications. But since human understanding is shaped by culture and personal experience, formal definitions have different interpretations, and identical ideas are expressed in different terms. Time invested in collaborative workshops as conducted in UNAM is, therefore, not wasted. Jointly developing an agreed 'local' sustainability definition and agenda builds trust, reveals hidden values and creates pre-conditions for successful collaboration and programme implementation (Pfeiffer and Leentvaar 2013).

Integrate teaching methods that prepare for 'messy' workplace realities: Problem-based classroom exercises are often characterized by attempts to represent all sides, balance positions and find compromise solutions. Few classroom role-plays feature fraud or bribery (unless prescribed), shouting matches, actors refusing to listen to a presentation, or parties outraged at carefully thought-through solutions. In contrast, real-world decision-making is frequently biased by power and personal affiliations, and dominated by greed, self-interest, or intransigent positions rooted in fear or ideology. Teaching methods should help prepare students

for the reality of sustainability professions, for example through analysis of complex historic decision-making processes, story-based and emotion-evoking case studies that bring multi-faceted and subjective arguments to the classroom, as well as journaling exercises that reveal own personal values to students.

Discuss core values of sustainability professions: It is increasingly recognized that education plays an important role in how students envision and judge personal conduct in their chosen profession (Gantt and Madison 2015). As many sustainability professions carry inherent social responsibility, ESD programme development should include discussions on the core values, motivations and behavioural expectations of the professions trained. Values might include an identity as change agents, acting with integrity, or the ambition to learn from failures (Brundiers et al. 2010; Myers et al. 2014). Methodically, it means to abandon the idea that information leads to knowledge which leads to behavioural changes. Newer research shows that students and professionals seek information on topics they care about. Supporting professional identity formation ultimately means teaching and *learning to care* about sustainability.

4.3 Building Institutional Capacities for ESD

The ESD programmes observed for this study involved interdisciplinary, inter-organizational and international collaboration; modules based on complex real-world problems; flexible and adaptive training designs; and collaborative learning approaches. Every case placed high demands on the educational institutions during the design process. Throughout implementation, collaborative programmes required extensive coordination; joint programmes in particular demand substantial investment in continued quality assurance. This observation corresponds with observations in the literature that the amount of time needed for ESD programme development is easily underestimated (Aktas et al. 2015). Accordingly, the assessment of organisational capacities and professional skills of education providers themselves are a crucial element of ESD programme development.

Competencies and professional skill development of educators requires particular attention. Faculty might lack knowledge about sustainability, or awareness for disciplinary differences. Aktas et al. (2015) document teachers learning the basics of sustainability alongside their students. Capacity development requires educators equipped with tools for mentoring and on-the-job-learning, intercultural communication and change management. To build institutional capacities for ESD, faculty in new interdisciplinary courses might consider ‘taking their own course’ before rolling out programmes for students—a time-tested practice in industry and more recently introduced in development collaboration. Updating teaching and learning techniques from e.g. a certified University Training Qualification (UTQ) supports the necessary professional skill development in third level educators.

4.4 Lessons for ESD Programme Implementation

Discussion of the three issue areas revealed a clear parallel between key issue areas in the ESD curriculum content and key success factors for the design process and programme implementation itself. Design of the UNAM sustainability science programme and the UNESCO-IHE joint masters was based on extensive multi-stakeholder processes, and required significant relational skills of coordinators to overcome disciplinary divisions and conflicts of interest. Similarly,

Table 2 Summary of programme development and implementation-related findings per issue area

Case study	Success factor for programme development and implementation		
	Build relational skills relevant for…	Integrate normative aspects to…	Institutional capacities critical to…
Sustainability Sciences MSc and PhD Programme, UNAM	• Facilitate cooperative programme design with academic units and external agencies • Ensure buy-in of faculty, and overcome disciplinary divisions and conflicts of interest • Ensure continued coherence and evolution of programme	• Identify conflicting priorities in training for academic and professional career • Build trust and reveal unconscious values to allow collaboration • Reflect local and regional development priorities in the curriculum	• Interdisciplinary collaboration and didactics • Competency based MSc programme design • Extensive collaborative programme design for dedicated local and regional ESD programmes
Environmental Sciences Joint MSc Programme, UNESCO-IHE	• Facilitate cooperative programme design with international partner institutions • Overcome differences in didactic approach, structure, standards, culture and expectations • Ensure continued mutual quality assurance	• Reflect norms and values embedded in teaching and training approaches • Align educational standards across different cultures	• Address increased coordination demand of international collaboration • Offer effective administrative support for students moving between institutions
CD Programmes for Water Professionals, UNESCO-IHE	• Facilitate cooperative programme design with trainers, beneficiaries and stakeholders • Cooperate with higher level stakeholders to improve participant selection	• Identify value conflicts between sustainability ideals and local customs • Address local power dynamics and institutions • Reflect projections and mind-sets embedded in CD programme design	• Address methodical requirements of workplace education and facilitation of autonomous learning processes • Offer effective project management balancing needed flexibility with outcome-orientation

successful UNESCO-IHE CD projects were typically those that were co-designed by trainers with beneficiaries and stakeholders. Discussions related to norms and values not only questioned priorities and professional identities of future water managers, but also the awareness of teachers and programme coordinators for norms and values embedded in teaching and training approaches.

Water and environmental management courses extensively address the importance of process coordination in classrooms, while programme coordinators work with very limited resources, rarely receive professional training in network management, and often depend on working groups of interested volunteers. Research shows that effective network management affects the outcomes of knowledge and implementation networks (Klijn et al. 2010), but is rarely systematically considered in interdisciplinary programme development. External standards such as the European Bologna framework can support collaboration and quality assurance in higher education, but usually demand additional formalisation and documentation. In joint degree programmes, organizational capacity to link administrative systems of partner institutions is a key factor to ensure a positive learning experience for students. Capacity development programmes expand requirements placed on coordinators to include negotiations with beneficiaries and funding agencies (frequently in politically sensitive contexts) and the execution of capacity needs assessments to inform programme design, adding strong project management skills to the list of required competencies. Table 2 summarizes how the three critical issue areas applied to programme development and implementation in the three case studies.

5 Conclusions

Lessons learned in three different types of higher education programmes, and discussed in the light of current ESD research, suggest including three important components into ESD programme development:

(1) In the training of sustainability professionals, skills and competencies necessary to successfully build, maintain and manage relationships and stakeholder engagement require increased attention. Embedding such aspects into ESD is supported by programme designs that use cooperative learning methods, and competency profiles to clarify expectations, bridge disciplinary boundaries, reveal conflicts and support inter-organisational collaboration.
(2) Programme development should openly discuss and address the normative component of sustainability education, including clarification of guiding values for the programme, method selection appropriate to prepare for real-world workplaces, and discussion of core values of sustainability professions.
(3) Programme development should include a systematic assessment of organizational and professional capacities available for the programme, ensure effective programme coordination, and invest in professional and didactical skill development for staff involved in sustainability education.

Further research is needed to clarify the conceptual categories suggested in this study. In particular, improved theoretical frameworks for sustainability competencies are needed, including an investigation of differences between general sustainability education, and training of sustainability professionals. A better understanding regarding the role of norms and values in ESD is also required, particularly with regard to teaching methods suitable to address normative questions in different contexts.

The most remarkable lesson of this analysis is that key issue areas suggested for ESD also apply to the development process itself. This strongly suggests that successful ESD programme development might well start with 'learning and applying what we teach' in sustainability education.

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Awareness and Attitudes Towards Sustainable Development Amongst Higher Education Students in Penang, Malaysia

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Abstract

The role of youth in sustainable development decision-making and the implementation of sustainability programmes are critical elements to the long-term success of Agenda 21 and national sustainable agendas. Thus, advancing the role of youth and actively involving them in national sustainable agendas in the context of environmental protection and the promotion of economic and social development are crucially needed. However, there is inadequate information available about Malaysian youth's awareness and attitudes with regard to this matter. The aim of this study is to determine the level of awareness and attitudes towards sustainable development amongst Malaysian youth. As an exploratory study, a survey was conducted in 2015 and 295 respondents from selected public and private higher education students in the state of Penang. This study has shown that the awareness of respondents about the concept and issues of sustainable development were well developed however, differed over semantics and what sustainable development encompasses. The survey also revealed that respondents were highly concerned about sustainability and were willing to practice more sustainable lifestyles. This study hopes to contribute as background information that will reflect on national sustainable development strategies.

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Sustainable development · Higher education · Youth · Awareness · Attitudes · Malaysia · Education for sustainable development

1 Introduction

> It is imperative that youths from all parts of the world participate actively in all relevant levels of decision-making processes because it affects their lives today and has implications for their futures. In addition to their intellectual contribution and their ability to mobilize support, they bring unique perspectives that need to be taken into account.
> (United Nations 1992, p. 224)

The youths of today are a powerful yet underappreciated agent of change. Currently there are about 1.8 billion young people in the world aged between 10 and 24 years of age making this the largest youth population ever in human history with the majority of youths living in the world's least developed countries (Edwards 2015). Youths as elaborated by Furlong (2013), are semi-dependent and is an age where the gap between childhood adulthood is bridged which makes it difficult to define an age as it can differ across time and societies.

Youths, have a relatively close relation to the environmental movement (Strandbu and Krange 2003). In fact, the United Nations (2010) started the World Programme of Action for Youths and highlighted sustainable development as a key element in the development of youths as they have a special interest in maintaining the environment, as it will directly affect them. This implicitly shows the potential youths have in implementing policies and addressing change needed towards sustainability making youths a target group in sustainable development especially in developing countries. In effect, the role of youths in steering nations towards sustainable development is crucial and their early development is of paramount importance.

UNESCO (1977) during an intergovernmental conference on environmental education in Tbilisi, identified awareness as an objective as it could help gather sensitivity to environmental issues or other issues allied to it. Attitudes was also another chosen objective as it helped cement values and concern towards the environment and more importantly for active participation in environmental protection and improvement. According to Ahmad et al. (2012) awareness is crucial, as it has to be established first before understanding, perception or knowledge can be imparted to an individual. Thomas (2005) further reinforced the importance of measuring attitudes in sustainability reasoning that it would enable educators to access the effectiveness of pedagogical approaches in enhancing the legitimacy of sustainability in curricula. In a broader context, Eilam and Trop (2012) argues that through a social constructivist process, changes in public attitudes are the driving force behind major political changes and not behavioural change as popularly perceived.

Higher education institutions are an excellent platform for educative purposes. Altner and Michelsen (2005) has shown that increasing research in higher education institutions due to economic and private interests in sustainable development has also peaked the interest of youths in academics. Higher education institutions, usually dominated by youths can be a place offering catalysts for ideas and change to occur as positive development in universities can entail to economic and democratic progress (Hansen and Lehmann 2006). This is particularly important for developing nations such as Malaysia. However, the noble notion of educating the masses is structurally flawed in Malaysia due to the increased influence of politics in education (Johari 2016).

Some higher education institutions in Penang have been adopting education for sustainable development, such as Universiti Sains Malaysia (USM) as elaborated by Campbell (2010) and the state itself has seen recent establishments of non-governmental and governmental organisations dealing with sustainability and environmental conservation such as the Penang Green Council, Penang Water Watch, Penang Institute and the Penang Development Corporation. Recently, Penang has had a steady economic growth with all economic sectors predicted to grow (Leng 2015). However, despite recent developments, Penang is still plagued with issues such as deforestation, decimation of water catchments, soil erosion, landslides, water pollution, sedimentation and flooding, much of it due to development on the island (Chan 1998; Shankar 2012). Despite this, the Penang Paradigm (2013) a ten year framework for the state's development has set three main environmental initiatives with the goal of improving environmental management, tackling waste and pollution, and dealing with climate change by 2023. However, Ponrahono et al. (2011) has noted that Malaysia has difficulties integrating sustainable development policies at a local level even though state and national planning has already been drafted. As such, it is imperative that the level of awareness and attitudes on sustainable development be measured to be able to gauge the effectiveness of such programmes and initiatives later on.

2 Literature Review

Nevertheless, sustainability is currently in full swing worldwide strengthened by a solid political backing (Kagawa 2007; Niu et al. 2010) even in the Asia Pacific region where education for sustainable development is gaining momentum (Ryan et al. 2010). As such, a number of countries have conducted research into awareness and perceptions of youths in sustainable development with positive results. Khalil et al. (2013) sought to identify Egyptian student's perspectives on concepts of sustainable development and found out that students had an interest to apply sustainability in their daily actions. However, Eagle et al. (2010) noted that Australian students do have awareness on sustainability related issues but noted that they lack experience on such matters.

A study conducted by Sykes et al. (2002) on attitudes and knowledge of significant environmental concepts of students from Australia, Brunei, China, India, Japan, New Zealand, Singapore and Thailand noted that the ozone layer and greenhouse effects are the most known concepts across all nations while the least known concepts were sustainable development, biodiversity and carrying capacity. This comes even though, Yencken (2000) also noted that Islamic traditions as dominant in several nations in the Asia Pacific Region, viewed that nature has to be managed and is not seen as solely for human use and that humans are warned against the abuse of natural resources.

An academic literature search through major library databases such as Web of Science, Emerald, EBSCOHost, Scopus and Oxford University Press using a combination of keywords such as awareness, sustainability, sustainable development, youths and Malaysia, revealed very little available literature regarding sustainability and Malaysian youths, even though colleges and universities worldwide have started to adopt the concept of sustainability (Corcoran et al. 2002). Although, there has been some research to gauge the awareness and attitudes of youths in Malaysia, current literature is limited to the scope of environmental issues. A study in the state of Sabah, Malaysia surveyed student's environmental knowledge and attitudes and found that students do have a high level of environmental knowledge however lacked in the areas of climate change and the rise of carbon dioxide in the atmosphere (Harun et al. 2011). Aminrad et al. (2013) also focused on secondary school students in Malaysia however found that students were highly aware on environmental issues and showed positive attitudes about environmental issues. A study by Ali (2015) revealed that secondary school students in Terengganu, Malaysia showed low levels of environmental awareness and only a moderate attitude towards the environment by which the author recommends that qualified educators should be employed to curb the issue.

Out of the secondary education system, a survey was conducted on knowledge, attitudes and practices on 16 institutions of higher learning in Malaysia in regards to the environment and revealed that students in general, have a good level of understanding of the environment but lacked quite significantly in implementing practices in their daily activities (Ahmad et al. 2015). This is further bolstered by Ibrahim et al. (2011) whom also investigated the level of awareness towards environmental issues and concern in tertiary level students, in and around the Malaysian capital and found that around 60 % have a medium to high level of awareness.

There seems to be contradictory results on environmental attitudes and awareness of youths in Malaysia that can be confusing. Although global progress on sustainable development seems to be taking off, the same cannot be said about Malaysia and Penang in particular. This lack of national sustainability assessment in Malaysia could be due to the knowledge gaps encountered in developing indicators (Hezra 2004), further increasing the need to establish baselines and start assessments.

3 Research Aims and Methodology

With the lack of literature and contradicting research, it is challenging to assume the awareness and attitudes of youths in Penang based on comparison and said implementations alone. In response to this absence of data, this paper aims to gauge the level of awareness of Penang's youths. Once this is achieved, this paper takes a look at understanding the attitudes of youths in Penang towards sustainability. To get the best understanding on this contemporary issue, youths enrolled in institutions of higher education were surveyed.

It is also important to note that in Malaysia, according to the Youth Societies and Youth Development Act (2007), youths are persons above the age of fifteen and below the age of forty in contrast with United Nations definition of youth as persons above the age of fifteen up to twenty-four. For the purpose of this research, the Malaysian definition of youths will be used to enable the research to be relevant locally especially with statistical data and policies involving youths in Malaysia. The latest statistics, based on the Malaysian Institute for Research in Youth Development (2012), show that youths in Malaysia themselves make up 45.5 % of the Malaysian population with 5.5 % of youths residing in the state of Penang alone in the year 2010.

The main goal of this research is to provide a benchmark to ascertain the level of awareness among university going youths in Penang in regards to sustainability and sustainable development. Then, this research looks to identify attitudes and perspectives of university going youth in Penang towards sustainability and sustainable development.

There were a total of 295 respondents from the survey that was conducted from June to November 2015 amongst higher education institutions in Penang, Malaysia as higher education institutions provide the most appropriate venue for surveying youths. Respondents were obtained using the cluster sampling method whereby 50 respondents were given questionnaires from six different higher education institutions in Penang. The questionnaires were segmented into five parts with questions gauging respondent's knowledge, level of awareness, level of understanding, attitudes and opinions regarding sustainable development and sustainability. Questions for the survey were formulated and adapted from several other surveys conducted elsewhere on the topic of sustainability including a survey conducted by UNESCO Office in Venice (2015) on Mediterranean youth's responses towards sustainable development and current crisis. Initially, the questionnaire gathered respondent's personal information such as age, level of education, ethnicity and gender.

To gauge respondent's awareness and attitudes, twelve statements regarding awareness and eight statements on attitudes were presented to the respondents. The use of a 5-point Likert scale was employed in which one represented a lowest level of understanding or agreement and five representing a highest level of understanding and agreement. All statements scored a Cronbach's Alpha for internal consistency at 0.871 and 0.849 for statements regarding awareness and attitudes respectively which according to George and Mallery (2003) indicate good correlation. Respondents were

also given a multiple-choice question on the statement 'which of the following activities describe your current lifestyle?' and were asked to check all elements that applied to them.

On ascertaining respondent's definition and view of sustainability, they were given a multiple-choice question on; 'which do you consider as components of sustainability', in which respondents were given the choices of environment, social and economy based on United Nations (2014) three pillars of sustainable development.

Besides that, this research also sought to investigate the effects of gender on awareness and attitudes towards sustainable development. To obtain accurate results, a random sampling of 121 female respondents was picked from the present sample to tally with 121 male respondents due to the large proportion of female to male samples. All results obtained are based on a 5-point Likert scale from one to five as previously mentioned. As the data is not normally distributed based on a Shapiro-Wilk statistic, the Mann-Whitney test for non-parametric data was used. To test and analyse the results, the software IBM SPSS Statistics version 22 was used.

4 Results and Discussion

4.1 Demographics

Altogether, there were 295 respondents comprising of 59 % female respondents and 41 % male respondents. Respondents were obtained from Inti International College Penang, Open University Malaysia Penang, SEGi College Penang, KDU College Penang, Cosmopoint College Penang and also USM, Penang. Respondents were predominantly of Chinese ethnicity accounting for 45.8 % of the total population. Malays made up 34.2 % and Indians made up 17.1 % of the respondents. 89.8 % of respondents were 25 years of age and below. It is also important to note that 64.2 % of respondents were in the arts stream of studies compared to 35.8 % in Science stream. A large majority of respondents were undertaking their Bachelor/Diploma (98.3 %) compared to Masters (1.0 %) and Doctorate (0.7 %).

4.2 Sources of Information Regarding Sustainable Development

The data was gathered to find out respondent's sources of information regarding sustainable development as presented in Fig. 1.

Figure 1 indicates that most respondents acquired their information regarding sustainability through the web followed closely by social media. Relatives and friends were the least picked form of information on sustainability. The findings are further reinforced by Lummis et al. (2015) who conducted a study on student teachers in Australia and found that students preferred the Internet as it was the

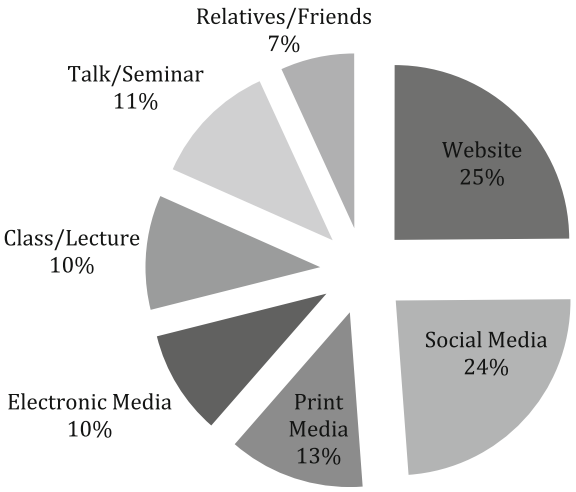

Fig. 1 Sources of information related to sustainability and sustainable development

easiest, best and most reliable source of information on sustainability and was less influenced by political agendas with some students using information on the internet as a starting point for more research.

4.3 Awareness

In general, respondents were highly aware of the sustainable development concepts and issues scoring an above average mean for all concepts and issues as shown in Table 1. Global warming, depletion of the ozone layer, climate change and environmental pollution scored relatively high means with global warming scoring the highest. The issue on renewable resources scored the lowest mean.

Table 1 Level of awareness on issues related to sustainable development

Issues	Mean	Std. Deviation
Water cycle in nature	3.53	0.91
Climate change	3.80	0.84
Over exploitation of flora and fauna	3.60	1.03
Over exploitation of natural resources	3.70	0.99
Renewable resources	3.34	0.97
Waste management/life cycle of products/recycling	3.48	1.03
Marine litter	3.42	1.15
Sustainable management of ecosystems	3.36	0.94
Environmental pollution	3.89	1.01
Global warming	3.99	0.96
Depletion of ozone layer	3.84	0.96
Sustainable production and consumption	3.56	0.91

Joseph et al. (2013) noted that typically better-known subjects or general terms such as global warming were known better than complicated terms and unfamiliar issues on sustainability. Issues such as climate change do not fare as well as global warming perhaps due to the lack of implementation in environmental and economic agendas especially by developing countries as noted in depth by Beg et al. (2002). Interesting to note however was the lack of awareness on renewable resources, even though renewables has been well conversed and discussed on academic and policy-making levels within Malaysia (Ahmad et al. 2011).

4.4 Attitudes

Based on Table 2, respondents were willing to be involved in sustainable development scoring an above average for all statements. Most respondents were in strong agreement the statement; 'I will reduce the use of plastic bags', scoring the highest mean. This, can be due to the Penang state directive ban on giving out free plastic bags every day since the start of 2011 in a bid of the state to reduce spending on waste disposal (Chong 2011).

The lowest average recorded was in response to the statement; 'I am willing to get involved in sustainability activities if it is held in campus/school'. It is also interesting to note that statements that only involved the respondents showed higher means than statements that involved participation with others including family members, the public or with their peers. This unsolved question could be due to the fear of going against norms in Asian environmental movements. Hsiao et al. (1999) has noted that there are differences to the Asian style of environmental movements citing Asian distaste for open criticism of authority, fear of creating instability within the community and knowledge that going against societal norms will lead to ostracism, which severely limits environmental movements.

Table 2 Attitudes towards sustainability and sustainable development

Statement	Mean	Std. Deviation
I am interested to learn more about sustainability and sustainable development	3.78	0.94
I am willing to get involved in sustainability activities if it is held in campus/school	3.70	1.00
I am willing to raise awareness on sustainable development to my family and friends	3.85	0.89
I try to practice recycling and composting	4.00	0.84
I will use water and electricity resources efficiently	4.05	0.89
I will practice 3R (reduce, reuse and recycle) in everyday life	4.06	0.91
I will reduce the use of plastic bags	4.15	0.87
I will use products that are environmentally friendly	4.11	0.84

Based on the multiple choice question as shown in Fig. 2, when describing their current lifestyle, 'turn off lights and fans when not in use' had the most number of responses. Once again, participation in environmental conservation activities, an action that involved others was the least chosen choice of lifestyle. Based on Table 2, whereby respondents responded rather favourably to the notion of using environmentally friendly products, Fig. 2 contradicted that statement which showed that a relatively low amount of responses towards respondents actually using environmentally friendly products. A study conducted by Cottrell (2003) corroborated with our results indicating that environmental concern only attributed to moderate change in environmental behaviour.

4.5 Components of Sustainability

Based on the collected responses as in Fig. 3, the environment was the most picked option followed by social and lastly the economy. Most respondents, had an enviro-centric view of sustainability which is consistent with research results by Summers et al. (2004) on Australian postgraduate student-teacher's conceptions on sustainable development who noted that a majority recognised the environmental aspect of sustainable development compared to the economic and social factors. Although respondents have acquired awareness on sustainable development and sustainability as previously shown, respondents were not fully aware of the scope of sustainable development and sustainability. Respondents were also unaware that the economy was a critical component in achieving sustainable development. This is fairly critical considering that the economic component is a huge contributing element towards sustainability. A study conducted by Ratiu and Anderson (2014) to

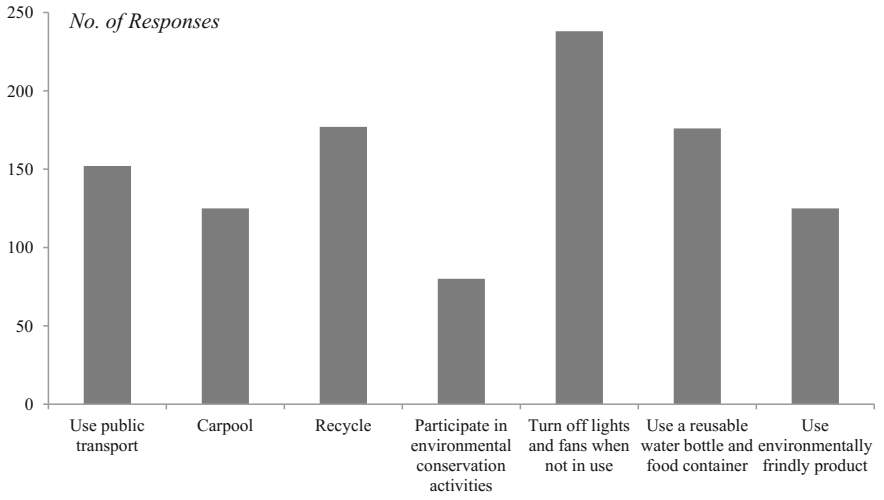

Fig. 2 Current lifestyle of respondents based on the questionnaire given

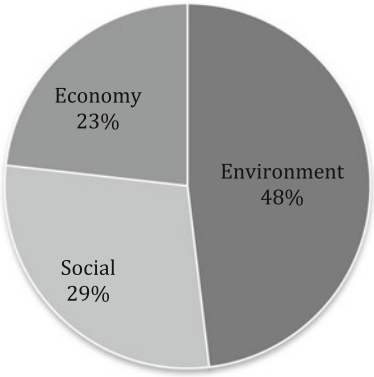

Fig. 3 Components of sustainability

find out words or phrases associated with sustainability among students, found out that the environment was identified more often than economy and that there were 200 different words or phrases describing sustainability. The struggle to understand the concepts of sustainability is widespread and the identity crisis that is endemic in sustainable development may just be an effect of the multidisciplinary, ambiguity and flexibility of the word added with the growing popularity of the use of the term.

Although, many universities have pledged to be more sustainable, this has yet to influence the thought on mainstream economics (Green 2015). Neo-classical economics, as the dominant form of economics todays, makes up much of what is thought in economic courses in universities leaving no room for thought and exploration of other form of economics that is more relevant for the future generation of economics (Rieser 2014).

Social aspects of sustainability are also just as imperative as its economic partner. Although there have been struggles in incorporating social aspects of sustainable development into curriculum (Björnberg et al. 2013), the stability that the social aspects of sustainable development provide towards economic and environmental elements is undeniable and thus should be emphasized as well.

4.6 Correlation of Gender to Awareness and Attitudes

Based on the collected data in Table 3, only three concepts regarding awareness of sustainability and sustainable development had a high significance ($p < 0.05$). Issues such as: 'water cycle in nature', 'environmental pollution' and 'sustainable production and consumption' had a significant difference in gender with higher mean ranks for male respondents.

Interestingly, although only three statements on awareness showed significant differences between male and female respondents with higher means for the males in awareness, males scored higher for all statements except on 'waste management/life cycle of products/recycling' as shown in Table 4. Male respondents seem to have higher awareness in regards to sustainability and sustainable development.

Table 3 Mann-Whitney non-parametric test for the effects of gender on awareness

	Water cycle in nature	Environmental pollution	Sustainable production and consumption
Mann-Whitney U	5940.000	6213.500	5679.500
Wilcoxon W	13321.000	13594.500	13060.500
Z	−2.743	−2.138	−3.195
Asymptomatic Significance (2-tailed), *p*	0.006	0.033	0.001

Note Grouping Variable = Gender; calculated probability, $p < 0.05$

Table 4 Rank of gender with awareness score

	Mean Rank	
	Male	Female
Water cycle in nature	132.91	110.09
Climate change	122.51	120.49
Over exploitation of flora and fauna	125.16	117.84
Over exploitation of natural resources	129.93	113.07
Renewable resources	129.18	113.82
Waste management/life cycle of products/recycling	119.00	124.00
Marine litter	127.19	115.81
Sustainable management of ecosystems	125.37	117.63
Environmental pollution	130.65	112.35
Global warming	128.17	114.83
Depletion of ozone layer	128.33	114.67
Sustainable production and consumption	135.06	107.94

Attitudes were also tested using a Mann-Whitney test due to the lack of normally distributed data after a Shapiro-Wilk statistic. Based on the collected data in Table 5, only two statements had a high significant difference: 'I am interested to learn more about sustainability and sustainable development' and 'I am willing to raise awareness on sustainable development to my family and friends'. Both statements showed more male than female respondents picking the statements.

As with awareness, respondents attitudes seemed to be skewed to the males as shown in Table 6. All statements had male respondents score higher than females with two statements showing significant difference on two statements as previously mentioned. Based on this, males seem to have a higher positive attitude towards sustainable development and sustainability.

The effects of gender on awareness and attitudes were also surprising. Most surprisingly were the higher mean scores for male respondents to female respondents however, this could be due to chance as the results were not significant enough according to statistical calculations. Results of these findings slightly differed from Sengupta et al. (2010) who conducted research on twelve grade students in Kolkata, India, which discovered no significant difference between both male and

Table 5 Mann-Whitney non-parametric test on the effects on gender on attitudes

	I am interested to learn more about sustainability and sustainable development	I am willing to raise awareness on sustainable development to my family and friends
Mann-Whitney U	5886.000	6152.500
Wilcoxon W	13267.000	13412.500
Z	−2.769	−2.160
Asymptomatic Significance. (2-tailed), *p*	0.006	0.031

Note Grouping Variable = Gender; calculated probability, $p < 0.05$

Table 6 Rank of gender with attitudes score

	Mean rank	
	Male	Female
I am interested to learn more about sustainability and sustainable development	133.36	109.64
I am willing to get involved in sustainability activities if it is held in campus/school	125.33	116.71
I am willing to raise awareness on sustainable development to my family and friends	130.15	111.77
I try to practice recycling and composting	123.67	119.33
I will use water and electricity resources efficiently	124.92	117.12
I will practice 3R (reuse, reduce, recycle) in everyday life	128.36	114.64
I will reduce the use of plastic bags	128.51	113.55
I will use products that are environmentally friendly	120.93	120.07

female students on environmental awareness and environmental related behaviour. Locally in Malaysia, another research was done on the effects of undergraduate's gender on environmental attitudes and attitudes on green products but also found no significant difference (Chen and Chai 2010).

5 Conclusion and Recommendation

Malaysian youths are an emerging force of change within the nation and involving them in programs and initiatives for sustainable development will create opportunities to foster the needed awareness, attitudes and knowledge in this age of the Anthropocene. Awareness and the attitudes of youths in Penang seem positive and is definitely a step in the right direction however; more research needs to be conducted in depth to identify the actions and knowledge on sustainability not only within the state but also at the national level. A lack of action can be a serious consequence indicating poor programs or outlets for youths to be involved and exposed to sustainable development.

Regardless, the awareness and attitudes of youths in Penang seem to tally with the global and regional trends of increasing awareness and positive behaviour towards the concept of sustainable development. Referring back to the literature reviewed, increasing environmental awareness as shown in tertiary students from other states may have contributed to the current level of awareness and positive attitudes in the state. As the environmental awareness in secondary school students differed among the states in Malaysia, education in the tertiary level can help with the chance of increasing the awareness and provide changes in attitudes among youths in regards to sustainability.

This research conducted in the state of Penang is not meant to be an indicator of the level of awareness and attitudes for the entirety of Malaysian youths but can serve as a comparison to other related research. Data obtained from the survey can be used as baseline data for further research related to sustainable development and youth in Malaysia. As such, the authors find that results obtained from this research prove to be viable as a baseline regardless of the relatively small sample size due to limitations encountered by the research team in collecting data. Besides that, findings from this research will greatly help with more accurate and effective public policy implementations towards sustainability. Results identifying the state of awareness and attitudes discussed here will enable policy and programme discussions that are perhaps more focussed on education, outreach and communication in sustainable development towards the public especially youths.

A shift towards sustainability has to occur in 'unconventional' sources of sustainability in higher education institutions' curriculum such as economics, the social science, engineering and design to ensure that all students can have a varied and multidisciplinary view on sustainability. There needs to be better integration of sustainability in all courses and programmes in higher education institutions which will encourage thinking and contributors towards sustainable development from all fields.

Higher education institutions nationwide need to foresee their role in creating a generation that is not only sensitive towards sustainability but also able to contribute to Malaysia's effort towards sustainability. A major shift in sustainable development by all higher education institutions within the country can help drive not only Malaysia, but also the world to meet the seventeen Sustainable Development Goals by 2030.

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Interdisciplinary Teamwork on Sustainable Development—The Top Ten Strategies Based on Experience of Student Initiated Projects

Mirjam Braßler and Miriam Block

Abstract

Interdisciplinary teamwork has been identified to be a key factor for sustainable development (SD) at higher education institutions. However, there are several difficulties with the practical implementation. Existing student initiated projects (SIPs) may hold the key to possible solutions. This paper presents the top ten strategies for successful interdisciplinary teamwork on SD. It is based on qualitative analysis of expert interviews describing experiences in SIPs. Using the method of grounded theory, the data was collected, interviews were coded and central categories were identified. Besides finding common ground, it is crucial to invest time and patience, adapt professional languages, share information and educate oneself, built a friendship, differentiate between person and discipline and deploy a professional moderator. Additionally to elaborating the main strategies, this paper will discuss related literature. This paper will be useful to anyone interested in working in interdisciplinary teams on SD or wanting to enable others to do so.

Keywords

Interdisciplinary teamwork on sustainable development · Student initiated projects · Grounded theory · Strategies

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1 Introduction

The 2030 Agenda for Sustainable Development includes global goals, such as ending poverty and hunger, protecting the planet from degradation, securing prosperity and fostering peace as well as global partnership (UN 2015). Due to their complexity, these problems cannot be solved within one discipline (Schmidt 2008). Instead, in order to achieve a holistic understanding and find solutions to these complex issues, sustainability and interdisciplinarity need to be combined (Blake et al. 2013; Newell 2007; Leal Filho 2010). However, interdisciplinary teamwork exhibits a large potential for conflicts and in practice most collaborations fail (Kezar 2005). Interdisciplinary teams experience difficulties in communication, disagreements on common goals, inappropriate expectations, and underestimation of collaborative work (Letterman and Dugan 2004; Rogers et al. 2005; Repko 2008; Epstein 2005). Hence, interdisciplinary teamwork is highly vulnerable and there is a need to identify strategies to overcome or prevent these conflicts. Currently, most research on interdisciplinarity focuses on medical or social workers' teams. Therefore, there is a lack of research on adequate strategies regarding interdisciplinary teamwork in the area of sustainable development (SD).

Higher Education Institutions (HEIs) were identified to be important players in the transition towards SD of the society (Hoover and Harder 2015). Universities train and develop future members of society, potential leaders and decision makers while simultaneously informing public policy and contributing to regional SD (Ferrer-Balas et al. 2009). Furthermore, universities facilitate innovation and research on SD and thereby achieving a better understanding of SD (Escrigas 2012).

Student initiated projects (SIPs) play an essential role in transforming universities towards SD (Barth 2013; Drupp et al. 2012; Spira 2012). They function as 'boundary agents', innovators and creators of social and institutional learning spaces (Drupp et al. 2012). SIPs are characterized to be highly committed and passionate about SD (Drupp et al. 2012; Spira 2012). By attracting other students and staff members to take action, they even serve as multipliers for SD (Barth 2013; Spira 2012). Not only do they successfully change universities but also communities and regions (Block et al. 2016; Drupp et al. 2012; Spira 2012).

This paper presents the top ten strategies for an effective interdisciplinary teamwork based on expert interviews describing experiences in SIPs providing a tool for stakeholders to design tomorrow's campuses and put society on the path towards SD.

2 Method

The data was collected using grounded theory methodology (GTM), as described in Strauss and Corbin (1990), with the aim of constructing of a theory on interdisciplinary teamwork. This paper uses a subsample of that data, focusing on the context

of interdisciplinary teamwork by SIPs on SD. Half structured expert interviews were conducted in order to benefit from implicit and explicit knowledge of experts with extensive experience in interdisciplinary teamwork (Riley 1996).

Six experts were selected using theoretical sampling (i.e., selected specifically because they present diverse disciplines and project types). The sample consists of two women and four men. All interviewees are between the ages of 23 and 34 years (*mean* = 27.8 years, *standard deviation* = 3.6). The interview length has an average of 35 min (*standard deviation* = 13 min). All interviews are based on a guideline with the following open questions (expanded with checklist regarding key topics):

- *Can you tell us about your experience with interdisciplinarity?*
- *What was helpful and what was not?*
- *In reflection, what is your conclusion?*

This interview guideline was constructed using the SPSS-method (Helfferich 2011) and was continuously adapted to the process as required by Strauss and Corbin (1990). Since there is no agreed-upon definition of interdisciplinarity (Klein 2010) the authors chose to give the interviewees full scope. All interviews were recorded by permission of interviewees and transcribed following the simple transcription guidelines by Dresing et al. (2015).

To analyze and interpret the data constant comparison was used. To maximize theoretical sensitivity the authors repeatedly reflected on previous knowledge and related research of interdisciplinarity (Strauss and Corbin 1990). Firstly, open coding was achieved by deconstructing each interview sentence by sentence thereby identifying concepts and categories. Secondly, axial coding was used to identify relations of concepts and predefined categories. Codes were sorted into the paradigm of structuring the phenomena: strategies, causes, consequences, contexts and intervening conditions. Thirdly, selective coding led to several key categories (Flick 2009). In line with the research question this paper singularly focusses on the findings of beneficial strategies in interdisciplinary teamwork on SD.

3 Findings in Discussion

In this section, the top ten strategies, as identified by the authors, are presented and discussed. They were selected according to the frequency of occurrence and the interviewees' elaboration. Since dealing with (potential) conflict is the key category in beneficial strategies all following strategies apply to that.

Regarding the phenomena of interdisciplinary teamwork on SD we also identified causes, consequences, contexts, intervening conditions and more strategies. In regard to our primary focus we only present a short overview. Causes are mainly an individual motivation, an existing network and an identified need for interdisciplinary teamwork within the chosen subject. The context of interdisciplinary

teamwork on SD depends on the diversity within the team, the research and higher education institution and the societal culture. Intervening conditions are e.g. institutional characteristics; individual traits, attitudes and experiences; characteristics of the subject and the team. Interdisciplinary teamwork on SD leads to individual, team- and project-related outcomes, like an increase of knowledge, change of work behaviors and multiplier effects.

4 Strategy 1: Find a Common Ground on SD

The strategy 'Finding a common ground' was mentioned repeatedly. The interviewees described taking some time at the beginning of the teamwork to identify common ideas, aims and theories regarding sustainability. One interviewee pointed out that missing this step resulted in tremendous conflicts over and over again. Further, another interviewee suggested determining a uniform topic regarding SD that interests all team members and includes disciplinary perspectives from everyone involved. Thereby, participants should aim at achieving a shared understanding of SD. One interviewee working on resource-induced conflicts recommended focusing on the mutual problem instead of problems within the disciplines. This had helped to gain a holistic comprehension of the problem. The shared understanding of SD functions as a reference point that everyone has agreed upon.

Similarly, in the literature of interdisciplinarity, finding a common ground is identified as precondition for discovering possible linkages and integrating knowledge (Newell 2007; Oberg 2009; Repko 2007). Likewise, Epstein (2005) and Nancarrow et al. (2013) also point out the importance of the determination of common visions and goals. Especially interdisciplinary teams on SD need a common ground, since sustainability is rather an ill-defined concept without an agreed-upon definition by natural and social scientists (Phillis and Andriantiatsaholiniaina 2001). In line with Sternberg (2008) one should put global problems before the monodisciplinary tools to fully explore problems in an interdisciplinary way. Following this advice interdisciplinary teams on SD should first ensure to find a common ground concerning their concept of SD and the pressing issues.

5 Strategy 2: Invest a Lot of Time

One important factor of beneficial interdisciplinary teamwork on SD is time. All of the interviewees focused on this. They emphasized that the initial period of the interdisciplinary teamwork was crucial for the entire process. One interviewee deliberately planned an entire weekend abroad to have enough time to get to know everyone involved. Generally, repeatedly discussing and reflecting on perspectives and positions on SD takes time, as well as exchanging ideas experiences, and negotiating a common ground (see strategy 1). Additionally, free time slots

motivate team members to freely express ideas, understand ones' perspectives and ignite new solutions for SD.

In line with these findings, Nancarrow et al. (2013) also identified having enough time as a key characteristic for good interdisciplinary teamwork. Spending time together is a foundation for building a common ground including a collective communication (Thompson 2009). In line with Letterman and Dugan (2004) as well as Wentworth and Davis (2002) you should be aware of additional work that comes with interdisciplinary collaboration beforehand.

6 Strategy 3: Adapt Professional Language

In different professional languages and terminologies, identical words, like sustainability, can have various meanings. Communication difficulties were often mentioned in the interviews. An interviewee recommended developing a common language for the interdisciplinary teamwork. One group even invented new terms to bind together otherwise loose concepts, which its members were dealing with. Another interviewee told us to adapt professional language by drastically simplifying concepts or even explaining them slightly incorrectly because of simplification. Moreover, the usage of colloquial speech and a reduction of speed were highly recommended. Especially in sustainability, disciplines use the same terms but mean something entirely different. This results in interdisciplinary misunderstandings.

SD has different approaches with different meanings (Hopewood et al. 2005). In the literature, too, language and terminology differences between disciplines have been identified as fundamental barriers to interdisciplinarity (Brewer 1999; Jeffrey 2003; Repko 2008). Since each discipline has its own patterns, meanings, knowledge traditions, and code of conduct (Frost and Jean 2003), adapting the use of professional language is crucial throughout the entire teamwork. Language adjustment was found to be topic competency in interdisciplinary collaboration (Brandstädter and Sonntag 2016). Especially in interdisciplinary teamwork on SD, one should adapt the use of professional language regarding monodisciplinary concepts on SD.

7 Strategy 4: Educate Yourself

One major requirement of successful interdisciplinary teamwork on SD is self-study. The interviewees emphasized the importance of knowledge of the basics in the foreign discipline as well as general knowledge of the SD related topic. One interviewee pointed out that every team members' knowledge regarding all aspects of a certain topic of SD is limited. Hence, members should individually ensure sufficient knowledge. Understanding the other disciplines' way of thinking and methods enhances options to create common ground by identifying academic

linkages (see strategy 1). Several interviewees reported having read scientific articles and books of the foreign disciplines to prepare oneself for the next meeting or used them during meetings. Also common inquiry of new information during a meeting was recommended. Two interviewees indicated that one should keep in mind that one can only become an informed amateur. Still, self-study was described as helpful in preventing conflicts within the interdisciplinary team.

Lattuca et al. (2013) define the awareness of disciplinarity and the appreciation of disciplinary perspectives as key factors of interdisciplinary competence enhancing interdisciplinary teamwork. The authors go a step further, not only recommending to be aware of different disciplines and appreciating them, but also conducting self-education in them. Similarly, Klein (2005) describes the willingness to learn as a requirement to interdisciplinarity. This is also found by Brandstädter and Sonntag (2016). They include a willingness to learn and a general curiosity as a special competence for interdisciplinary collaboration.

8 Strategy 5: Share Your Knowledge

While working in an interdisciplinary team on SD the share of knowledge is crucial for success. This includes knowledge regarding non-disciplinary insights to sustainability, discipline-based knowledge on sustainability as well as practical skills and experiences. One interviewee stressed that intensely contributing helps the group to build groundwork to evolve from. This opens up new avenues for the group to integrate knowledge throughout the disciplines. Proactively providing information is important, since coming from other disciplinary background, most members are unaware of others' expertise. Again, communication and information accumulation is the only way to put knowledge to use. One interviewee reported that using presentations is a good way to share expertise and explain ideas. Moreover, improvisation with shared disciplinary content might lead to innovative solutions. As a side effect, another interviewee felt an increase in his confidence after having, for the first time ever, experienced himself as a disciplinary expert in his scientific field.

In the literature, sharing and discussing knowledge is necessary since shared team members' mental representation of knowledge leads to better team performances (Mohammed and Dumville 2001). The more knowledge is available to members of a team the more ideas that team can generate (Nijstad and Stroebe 2006). Diverse teams with access to diverse knowledge are highly associated with innovation (Harrison and Klein 2007). Especially aiming to put the diversity in disciplines to use, interdisciplinary teams on SD depend on input by all disciplines involved in order to integrate knowledge. Additionally, supporting the beneficial character of deliberate knowledge exchanges, there is evidence that students' perceptions of their own professional competency and autonomy improved after working with other disciplines (Goelen et al. 2006; Cusack et al. 2012).

9 Strategy 6: Build a Friendship

Having a good relationship was described to be fundamental to successful teamwork. The interviewees even encouraged having a friendship. According to them being friends with a shared passion leads to a better and more respectful way of communication (see strategy 3 and 7). One interviewee stressed that talking in an informal and friendly manner facilitates the discovery common ground (see strategy 1). Moreover, another interviewee pointed out that a feeling of companionship functions as a motivator, driving power and a support to overcome discipline-based conflict. Further, friendship prevented team members from taking discipline-based critics personally (see strategy 9). All in all, the interviewees emphasized trust and mutual respect as key factors of working effectively as an interdisciplinary team on SD.

Friendship has a positive effect on group task performance (Chung 2015) and correlates with trust (Warris and Rafique 2009). Even though disciplines have different views on trust (Rousseau et al. 1998) it was found to be supportive to build collective communication competence in interdisciplinary teams (Thompson 2009). It is strengthened through informal contact, especially in the initial phase (Nancarrow et al. 2013; Thompson 2009; Sias and Cahill 1998).

10 Strategy 7: Take a Step Back and Be Patient

At some point most of the interviewees reported how important it is to take a step back and to reflect the interdisciplinary team process, especially during discussions. One interviewee described having been offended by harsh and arrogant behavior of a team member from a foreign discipline. He tried to stay calm to avoid conflict. Similarly, another interviewee recognized incorrect use of information in a discussion. To enhance mutual understanding she did not point out the mistake but carefully expressed her view on the topic instead. Someone else described a heated discussion about personal beliefs on SD. Everyone took some time for oneself. In each case, the situation could be resolved with patience by all team members and their wish to continue their work, albeit, with a compromise. They all recommended taking a step back to refocus on common visions and goals regarding SD (see strategy 1).

Brandstädter and Sonntag (2016) identified self-reflection, process reflection and the willingness to compromise as key competencies in interdisciplinary collaboration. In the special case of interdisciplinary teamwork on SD it is important to repeatedly reflect ones view on SD and compromise on joint strategies. Feeling superior to another discipline is also known in the literature and is called profession-centrism (Pecukonis et al. 2008).

11 Strategy 8: Design Tasks Besides Discipline-Based Roles

Discipline-based roles are based on behaviors associated with one discipline. Certain competencies, abilities and knowledge are affiliated with one particular discipline. However, the interviewees recommended distancing oneself from designing tasks singularly based on expected discipline-based roles. One interviewee described a situation where one team member had to fight for a creativity task because her disciplines stereotype was to be rather stiff and inflexible. Another interviewee suggested distributing tasks according to interest and experience rather than a disciplinary fit. Switching roles could allow all members to have a holistic view on the project while appreciating all contributions. Moreover, this approach allows every team member to function as a spokesman for the entire group instead of one view of one discipline within the group. Summarizing, one interviewee warned becoming a multidisciplinary instead of an interdisciplinary team, if every single team member stayed within the boundaries of his or her disciplinary field.

Explicitly defining and clarifying roles was found to be a central step for interdisciplinary teams (Nancarrow et al. 2013; Bronstein 2003). Solomon et al. (2003) conclude that students developed an appreciation of the discipline-based roles of others after working in an interdisciplinary team. While the appreciation and clarification of roles was also mentioned by the interviewees, they added the advice to dare leaving anticipated disciplinary boundaries in designing tasks. Correspondingly, research in interdisciplinary social care found that professional stereotypes regarding characteristics and competencies exist and inhibit interdisciplinary collaboration (Cook and Stoecker 2014; Barnes et al. 2000). Consequently, the awareness of individual discipline-based stereotypes allows perceiving a team member holistically and acknowledging expertise besides discipline-based expertise. Hence, designing tasks beyond discipline-based roles supports a holistic appreciation of each individual team member.

12 Strategy 9: Differentiate Between Personal and Disciplinary Conflicts

Most of the interviewees described conflicts within the interdisciplinary teams to have originated in disciplinary differences. In several cases, those conflicts escalated into personal conflicts or conflicts on individual views on SD. Consequently, feeling highly offended, misunderstood, underappreciated team members took a time out or permanently left their team. One interviewee described a discussion of strategies on SD with immensely different positions of team members. Psychologists wanted to focus on individual behaviors, while political scientists demanded structural change accusing the psychologists to be too narrow-minded. Behind these positions are fundamental beliefs, approaches and interests by each discipline.

Hence, the interviewees recommended differentiating between personal and disciplinary conflicts.

The positive effect of the strategy of differentiation between the person and the issue is well known in the literature on negotiation (Olekalns and Adair 2013). With regards to the described interdisciplinary negotiation on SD, this would focus the attention towards the disciplinary conflict while the personal conflict should be dealt with separately. Belonging to a discipline is personal. The own profession was described to be a part of the own identity (Calisle et al. 2004). Therefore, criticism on the own discipline can be seen as personal criticism. Hence, it is difficult to separate personal conflict from disciplinary conflict. However, this paper strongly recommends trying and following strategy 10.

13 Strategy 10: Ask Someone Professional to Moderate Your Meetings

As described in strategy 9, it appears to be rather problematic to differentiate between personal and disciplinary conflicts. Two interviewees reported successfully overcoming this issue by asking someone professional to moderate their meetings. One interviewee pointed out that professional support helped finding common ground (see strategy 1). By asking open-ended questions and follow-up questions while paraphrasing and summarizing the comments for everyone to ponder, a professional moderator functions as an objective group facilitator. The interviewees mentioned two distinct times in the team process to deploy a moderator. First, at the beginning of the team process to support identifying common ground on SD, aims and roles. Second, as a reaction to accruing conflicts to prevent the group from splitting up. Refocusing on mutual aims regarding SD was found to be a key moderation strategy.

Discourse and moderation skills as well as diplomacy and ability to negotiate were found to be essential leadership competencies in interdisciplinary collaboration (Brandstädter and Sonntag 2016). However, not all team members have highly developed competencies in this area. Therefore, a professional moderator should function as a discussion leader.

This paper intended to identify beneficial strategies for interdisciplinary teamwork on SD by learning from SIPs in order to give advice on designing tomorrow's campus. Several strategies confirm recent findings on interdisciplinary teamwork. Especially the strategies finding common ground, investing a lot of time and adapting ones use of professional language are in line with latest research (Newell 2007; Oberg 2009; Repko 2007; Nancarrow et al. 2013). However, the presented strategies additionally focus on SD. Therefore, one should find common ground on ideas, interests and goals in SD, invest a lot time to really understand contrasting discipline-based views on SD, and adapt ones language to enhance each other's understanding of monodisciplinary concepts and research on SD. The findings regarding the other presented strategies extend the literature on interdisciplinarity.

Even though trust between team members was identified as helpful in interdisciplinary teamwork, the authors recommend going one step further by building a friendship. While the importance of reflection on the interdisciplinary team process is described by Brandstädter and Sonntag (2016), the findings of this paper indicate that this might not be enough. Reflection should lead to taking a step back, restrain personal desires and being patient with each other. Sharing knowledge to increase innovation is well known in research of diverse teams (Harrison and Klein 2007). This paper expands these findings to interdisciplinary teams on SD. Regarding the design of tasks within the teams the findings indicate that just focusing on the clarification of discipline-based roles as suggested by Nancarrow et al. (2013) and Bronstein (2003) might be harmful. To support a holistic view beyond discipline-based stereotypes on each team member one should design tasks including expertise and experiences besides disciplinary roles. Moreover, to differentiate between personal and disciplinary conflict, one should reflect on ones' professional identity and find a view on SD besides common views by ones' monodisciplinary scientific community. Additionally to putting moderation skills within the team to use (Brandstädter and Sonntag 2016), the findings of this research suggest asking someone professional outside the group to moderate ones' meetings.

This research has several limitations. The data consisted of the experience of SIPs that reached a point of success. Experiences of entirely failed interdisciplinary SIPs on SD could be a beneficial addition. Another limitation is that the authors could not reach theoretical saturation. Therefore, additional interviews are needed. Especially, including non-SIPs projects would reach a holistic view on interdisciplinary teamwork on SD. The qualitative findings should be confirmed by quantitative research.

14 Conclusion

This paper presents groundwork of an effective interdisciplinary teamwork on SD, by learning from experiences of SIPs. Apart from finding common ground, it is crucial to invest time and patience, adapt professional languages, share information and educate oneself, built friendships, differentiate between the person and the discipline and deploy a professional moderator. These ten strategies can both benefit interdisciplinary teamwork in HEIs and interdisciplinary teamwork in the field of SD. A functioning interdisciplinary teamwork is necessary to develop interdisciplinary solutions for the Agenda 2030 for SD. This paper calls on tomorrow's campuses to take on the challenge of SD by implementing interdisciplinary teams following these guidelines and thereby dealing with its vulnerability.

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The Will and the Skill in Education for Sustainability

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Abstract

Sustainability is possibly the biggest critique that fashion education has ever known. By its nature connecting a vast range of disciplines, fashion explores technical, philosophical, artistic and economic parameters within and beyond its material dimensions and might therefore challenge a broad range of societal practices. Design education more broadly, as with industry, is steadily taking on bold language around sustainability, but this is not always matched with deep change in disciplinary practice. Whilst new skills for sustainability are increasingly being endorsed as crucial for graduate employability by business and governmental agendas, those needed to shape a radically new kind of future are often poorly defined. This paper outlines research into ways in which the educational space might negotiate the needs of the present with the future using evidence from an academia-business collaboration. It explores fashion's potential to inform sustainability practice in relation to and beyond fashion education using analysis of participant interviews, curriculum creation and participant feedback to navigate relevant knowledge and values and their recognition in academic terms. It involves actors from a diverse student body, teaching staff and business practitioners. It will be of value to those interested in the transformation of education through sustainability, referencing a range of change levels identified through the research.

Keywords

Education · Transformation · Sustainability · Agency · Design for sustainability · Co-creation · Exchange

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1 Introduction

> Achieving sustainable development requires a change in the way we think and act (UNESCO 2012).

The imperative of sustainability has offered an urgent, yet widely ignored call for action on the part of governments, businesses, educators, learners, citizens and other spheres of humanity. Against this backdrop, collaboration between academia and business is increasingly acknowledged as an explorative space to realise present and future necessities and possibilities. This paper explores how transformation and education as sustainability (Sterling 2001) might be formed through a combination of teaching and learning the *skills* that inform restorative action and the *will* that enables it through values-led enquiry. These findings have been drawn from research conducted as part of a five-year partnership between the London College of Fashion (LCF)[1] and the Kering group.[2] The aim of this partnership is to explore and identify new ways to 'empower imagination'[3] through sustainability and fashion, and consists of 4 intertwining strands; annual public talks, student mentoring and awards, co-created curriculum at master's level and a research project. This paper focuses on the first phase of research and curriculum development and is made up of 5 parts:

(1) A framing of this academia-business collaboration;
(2) An overview of emerging themes around sustainability actions;
(3) The prototyping of a scales of transformation assessment model;
(4) The creating of conditions for sustainability to be enacted;
(5) Conclusions and recommendations for designing tomorrow's campus.

The emergence of transformation design in industry and academia includes the ambition to proactively transform systems and organisations themselves (Burns et al. 2004). Applying this as a process of transformative learning, according to Cranton means 'the revision of previously unquestioned perspectives and assumptions based on critical reflection and critical self-reflection, leading to more open, permeable and better justified perspectives' (quoted in Landgren and Pasricha 2015, p. 189). However, in universities and businesses, questioning systems whilst working inside them is increasingly at odds with the speed of information flow and expectations of time poor students, tutors and businesses. If the ambition is to cultivate 'minds capable of creating new possibilities' (Stern 2006), this means not

[1]London College of Fashion is a leading global provider of fashion education at undergraduate and postgraduate level, as well as offering short courses, study abroad courses and integrated masters.

[2]Kering is a world leader in apparel and accessories, developing powerful brands across Luxury and Sport and Lifestyle. The Kering brands include Stella McCartney, Alexander McQueen, Brioni, Gucci, Bottega Venetta, Balenciaga, Christopher Kane and Puma.

[3]In terms of sustainability, 'empowering imagination' means spurring innovation with processes and products that have more positive social and environmental impact, while ensuring designers and brands stay true to their own identity and values. This term is used by Kering in their public communication.

just learning through education, it requires learning *within* educational systems (Jones et al. 2010), and it requires learning within business systems as well. Designing tomorrow's campus is about transforming student learning and our own learning as educators, businesses and citizens. It must also include a revision of assessment techniques and what we recognize as success. The acquisition of knowledge, applied as action is often visible, public, tangible and recognizable, it can build confidence and momentum. Consideration of perspectives and the application of values is often private, intangible and less easily quantifiable, whilst critical in moving from a remedial to a transformative position. Through this paper, we propose a triangulation between a model for curriculum content creation, conditions for teaching and learning and a prototype tool for assessment with the measuring of change over time.

Research was undertaken using Grounded Theory techniques through a series of 9 semi-structured interviews with academic, industry and student representatives. Transcripts of interviews were analysed to identify sustainability actions taking place within the organisations and their effectiveness as identified by interviewees. These were clustered into emerging significant and crosscutting themes. A Grounded Theory methodology was chosen for its relevance in studying evolving processes, in gaining insight into an emerging field and in analysing qualitative data (Urquhart 2013). Participants were selected as representatives of different degrees of seniority and types of role. The commonality between participants was that each had some involvement in the partnership and some connection to sustainability in their roles. This was supported by a literature review, examination of a prototype course co-created through the partnership. Participants include members of Centre for Sustainable Fashion (CSF), members of Kering's sustainability team and a cross disciplinary team of students from the schools of Design, Business and Communication.

2 Industry-Business Collaboration

There is a much to learn from a close dialogue between ideas in incubation through education, and ideas in application through industrial practice, but care must be taken to acknowledge that some incubator ideas might be rough and unformed, next to the refinement of industrially validated practice. It is essential that the early iterations of unfamiliar ideas be not diminished by their proximity to the polish of business practice. Universities and businesses have increasingly been encouraged to collaborate, stimulated in part by the realization 'within both business and universities, of the central role of universities in providing high-level skills, a world-class research base and a culture of inquiry and innovation' (Wilson 2012, p. 8). In the case of sustainability, it is vital that these skills and research go beyond that recognized within existing operations and short-term goals. Thus, universities might be viewed as knowledge hubs having a more embedded role in society, in order to contribute to its development. There lies a tension however between short

term problem solving and long term generation of new ways of living and being, which affects businesses, students and us all.

The framing of the partnership was based on a premise of benefit in the short, medium and long term, relating to 4 partnership elements. Partners agreed that academia has a role to play as a vital influencer of the practical world but that it must do this without its critical activities being co-opted (Simmonds et al. 2001). Findings from interviews with participants from each of the relevant partner organisations substantiate this approach. Furthermore, we find that to successfully create conditions for change, it is imperative to simultaneously look critically at both industry and education. The first phase of this partnership has solidified the understanding that academia and business must transform themselves and each other.

Our research finds that some sustainability professionals seek to give students an efficient transfer of a body of working practice knowledge regarding sustainability in their discipline. This was reported as motivated by the imperative of sustainability and a lack of such insight in participants' own educational experiences. A corresponding desire was also evidenced in students' requests for case studies and 'ten-point' plan type resources. This desire for quick fixes and efficient knowledge transfer is not however sufficient when dealing with complexity and the ambiguity of the current ever shifting world (Gulwadi 2009; Landgren and Pasricha 2015). For academia and business to investigate deep change requires us as academics and businesses to undertake the same transformative processes that we encourage in our students. As educators, we must balance our responsibilities between a wide range of stakeholders with differing expectations. This involves taking risks, becoming vulnerable and fielding consequences that we cannot as yet predict. This can be an uncomfortable contradiction to the educator's role of preparing students for success and defining detailed workplans or in achieving education or business targets. Through mutual support, the aim is to create conditions for the future to be conceived and created by those who actively participate in its making.

3 Emerging Themes

Organisations often approach sustainability as an iterative process, informed by scientific, economic, cultural and participant related phenomena. By examining the types of sustainability actions and their processes of interaction and development, we may then be in a position to speculate about tomorrow's campus and the ways in which sustainability might be taught, experienced and evolved. Firstly it was necessary to identify the sustainability actions already occurring in academia and industry; thus an analysis was made through interviews to illuminate exemplars of current practice. Whilst limited by the singular representation of each type of organisation, it should be noted that LCF is home to tutors and students from over 150 countries, the largest college in a university of over 17,000 students, and that

Table 1 A précis of sustainability actions identified as taking place in the academic institution and industry organisation, grouped by theme

Actions reported by industry partner	Actions reported by academic partner
Bold vision/desire for innovation and major longer-term changes (not just efficiencies), coming from the top	Encouraging sustainability perspectives, that push boundaries, often surpassing the teacher's own knowledge
	Fostering a knowledge exchange between international students and business
Infrastructure for sharing: collaboration across the group and throughout industry plus outside of business (NGOs, academia, etc.)	Facilitate dialogue across courses and be able to talk about the big picture of teaching to share ideas
Evidence-based decision making rather than the use of emotional or instinctive criteria	Engaging in speculative creative acts—guided by own research assessment
	Standing back—looking holistically at how things fit into the bigger picture
Use mediation/relationship building to bring about change	Designing visions for a sustainable future through research projects of many different scales with different types of partners
Be proactive as a company to make changes that are going to be needed in the future world	Teach students for a future that does not yet exist; encourage outliers
Not a strict hierarchy; flow of information up the chain of command as well as down	Supporting knowledge and investigation that comes from the students, as well as the teacher
	Empower the students to be part of a community, to take ownership

Kering represents 20 world leading fashion companies with studios, offices and stores in over 120 countries with over 37,000 members of staff. Transcripts describe actions taking place in academia and industry and the subjects' assessment of their effectiveness, alongside a range of other related reflections (Table 1).

A second level analysis of the interviews was then carried out by referencing actions against reflections and feedback from the first phase of the co-created masters course. Emerging themes were identified and developed into an initial hypothesis of the crucial factors for consideration in the design of education for and as sustainability. These are listed in Table 2 and discussed in detail below.

3.1 Embracing the Maverick

Analysis of the findings evidences openness to change and being able to identify and champion novel and appropriate ideas before they are more widely recognised. It is however acknowledged that such change-making involves hard to define capabilities such as empathy, negotiation and brokering cross-cultural dialogue. Additionally, it means bold and also careful experimentation, based on an ecological paradigm for fashion. In such a scenario education develops graduates who

Table 2 Emerging themes drawn from an analysis of data gathered from a range of feedback sources

Emerging themes	Summary findings (student feedback, interviews researcher reflections)
Embracing the maverick	Go beyond known and accepted practice and parameters
	Negotiate change-making actions and interactions
	Create cultural consensus
	Take and manage risk
	Make change before it is recognized, be able to link vision, possibility and application
Developing the double helix	Knowledge-led understanding informs decision-making
	Values-inspired commitment leads to active participation
	Measure a new set of skills and capabilities
	Bridge possibility into tangibility
Practical heroes	Create networks, not hierarchies
	Adapt to a changing context by engaging empathic care-taking and risk-taking
	Develop agency for individual and collective action
	Lead from beside, see pattern not parts
	Foster exchange between a diverse cohort
A navigation system	A literacy for sustainability and fashion
	A lens to view systemically, holistically and interdependently
	A companion guide rather than a toolkit
	A system that creates conditions for innovation

are social activators. These individuals see sustainability as an opportunity for their practice to be creative, experimental and based on alternative success measures, whilst being cognisant of the essential aesthetic, viability and feasibility elements involved in fashion's interactions.

3.2 Push/Pull Strategies (the Double Helix)

Two interactive thematic strands emerge through the findings, the push:pull, first described by the author in a previous paper (Williams 2015). Where push offers a knowledge-led understanding of relevant issues in order to make informed decisions, often including tangible, quantifiable elements, which can be assessed. These are often hard-data driven, or scientific in nature, offering tangible guidelines to follow and can drive consensus in practice. The pull is characterised by a values-led exploration of self and ethical considerations in relation to personal, cultural and moral stance, which act as enticements and inspiration based on a system of commitments, beliefs or political stance. Numerous examples of these two strategies were identified in the data along with suggestion that push strategies fail in effectiveness or are limited in their scope without 'pull' counterparts.

3.3 Practical Heroes

A recurring lamentation by students and some industry and academic participants was the lack of exemplars, counterbalanced by other academic participants questioning whether such a 'how to' guide could exist or if it would be effective. There exists a tension between the desire for practical applicable knowledge and values into working solutions and more radical alternatives. Students expressed difficulty in connecting their evolving sustainability principles and values with practice. This might otherwise be identified as a values-action gap, which was particularly evidenced in student submissions of 'manifestos' and 'possibilities', where the latter lacked application of the ambition of the former. It is recognised that the space for students to experiment in practice that bridges knowledge and values is essential to generating practical, risk-taking or heroic examples that might deepen understanding of the matter at hand. New kinds of heroes, role models and leaders might encourage confidence in those who are cautious in exposing unheard of ideas.

3.4 A Navigation System

Significant elements of the data suggest the need for an expansive landscape to be drawn around sustainability as concept and practice, as trade offs and fundamentals. This might provide guidance in teaching and learning which merges skills and capabilities for a contingent world with the most up to date knowledge and a means to start from different places and undertake a range of journeys according to participant skills, time and scope for risk or ambition. Such a navigation system might bridge current contexts with future requirements; 'The future is never a blank space ahead of us; it is littered with what the past has thrown in.' (Willis 2014, p. 153). Whilst a great many toolkits for sustainability exist, the multiple points of intervention in the system, through a range of academic and industry contexts, suggests that the potential for sustainability can only be realised through a multidimensional approach.

A point of consensus found amongst academic participants specifically, was a self-identified role in modifying the use of design in a non-traditional way. Actions identified specifically by industry participants can be summarized into 4 categories:

(1) Breaking sustainability aims and targets into manageable, pragmatic pieces;
(2) Increasing strength in governance and also in company culture;
(3) Data collection and environmental monitoring;
(4) Risk management.

These findings remind us of the differing and similar risks affecting academia and industry and the potential that ideas too risky for one might be tested out in the other. Whilst not generalizable, this qualitative primary research cross-referencing industry, tutor and student identified actions for sustainability within a context

(fashion) represents a range of elements connecting nature, society, education and industry.

4 Scales of Transformation

The ambition of the academia-business partnership in this case is to realise a transformation towards an ecological paradigm in business and education.

> *'Through this, we seek to shape the future of sustainable fashion and the whole industry of apparel and accessories.'* François-Henri Pinault, CEO of Kering

In developing and delivering the course, it became clear that an alternative means of assessment was required, of teaching, learning and of student attainment. Formal assessment criteria in place at the university often lacks flexibility and does not provide a baseline for education for sustainability and change over time. The push-pull or double helix of learning outlined above requires us to quantify knowledge gained alongside skills, capabilities and application of values for sustainability. A system has been piloted to map teaching and learning for sustainability that can be identified through course work through a set of principles developed at CSF (Table 3) to plot change towards transformation (Table 4). In this way, we are able to see relational elements of sustainability against levels of change. Thus we can map where and in what respect change is taking place to better understand strengths and gaps in teaching and learning design for sustainability in fashion curriculum.

CSF has evolved these six pedagogic principles for sustainability education through practice and with reference to UN Economic and Social Council (2011) and other scholars (Sterling 2001; Ryan and Tilbury). These principles have informed a range of the centre's teaching and learning projects over the past five years, (Williams 2013) but without analysis in direct relation to them or against scales of change.

An initial scale of change was developed and tested out by the author and N. Stevenson in 2010 with a range of tutors from across fashion courses and subsequently developed through this current research linking sustainability principles to scales of change. We tested this matrix using examples of student work submitted through this collaboration (Table 4).

In marking submissions along the scale, reference has been made to Sterling's definition of transformative learning, a process that is deeply engaging and changes levels of values and beliefs through a process of realisation and re-cognition (2003, p. 94). Sterling categorises 'hard' system approaches as first order change, 'soft' system approaches as second order change, and whole systems thinking as transformatory or 3rd order change (2003, p. 12). Using a scale to mark what he sees as the 'historic movement from the still dominant modernist paradigm, to the idealist/constructivist position or movement, he points towards the emergent postmodern ecological worldview (2003, p. 90). This construct is also based on

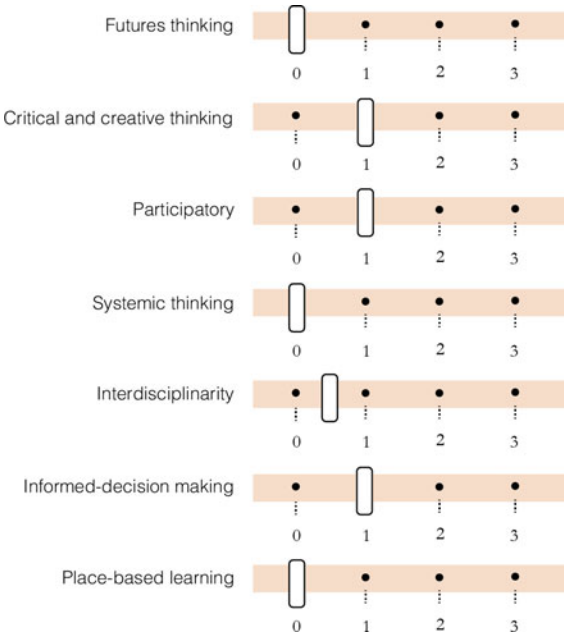
Table 3 CSF pedagogic principles for sustainability

Futures thinking
Futures thinking engages people in imagining preferred visions for the future. It involves exploration of assumptions and of meaningful interpretations of thriving. This process of envisioning futures can lead people to take ownership and responsibility for individual and collective prosperity
Critical and creative thinking and Informed decision making
Critical and creative thinking enables people to explore new ways of thinking and acting. It involves reflective and reflexive processes to better understand how people interrelate with one another and with nature, recognising cultural differences and creating alternative ways to live well together. It relies on informed decision-making through the acquisition of relevant knowledge and data
Participation and participatory learning
The participation and engagement of people is needed to collectively builds sustainability futures. Engaging diverse communities is essential, as they value and include differing knowledge systems and perspectives
Systemic thinking
Thinking systemically is essential to sustainability, as piecemeal approaches have proved not to work—instead resolving one issue while creating other problems. Design for sustainability requires an approach which goes beyond analysis in terms of 'problem-solving' and/or 'cause-effect'
Interdisciplinarity
Diverse partnerships are a motivating force towards change. They enable people and groups to take action, to take part in decision-making processes, and to build capacity. Intercultural and multi-sectoral partnerships can offer critical perspective sharing and foster new thinking and doing.
Place-based learning
Situated learning offers context and roots to place and culture. An education rooted in the physical location as well as cultural concerns brought by participants' home countries must be taken into account in the quest for a relevant ecological literacy in the discipline

Bateson's theory of learning levels (2003, p. 93), echoing Pepper's distinction between reformist and radical environmental approaches (1996, p. 7). Applying these theories into a framework, we piloted an appraisal method for the teaching and learning on this course. The aim was to create a novel quantitative measuring of activity towards transformation and to plot evidence of pedagogic practices in student project work and reflective journals.

Universities are intended to be spaces where paradigms are challenged and new knowledge is generated (Moore 2005b), but this question of how universities can realise this powerful role is much debated. Paradigm shift is defined by Harman as

Table 4 Test Scale, using elements of change as vertical axis and Scale of Change as horizonal axis



'a basic way of perceiving, thinking, valuing, and doing associated with a particular vision of reality' (in Sterling et al. 2010, p. 5). It requires a change in perceptions, values and understanding of reality. It is anticipated that this scale might offer a means to map and identify locations of such change over and beyond the project.

Test Methods

(1) To review best practice pedagogical principles for sustainability;
(2) To define levels of transformation towards an ecological paradigm;
(3) To seek evidence of application of these principles in student work;
(4) To map work on a matrix of principles and transformation scales, to assign a numeric score; and
(5) To set a baseline for the project and develop scale for further application.

For the pilot, this matrix was used to chart each of 8 final group projects developed by students during the co-created course. In order to compare the work, we gave each of the projects a score against each principle ranging from 0–3, corresponding to the order of change, 0 being business as usual sustainability and 3 being work that may mark a radical new context or paradigm.

See Table 4 for an example of the scales generated to assess each project.

In this way projects can be granted an average score, potentially equating to the level of change. This method has enabled us to assess the average level of change and principles evident in the work completed in year 1. This gives a benchmark against which to map change within a cohort and across cohorts over time.

It is important to note that in this method, numbers and scores are used in an abstract sense. In an age of ever-increasing test taking and scoring of teaching in Western and other education systems, our aim is not to develop an additional numeric measurement to rate students and tutors, but more as an instrument by which to capture change in parts and as a whole.

Findings from the first phase of this work show an average numerical score of 0.97. We take this as an early indication that the student work on average is operating in a space of 1st order change. Student projects mainly replaced components in an existing system to make it better, offering singular solutions applicable in the short term in an existing industry context. Some work however, was designed to take on the system itself or to put new systems in place, but, whilst well intentioned in regards to change, most found it too difficult to imagine possibility in a changed paradigm.

Using this matrix to assess manifestation of pedagogic principles in student work offers a useful alternative to established learning criteria. It acts as a baseline for the module and a means to assess transformational characteristics of teaching and learning in the academy and could potentially be applied in industry too. A review of the elements defining the axes as well as a longitudinal study of the module offers the opportunity to mark where and how transformation might take place.

5 Elements and Conditions for Agency

> As we reach heightened modernity, agency is increasingly important and increasingly difficult to achieve. (Giddens 1991).

Analysis made of the emerging themes of this research (Table 2) against the prototype scales of transformation (example in Table 4) suggests that a values-action gap exists between the stated ambitions of participants and the level of change evidenced to date through the project. The next phase of research will involve curriculum design along the lines of the push-pull or double helix approach (Williams 2015, p. 227). This approach seeks to engage the interpretation of knowledge, application of skills and the engagement of a set of values to realize change for sustainability. There is a need however, if we are to consider the future in the now, not only to connect will and skill towards sustainability but also to connect temporal elements of past and present with a sense of the future we want (United Nations 2015). In going beyond the known into a place that does not, as yet exist, we must imagine ourselves in a place of vulnerability and ambiguity. We must then be able to look back to decide actions to take in the now. As the empirical evidence of our research to date shows, some educator and industry participants

seek ways to go beyond the now (Table 1). Yet in contrast to this, some students experienced an impasse between ideas and actions, inclined towards current industry insights and case studies alongside an acknowledgement that it is difficult and uncomfortable to consider new perspectives.

There is, perhaps, a pragmatism and honesty in the students' perspectives. If so, then how might students and their educators, create work that exemplifies their identities and values and is viable for both short and long-term prosperity? For many of these students, the future is a place where risks of failure whilst being in the current system seem too big and their consequences too apparent, 'it is now easier for us to imagine the end of the world than an alternative to capitalism.' (Frederic Jameson cited in Dunne and Raby 2013, p. 2).

> 'To be honest, [the idea of a triple bottom line] is almost paralyzing in my mind. Assuming you could hold all three of these values equally, how can you ever feel confident in a decision you make when there are inevitably consequences somewhere along the line?' LCF Student participant.

The application numbers for the course (oversubscribed by 2 to 1 in the most recent application round) suggest that students seek sustainability in curriculum, borne out in wider studies (HEA 2014), but our findings evidence barriers in students applying agency to take unprecedented action, a shift in paradigm is, as yet, far from sight. Curricula that allows for a better understanding of the interrelationship between learning, identity and agency in (fashion) education might be a catalyst to realize the ambition of transformation in conceptual and practical terms. For until students are able to enact agency, the learning generated will remain unpracticed and change stay unrealized.

The encouragement of autonomous values and actions through a process of critical thinking is at the heart of Western arts educational theory and practice (Biesta and Tedder 2006). Sustainability education situates such ideas within an ecological and social paradigm, with agency as the ability to connect across this wider relational context of self in the world. If we seek to develop such curriculum, students may be more able to apply influence over and to steer the course of their own lives in support of nature and society. Reflection, a catalyst for critical thinking (Gulwadi 2009), has been undertaken in a number of ways through the prototype course, via group online diaries, individual written and verbal responses to key texts and workshop experiences, privately and through group discussion. In an educational environment that is diverse in culture, educational practices and language (over 100 languages are spoken at LCF), it is vital to consider different educational perspectives and their relationship to sustainability. Chinese education for example, based on a Confusionist model, differs greatly from many sustainability approaches such as mutual learning, critical reflection, learning by doing etc. (Iannelli and Huang 2014). It is hoped therefore that the double helix model of values and knowledge being developed through this research can offer on the one hand, a guide-rope of scientific evidence, key texts, case studies and information sets, and on the other hand, a personal reflection and study of values and a range of ways for students to express the results of self reflexive thinking. Only then can we create

increasingly necessary conditions for agency as 'the capacity for actors to critically shape their own responsiveness to problematic situations.' (Embayed and Mische in Biesta and Tedder 2006).

Elements of agency described by Biesta and Tedder have been adapted in response to the research findings from the project to date, to critically consider in the next iteration of the course. The table below outlines parameters for agency developed through this research, drawing on the first year of the project and evidence gathered from the author's longstanding teaching experience.

Agency should not be understood as an individual's capacity, but should always be understood in transactional terms, that is, as a quality of the engagement of actors with temporal-relational contexts of action, that both actor and environment are affected by the 'engagement' (Dewey and Bentley 1949; Biesta and Burbules 2003).

Consequently, in the design of tomorrow's campus, there is a need for an ecological understanding of agency, where we teach and learn through interacting with nature, communities and economic systems across a temporal landscape. This calls for immersive learning, experiential methods and a reflexive process that flows between consideration of self and individual actions and those relating to others (directly and indirectly involved). The agency elements described above might allow us to see challenges as a web of dynamic interactions rather than an insurmountable status quo juggernaut. This opens up the ability for transformation of students, tutors and the world, with the progressive transformation of ourselves (Landgren and Pasricha 2015; Moore 2005a) being perhaps one of the greatest parts of the shift.

6 Concluding Comments

If we are to realize a step change from business-as-usual-sustainability through to acting in an ecologically framed outlook, then we must create and recognize qualities in people and products in relational ways. The double helix education model described in this paper, links knowledge-led aspects of learning about fashion as products, services and business with values-led ones that articulate and realize human dreams and capabilities. When assessed against scales of transformation (Table 4) with sustainability principles on the horizontal line, a range of expansive possibilities might be visualised. The third element of triangulation in developing future campus is developing conditions and processes for the enabling of agency (Table 5) offering the opportunity to apply learnt and novel ideas in society, business and the academy. It is hoped that the elements described through this paper will be applicable to colleagues across sustainability education in a range of disciplines and practices.

> 'Many students come to class saying that they cannot change anything because they are not the boss. By understanding reality as relational and socially constructed and by developing

Table 5 Elements of agency

Considerations	Dimensions	Practice
Temporal	Past (reflective) Present (reflexive) Future (projective)	Backcasting/forecasting exercise Reflection time during sessions Future scenario planning
Composition	Affinity groups	Each student group to include members from each school and range of skills whilst all from with sustainability interests
Configuration	Course timing, content Pace, level	Course placed directly before students Make their decisions about their own masters projects, configuration dependent on flexibility in curriculum
Exchange	Create trusted space Break down hierarchies	Peer to peer exchange, online and face to face, cross course groups
Action	Assessment criteria reflects change towards transformation	Pilot scales of transformation

their ability to question in a critically reflexive way, they realize they can influence situations.' (Cunliffe 2004).

In teaching, assessing and rewarding knowledge-led and values-led achievements, we remove the blinkers that focus solely on job readiness as the accumulation of testable knowledge and expand a scope of reference to include ways of thinking and doing that relate our own values to an interconnected world.

Whilst drawing out emerging themes, scales and conditions for the application of agency, a non-linear approach has been taken. An emphasis on the quality of interaction linking conceptual problem *dissolving* (Ehrenfeld 2009) with practical problem *solving*, has been described as the will and skill of sustainability.

Through this curriculum, parts of (fashion) education are brought together physically, philosophically and pragmatically. In doing so through sustainability, starts to be defined as a new discipline, fashion design for sustainability where fashion is seen as a relational process of human and material interactions grounded in nature and society.

Designing tomorrow's campus is about creating spaces, configurations, compositions and exchanges that invite diversity and experimentation to achieve agency for transformation. In this way, we identify, develop and apply teaching and learning for skills and capabilities that might evolve a new kind of ecologically and ethically literate (fashion) graduate, '*a synthesis of artist, inventor, mechanic, objective economist and evolutionary strategist*' (Buckminster Fuller).

Through a dynamic between the participants, tutors, students and professionals and the practices involved, we have seen an indication that there is scope for jumping out of the comfort zone of small efficiencies or 1st order change, to challenge assumptions about our own and others' usual practice. There are signs too that, if we can guide students to develop the will and the skill to insert a lever into the system in well chosen places, they might create the opening for other ways of

seeing, knowing and doing, and thereby those levers can make for a radical present before our very eyes.

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Professor Dilys Williams FRSA is Director of Centre for Sustainable Fashion, a University of the Arts London Research Centre, which she established in 2008. Dilys' work contributes to the study of fashion as a life well lived within ecological boundaries and practices of human equity. This study is applied to new forms of education, business, public and political engagement. Her place on the London Evening Standard's Progress 1000 list in 2015 and again in 2016 evidences the public and academic influence of her work. Dilys publishes widely on fashion and sustainability in academic journals and published books.

Katelyn Toth-Fejel is an artist, designer and educator. At the Centre for Sustainable Fashion, Katelyn is a research assistant on educational and industry projects. Katelyn is a co-director of the design collective Here Today Here Tomorrow, showcasing different elements of sustainable fashion and accessories such as high quality handmade craftsmanship, durability, localism, recycling, organic materials, individuality, fair trade and transparent production.

Space for Interdisciplinary Collaboration: One Mode of Achieving Social Sustainability at Universities

Kristina Careva and Bojan Baletic

Abstract

Future development of universities should consider all three aspects of sustainable development: environment, society and economy. The aspect of society or social sustainability at universities can be achieved primarily by planning spaces which encourage interaction. Interdisciplinary research which connects experts from various disciplines who are solving numerous global issues of today represents a specific mode of interaction. Interdisciplinarity has recently been actualized to the extent that reputable universities are forming new educational programs, which combine curricula of several faculties. This paper presents the analysis of several architectural works that were designed and erected for the purposes of interdisciplinary research or other interdisciplinary activities. Although at the first glance they seem to be different, detailed analysis of their spatial distinctiveness reveals several architectural features notable for productive interdisciplinary collaboration. The imperative for conceiving and designing buildings for interdisciplinary research has been identified as creation of spaces for multiple levels of collaboration by disposition of the required spaces, i.e. that the character of the established model is primarily functional-social. We believe this paper can be of interest to all of those dealing with social sustainability at universities.

Keywords

Research in art and technology · Campus interdisciplinarity · Social sustainability · Architectural design

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1 Introduction

Research into the sustainable campus of the future examines all three aspects of sustainability: environment; society; and economy. Layering each of these three aspects reveals many sub-themes that are not (yet) uniformly defined by authors dealing with this subject. Interdisciplinary approach represents one of the important themes that cannot be bypassed. It is important for assessing the aspect of social sustainability. However, interdisciplinary skills are also essential for practicing sustainability in general, because sustainable context implies interconnection. Relying on the interpretation of several authors, this theme was illustrated by Rene Lisac (2012) in his work entitled "Guidelines System for University Campuses Sustainable Planning". Crises in today's society and civilization itself indicate that there is a need for gradual, but fundamental social change as a prerequisite for the implementation of sustainable development (Lay 1992). Addressing of this problem, due to the complex image of the environmental impact and interconnectedness of social processes, requires a holistic approach where more disciplines combine their knowledge through interdisciplinary process as a prerequisite for the development of science (Pravdic 1993). Partial and linear solutions for achieving sustainability sought by single branches of sciences have failed, which stressed the need for global initiatives and networked thinking (Strange and Bayley 2008). At university campuses different learning and disciplines form vivid community capable of creating environment for interdisciplinary and comprehensive approach to addressing multiple issues of today, including sustainability. It is a polygon for achieving social sustainability as Stephen McKenzie (2004, p. 23) explains: "a positive condition within communities, and a process within communities that can achieve that condition". Interdisciplinary cooperation at a campus can bring about a qualitative shift in thinking, as a prerequisite for the development of the paradigm.

The topic of the research presented in this paper emerged from an effort to achieve sustainable campus performances within the new Borongaj Campus in Zagreb while it was in its programming phase. University of Zagreb needed a campus design that would ensure the best conditions for sustainability through innovation, bio-consciousness, creativity, interdisciplinarity, knowledge transfer and new educational experiences. In that context, an interdisciplinary approach supporting not only the creation of new teaching methods, but also contributing to the creation of cohesion at a campus, the creation of atmosphere which contributes to the development of green campus ideas and the development of the campus itself. As Elizabeth Dzeng (2013, p. 1) says "a key aspect to achieving interdisciplinarity is through the design of physical and social spaces. Creating spaces where people continuously come into contact with people outside their discipline in natural, casual social settings over and over again, helps develop social networks that eventually become the source of intellectual inspiration and creativity." The University of Zagreb's idea is to develop a creative incubator as a centre for creative research in art and technology on the Borongaj Campus. The planned Centre for Artistic Research as a place for cultural development would provide a new life

quality and diversification of interests at the campus area with predominantly technical and technology-oriented faculties. The Centre should have three main roles: it should become a place of artistic research, then incubation space and, finally, its launch might initiate the creation of new interdisciplinary studies (Centre regulations 2009). The non-conventional Centre was placed in the eastern part of the city on the new Borongaj Campus, and the choice of location aimed at stimulating dynamism and communication on several levels: at the Campus, within the University; and between campus and the city (neighbourhood) population. The role of the Borongaj Campus in revitalizing urban and social transformation of that neighbourhood and its role as a motivator of new ideas and social processes are strongly emphasized by placing the Centre with its non-conventional contents within Borongaj's boundaries. This encouraged the study of spatial configurations that provide the best possible interdisciplinary cooperation, which will be presented in this paper. Given the importance of interdisciplinary collaboration in achieving a sustainable society, this paper focuses on spaces intended for interdisciplinary research into art and technology. The aim of this paper is to discuss the spatial characteristics that support and strengthen those complex interdisciplinary processes.

2 Interdisciplinary Collaboration

Julie Thompson Klein explains that traditional division of knowledge experienced subtle restructuring in the late twentieth century due to a number of causes such as new division of intellectual labor, collaborative research, hybrid fields and "holistic" perspectives (Thompson Klein 1990). Interdisciplinary collaboration is equally interesting for researchers, practitioners and educators. They all use it to either answer complex questions, address broad issues, explore disciplinary and professional relations, solve problems outside the scope of a specific discipline, or achieve the unity of knowledge (Thompson Klein 1990). Because of a wide range of interdisciplinary actors and activities, the subject of interdisciplinarity raises a number of questions and is not always easily explained, but it has become a mantra for change in the twenty-first century (Thompson Klein 1990, 2010).

The interest of this research on interdisciplinarity focuses on collaboration between artists and engineers. The specifics of that relationship are best illustrated by the protagonists themselves. Stefano Boeri, in retrospect of his work, explains interdisciplinarity as a process in which "we should continually seek to circulate information in different formats and to collect a diversity of evidence on one specific condition" (Obrist 2003, p. 107). Positive aspects of interdisciplinary collaborative practices, as Brian Eno says, can be seen in: positive pressure of finishing the work; being put into positions that you would never found yourself in otherwise; and constant need for rebalancing yourself because of landscape changing underneath you (Obrist 2003). Another positive aspect mentioned by Olafur Eliasson is that collaboration with other professions helps to open up

different discourses to engage in matters other than their own formal setup (Obrist 2003). Consecutive thinking of Maurizio Cattelano perceives the human being as an empty box that can't do anything without others (Obrist 2003). This way of thinking is by all means radical but it indicates the fact that every concept evolves better if the opinions are exchanged.

Every collaboration is based on conversation where individuals explain the basic idea and it continues to develop from there. The development of a dialogue between different professions often ends up being more productive because different disciplines do not use the same vocabulary whereas, for example all artists, wind up with a similar language, says Dominique Gonzalez-Foerster (Obrist 2003). Stuart Hall explains his experience of slight but important transition of perception through interdisciplinary dialogue with artists. He points out the importance of moving on a little bit from analytical and conceptual moment towards the knowledge-producing capacities of the creative arts (Obrist 2003). Joseph Grigley explains that, since art and science belong to two very different domains when it comes to expression, the mode of bringing them together in a comprehensive context is not easy (Obrist 2003). That indicates that the same words have different meaning within a different setting. In a group, as Pierre Huyghe points out, "the exchanges are always between the same people, whereas in collaborations, it's occasional: the associations are temporary and more diverse, they disappear and reappear, taking on new forms elsewhere, producing singular solutions" (Obrist 2003, pp. 467–468). It is therefore rewarding to periodically encourage collaborations between individuals of different professions who do not work together on a daily basis. While doing that, it is important to have in mind the "critical group size", as Yona Friedman calls "the limit in order that communication can be made without it becoming deformed" (Obrist 2003, p. 342).

In order to achieve a dialogue between members of different professions there is a need for willingness, but also for space. Sometimes, enthusiastic individuals can find any space suitable for starting a conversation. However, this does not encourage the dialogue but leaves it to chance. People who wished to assist the full development of the interdisciplinary dialogue in art and technology, founded institutions or study programs. Some of them are housed in tailored spaces and this work focuses on those spaces.

3 Interdisciplinary Collaborations in Art and Technology and the Spaces that House Them

Interdisciplinary cooperation in art and technology is not new, but the society has become fully aware of its importance only during the last twenty years. The ideas to institutionalize the interdisciplinary activities developed in the middle of the 20th century because spaces for conversation were lacking from the universities, which focused only on conducting knowledge taxonomy. In the 1980s two reputable and

still active institutions, MIT Media Lab and ZKM Karlsruhe, have been established to shape the impact of new technologies on everyday life. In the 21st century interdisciplinary institutions have been established at universities, recognizing the benefits of blending diverse knowledge.

Products arising from interdisciplinary collaboration in art and technology can enrich human perception in terms of artistic works, as is in the case of ZKM Karlsruhe. Products can be practically applicable and relevant to improving the quality of life as evidenced by the works of the MIT's Media Lab experts. We can begin the research into spatial characteristics of spaces for interdisciplinary collaboration by analyzing these two exceptionally productive institutions. At the first glance, one can conclude that these spaces are neither classical laboratory, nor atelier, nor museum spaces. Interestingly, one can also notice that the premises of those institutions neither look alike nor have any strong similarities (Fig. 1). However, since both institutions deal with interdisciplinary collaboration in art and technology, we will assume that, although the specifics of space for interdisciplinary research are not immediately discernible, one can notice and distinguish those specifics by detailed analysis of important architectural examples. Building a new, typologically innovative space requires substantial financial resources as well as political support, which is why there are not many of erected or even designed architectural examples suitable for this analysis. The two productive interdisciplinary institutions that we have already mentioned were the only ones to create spaces exactly corresponding to their needs and ideas. ZKM Karlsruhe was supposed to be housed in the open competition first prize-winning project by architect Koolhaas but, due to financial constraints, the city abandoned that idea and

Fig. 1 Interiors of ZKM (*left*) and MIT Media Lab (*right*). *Source* the authors

announced a new competition for the conversion of an abandoned WW1 ammunition factory. Schweger and partners won the competition, and ZKM was finally located there (Koolhass and Mau 1997; Menges 1999). MIT Media Lab was at first located in the newly built Wiesner Building by architect Pei, but recently it has been relocated to the Media Arts and Science Building, an extension designed by architect Maki. Media Arts and Science building represents a particularly valuable architectural artefact for this analysis, because the experiences of working inside the first building brought about the design of the second one (Campbell 2009).

A small number of identified examples of buildings for Interdisciplinary Research in Art and Technology pointed out to the need to find additional examples of constructed artefacts. Paying attention not to exceed the framework of this research, only those buildings that were designed, erected and used in order to join diverse contents (art, design, technology, economics, etc.) were chosen. Examining available graphic and textual materials brought three more buildings into focus: Mediatheque Carré d'Art in Nimes, France by Foster; Sendai Mediatheque in Japan by Ito and the Zollverein School of Management and Design in Essen, Germany by Sejima and Nishizawa (Powell 1993; Sakamoto and Ferré 2003; Cecilia and Levene 2008). The idea of introducing two Mediatheques into the analysis resulted from studying "Toyo Ito, Sendai Mediatheque", a book edited by Ron Witte. It says that the project team of the Sendai Mediatheque programme had two references: ZKM in Karlsruhe and Carré d'Art in Nîmes. The ZKM building is referred to as the "German type mediateque" that is … A facility integrating art and information and providing education for media artists… while Carré d'Art, a "French type mediateque", is described as … "A complex containing a museum of contemporary art and a public library" (Witte 2002, p. 83). Carré d'Art, although not an experimental institution building, represents a highly significant building for the city and it is at a very prominent location. By combining a museum and a library it became a significant social element of the city. Zollverein School of Management and Design building is subjected to analysis because it was designed and erected to house an interdisciplinary educational institution, established in 2003 as a business school of creative disciplines. It is a research and educational institution with interdisciplinary educational program that combines corporate management enablement with developing creativity. The basic premise of its teaching is that creative thinking and actions are the key qualifications for understanding the market in today's increasingly complex environment.

4 Implemented Methodology and Research Findings

The objective of this research is the application of the process of architectural design, thus the research is based on comparative analysis of appropriate architectural artefacts. Since the research relies on learning and drawing conclusions from material examples of buildings, the research parameters are selected to

describe function, shape, and construction of each building, all in the context of achieving space that enables and encourages interdisciplinary collaboration (Careva 2012).

The following parameters of analysis were set:

basic information—address, designer, investor, time frame;
basic numerical indicators—plot, building construction, the gross floor area, number of floors, the volume ratio and the sum of the area of all floors;
location—the specifics of the surrounding area essential for the completed spatial concept;
facilities—the institutions, functions, functional units;
spatial concept—architectural thought;
disposition and interrelationship of spaces for different purposes—horizontal and vertical composition of the building, communication systems, space usage;
construction and non-load-bearing walls—flexibility and variability of the interior;
façades—materials and transparency;
equipment—infrastructure and IT.

4.1 Space for Cooperation as an Imperative

The analysis proved that it is essential to ensure the fluidity of social cooperation process by providing spatial organization that enables as many levels of social cohesion as possible. Because of that, the knowledge gained through conducted analysis should primarily be seen in the context of social relationships that take place in the building since the idea of interdisciplinary collaboration is based on encouraging social contact between members of different disciplines (Careva 2012). The interdependence of space and social relationships is well elaborated in book The Language of Space by architect Bryan Lawson who says that … "Before professionalism, the design and creation of space was a more social and vernacular process seamlessly integrated with all other aspects of a culture." (Lawson 2001, p. 3).

4.2 Spaces for Different Purposes and Their Relationship—Reduction of Borders

All analysed architectural artefacts have several functional units and consist of spaces for employees and spaces for occasional users or visitors. Thus, building becomes a testing ground for establishing contacts that could lead to collaboration between employees and visitors. Closeness of different functional units creates an atmosphere which allows potential unexpected encounters. Although the functional units are typically located on different floors, there are enough common areas where

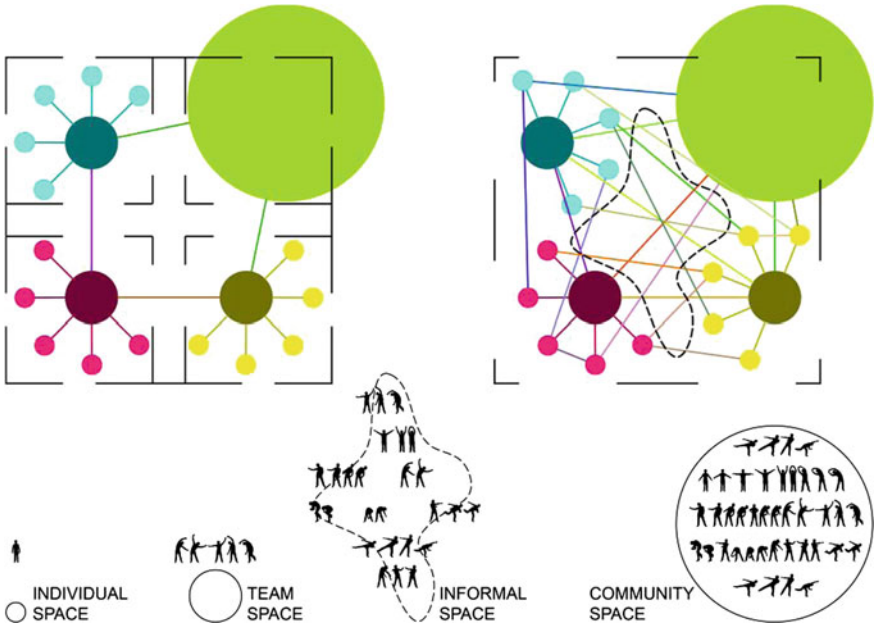

Fig. 2 Diagrammatical representation of cooperation in space—linear or hierarchical (*left*) and cross-linked (*right*). *Source* the authors

the encounters could occur. One must keep in mind that an individual can collaborate with a team, then the team with the community in the building, the community with visitors, and finally, to a small, but inspiring extent, the community with the environment determined by the building's location. In addition to this linear sequence of cooperation, analysed examples show a tendency towards allowing cutting across, or skipping certain links in this linear sequence from individual to the team leading up to the community, the wider community and the urban population (Careva 2012) (Fig. 2).

4.3 Flexibility and Adaptability of the Interiors—New Treatment of Horizontal Communications

High level of spatial flexibility, achieved by using supporting systems of columns and beams, has been detected in all analysed architectural examples. Besides this commonly used supporting system, the Sendai Mediatheque features innovative construction that became its essential feature. Spatial flexibility ensures using the interior both in a common way as well as in new and innovative ways. The analysis has shown that, in all examples, achieved spatial flexibility provides multipurpose spaces (Fig. 3). In some examples, flexibility of space has been accomplished by barrier-free or glass walls freely defining floor layout, thus omitting horizontal

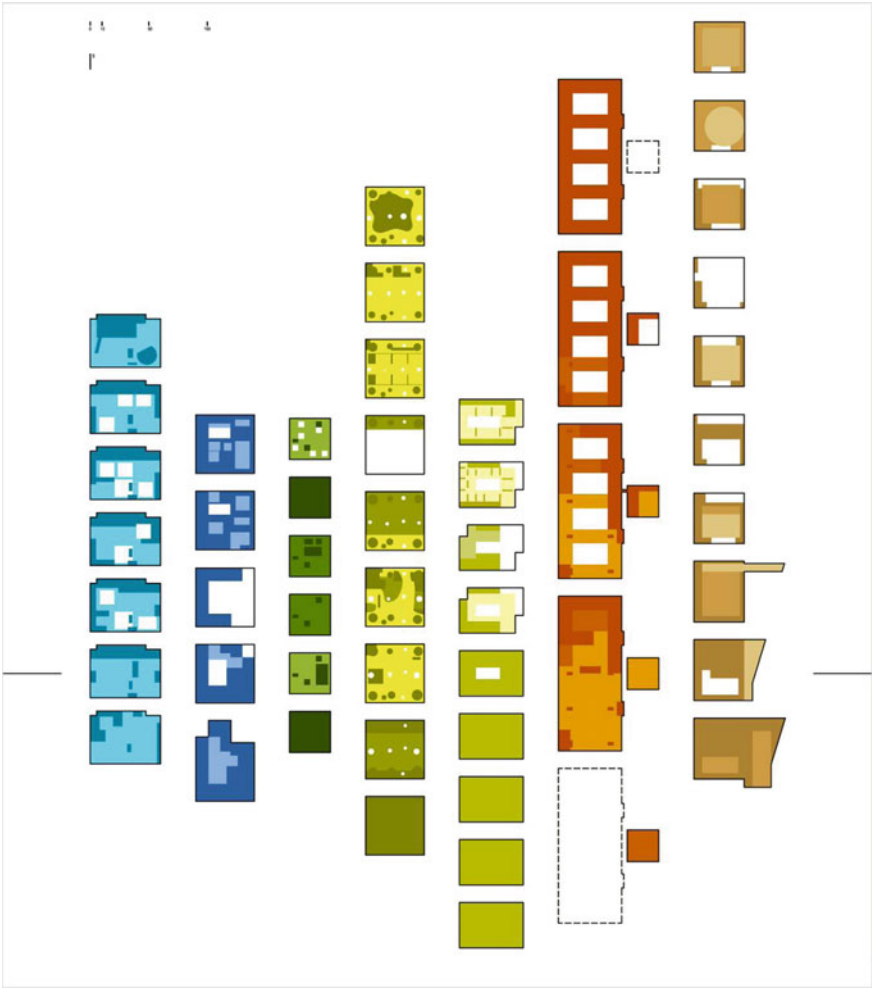

Fig. 3 Analysed examples floor space usage (brighter coloured are spaces for multiple purposes). *Source* the authors

communications. In other examples, horizontal communications are oversized, thus enabling occupants to use this additional functional space freely for informal meetings and gatherings. This non-conventional treatment of horizontal communications emerges from their interdisciplinary nature, namely from creation of new methods of thinking and cooperation in areas of informal meetings. If there is a desire to encourage the occupants to find new methods of thinking, the workspace could be easily reorganized for various modes of cooperation. In Sendai Mediathèque not only the space is flexible and adaptable but even the furniture can be used in many ways and can easily be moved (Careva 2012).

4.4 Spatial Redundancy—Space Higher Than the Required Minimum

The ratio between volume and the total area of all floors in analysed examples ranges from 5.4 to 6.7, which indicates that some of the spaces within a building are higher than the required minimum. This spatial redundancy is present in all analysed examples in one of the two ways: designing one or more empty spaces (voids) within a building; or juxtaposition of different floor heights within a building. Voids allow building occupants to see each other from one floor to the other, and thus the voids become the centre of interest, communication and creativity within the building. This spatial concept of one or more voids within the building is present in the following analysed examples: the two MIT's Media Lab buildings, building Carré d'Art and the conversion of the ammunitions factory into ZKM building (Table 1; Fig. 4). It could be interesting to point out that, in the case of MIT Media Lab, the void from the first building served as a model of good practice and was therefore replicated several times in the new building. The second detected mode, juxtaposition of different floor heights within the building, creates a diversity that allows different usage and different experience of space (Table 2; Fig. 5). The observed spatial redundancy is important also in the context of rapidly changing new technologies widely used in interdisciplinary research (Careva 2012).

Table 1 Calculation of un-built floor surfaces (voids) for MIT Wiesner B., Media Arts and Science B., Carré d'Art, ZKM building. *Source* the authors

floor	*-4*	*-3*	*-2*	*-1*	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*total*
MIT Wiesner														
floor projection				2900	2500	2500	2500	2500						12900
floor surface				2900	2050	1100	2350	2350						10750
void surface				0	450	1400	150	150						2150
void percentage				0	18	56	6	6						17
MIT MASB														
floor projection				2630	2630	2630	2630	2630	2630	2630				18410
floor surface				2630	2630	2100	2270	1960	2200	2630				16420
void surface				0	0	530	360	670	430	0				1990
void percentage				0	0	20	14	25	16	0				11
Carre d' Art														
floor projection	2115	2115	2115	2115	2115	1945	1945	2010	2010					18485
floor surface	2115	2115	2115	2115	1915	1515	1070	1575	1735					16270
void surface	0	0	0	0	200	430	875	435	275					2215
void percentage	0	0	0	0	9	22	45	22	14					12
ZKM														
floor projection					7170	7170	7170	7170						28680
floor surface					7170	5010	5010	5010						22200
void surface					0	2160	2160	2160						6480
void percentage					0	30	30	30						23

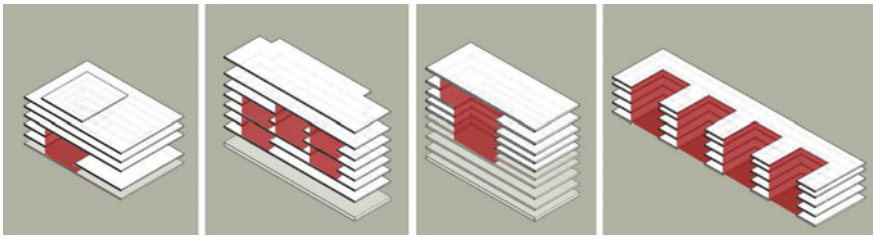

Fig. 4 Representation of voids on reduced intersections of the examples in Table 1. *Source* the authors

Table 2 Calculation of individual floor height and their variation in relation to the ground floor for the Zollverein School, Sendai Mediatheque, ZKM project and extension of ZKM building. *Source* the authors

floor	*-4*	*-3*	*-2*	*-1*	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Zollverein												
entrance floor height				4,55	4,55	4,55	4,55	4,55	4,55			
floor height				3,50	4,55	9,65	4,95	3,45	7,90			
deviation				1,05	0	5,1	0,4	1,1	3,35			
deviation percentage				23	0	112	9	24	74			
Sendai												
entrance floor height			6,6	6,6	6,6	6,6	6,6	6,6	6,6	6,6	6,6	
floor height			4,8	3,3	6,6	3,2	5,2	3,4	4,7	3,9	3,8	
deviation			1,8	3,3	0	3,4	1,4	3,2	1,9	2,7	2,8	
deviation percentage			27	50	0	52	21	48	29	41	42	
ZKM project												
entrance floor height				3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2
floor height				4,15	3,2	14,5	7,1	8,2	2,6	6,2	6	2,6
deviation				0,95	0	11,3	3,9	5	0,6	3	2,8	0,6
deviation percentage				30	0	353	122	156	19	94	88	19
ZKM extension												
entrance floor height				4,75	4,75	4,75						
floor height				2,5	4,75	9,9						
deviation				2,25	0	5,15						
deviation percentage				47	0	108						

4.5 Visual Connection of Space

The analysis demonstrated that it is advisable that the contents of the building are visible and that transparency should be applied both in interior organization as well as in façades. Visual connection of interior spaces is achieved by one or by the combination of the following features: flexible spatial organization; voids; and glass walls. Façades of the majority of analyzed examples, although not of all, are made of glass so that the interiors and the events taking place in them are open to view. One must bear in mind that elimination of intimate workspaces is neither possible

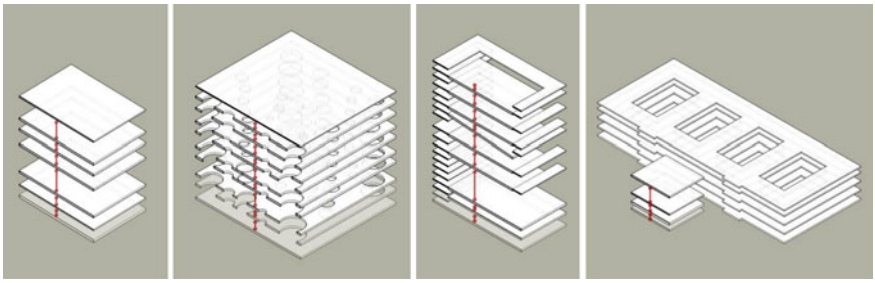

Fig. 5 Representation of slabs on reduced intersections of the examples in Table 2. *Source* the authors

nor advisable, but the borders between them can be less strict. The purpose of visual connection is to terminate spatial separation of an individual from other colleagues, work groups, community and eventually to make interaction between the occupants and passers-by possible (Careva 2012).

4.6 The Impact of New Technologies

Information Technology influences the spatial configuration of a building for interdisciplinary research on three identified levels. The first relates to the personal use of IT, the second to the use of IT in the process that is going on inside the building, and the third in the process of architectural design. As in all buildings for higher education and research, due to personal usage of laptops and mobile phones, people tend to linger in communication spaces, not only pass through them. In analysed architectural artefacts that is visible in the treatment of horizontal communications (either excessive or abolished). Easily reorganized spaces of analysed architectural examples are well equipped with IT thus supporting new teaching and research methods. The use of IT in the design process leads to innovation and the best example in this respect is the innovative construction of Sendai Mediateque which uses both human thinking and robotic precision. This breakthrough design allowed great flexibility of floor layout with novel additional specifics—placing the vertical communications inside the bearing structure which is, furthermore, partly transparent (Careva 2012).

The analysis of designed and built architectural examples intended for interdisciplinary research, or some other form of interdisciplinary activity which takes place in a building, has shown that all relevant architectural examples taken into account have several spatial characteristics in common. Those characteristics include: several functional units; high level of spatial flexibility; informal gathering spaces; spaces higher than the required minimum; and visual connection of spaces. It has been identified that the imperative in conceiving and designing buildings for interdisciplinary research is to create spaces for several levels of collaboration by disposition of required spaces, i.e. that the established model primarily has

functional-social character. In order to ensure fluidity of social processes their design should: provide spaces whose function is not clearly defined; allow spatial flexibility by correct selection of the structure; and achieve transparency and connectivity by selecting appropriate materials, providing easily changeable spatial organization and designing spaces larger than the required minimum. Conclusions of this analysis served for the assessment of architectural design project for future Centre for Artistic Research at the Borongaj Campus and for giving the recommendations for project's improvement. The conclusions can also serve as a starting point for architectural solutions for spaces intended for any kind of interdisciplinary activities.

The established spatial characteristics observed through comparative analyses of buildings for interdisciplinary research in art and technology, should be examined in the context of the spatial organization of a sustainable university campus. Lisac (2012) explains the impact of architectural and urban principles on sustainability. His findings point to the links between several architectural principles presented in this paper and attaining a sustainable campus. Lisac has identified that visual connection of space obtained by transparent surfaces has a positive effect on all three components of sustainability: reducing energy consumption (as one of the important factors of the environmental aspect); improving the life quality in terms of security, enabling contact, experience of the aesthetics of the environment, education and work (the social aspect); a positive impact on community cohesion (social aspect); and cost effectiveness on a global/indirect as well as local/direct level (economic aspect). Another common point is the flexibility and adaptability of space, which in Lisac's opinion also affects all three components of sustainability by: energy consumption and reduction in exploitation of resources in terms of waste production and material consumption (environmental aspect); the achievement of flexibility (social aspect); and all aspects of cost-effectiveness (economic aspect). Finally, an essential quality of the space for interdisciplinary research identified in this paper, space for cooperation, Lisac characterizes as having positive influence on the emotional quality of life by way of creation of space for contact, on the mental quality of life by means of knowledge transfer and on the cohesion of community (social aspect); as well as on economic viability.

5 Conclusion

The university campus of the future needs to bolster sustainability of all of its components—environmental, social and economic. One mode of fostering sustainability on a campus is interdisciplinarity with its special ability to establish the dialogue between various academic cultures. Since every academic field develops specific language and problem solving approaches, engaging those different cultures into dialogue is seldom easy. It is, however, rewarding because interdisciplinary dialogue is necessary for solving today's wider issues. This paper focuses on that specific modus, namely on detecting spatial characteristic of spaces for

interdisiciplinary research in art and technology. The comparative analysis of several architectural artefacts pointed out to several common spatial features important for ensuring the fluidity of social processes, identified as essential in conceiving and designing buildings for interdisciplinary research. Those are: creating space for cooperation as an imperative; reducing or abolishing the boundaries that separate spaces for different purposes; assuring flexibility and adaptability of the interiors; providing higher spaces thus achieving spatial redundancy; and assuring visual connection of space. Creating a space suitable for interdisciplinary research in art and technology is associated with creating a sustainable university campus space. Some of the spatial features detected in this research which enhance progress of interdisciplinary research in art and technology have a positive impact on reducing the energy consumption and usage of resources at campuses. Furthermore, detected spatial features also contribute to improving education and work process as well as safety, making contacts and cohesion of the campus community. Finally, they ensure spatial flexibility, the aesthetics of the environment and economic viability.

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Author Biographies

Assistant Prof. Kristina Careva, Ph.D. M.Arch., is Assistant professor at the University of Zagreb, Faculty of Architecture. She graduated from the same Faculty in 2002. After graduating, she worked in architectural offices in Zagreb and Helsinki. She started working at the University of Zagreb, Faculty of Architecture as a junior research fellow in the autumn of 2004. In 2007 she enrolled in the Doctoral program at the Faculty of Architecture and has defended her doctoral thesis entitled "Architectural model of space for interdisciplinary research in art and technology" in 2012. Kristina Careva has participated in several national and international scientific and professional projects. From 2010 together with Rene Lisac, she is the head of the interdisciplinary program "City Acupuncture" with the emphasis on community participation and social innovations. With "City Acupuncture" she organized and mentored many interdisciplinary workshops. Alone or as a part of a team, she participated in many architectural and urban planning competitions and has won 12 awards so far. She is one of the authors of architectural manuals for children "The Space around me" that won the UIA Architecture & Children Golden Cubes Award in 2014 and was nominated for the award of the 50th Zagreb Salon in 2015.

Prof. Bojan Baletic, Ph.D. M.Arch., is a full professor at the University of Zagreb, Faculty of Architecture. From 2006 to 2014 he served as vice rector for master planning and inter-institutional cooperation at the University of Zagreb. He is the author of the University master plan and was responsible for the development of the new campus areas. He was the editor of the "University and the City" book edition at the University of Zagreb. In 2011 he was a working group coordinator in the International Sustainable Campus Network. He serves as a member of the City of Zagreb Partnership Council. He is a member of the Croatian Academy of Engineering and a member of a number of professional associations.

At the Faculty of Architecture he teaches the Digital Design course. He served twice as the vice dean and was responsible for the curricula reform. From 2005 he was a member of the workgroup for architectural education at the Architectural Council of Europe. He was also a member of the workgroup for education and a member of the workgroup for international relations at the Croatian Chamber of Architects. In 1989 he established the CAD Forum conference in Zagreb and a year later the MediaScape international conference that is still active. Bojan Baletic is also the author of architectural projects and multimedia presentations. He has headed or participated in a number of national and international interdisciplinary research projects. He has published over seventy scientific and professional articles and has been invited to give lectures in Croatia and abroad. In 2005 he received from the University recognition for the promotion of international cooperation in the scientific, artistic and educational field.

Overcoming Traditional Boundaries in Advancing Education for Sustainable Development

Tanya Dahms, Dena W. McMartin and Roger A. Petry

Abstract

Objectives of education for sustainable development (ESD) require interdisciplinary and collaborative approaches to build and sustain momentum, activity, and research. The current study region is characterized by low population density, diverse geography, and extreme climate, requiring that significant challenges are recognized and overcome to respond to opportunities for developing and incorporating ESD in formal and informal educational environments. In response to these and other challenges, the citizens of Saskatchewan (SK) boast the highest per capita rate of volunteerism in Canada and a tradition of institutionalizing progressive social values. Here, we examine how ESD research in SK has been advanced through a multi-stakeholder network, incorporating volunteerism and progressivity. We analyze the establishment of RCE SK through grassroots discussion, its development, and its decentralized, collegial, and democratic structure which transcends barriers to

In memoriam: We dedicate this article to the loving memory of Lyle Benko. Lyle was an educator, consultant and unwavering supporter of education for sustainable development. Lyle was instrumental in founding RCE Saskatchewan and served as its Co-coordinator until his passing in February 2016.

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ESD. The structure of RCE SK provides a basis for non-traditional collaboration, enabling novel interdisciplinary projects, research, educational opportunities, and community service. The model breaks down traditional boundaries and barriers in the region, specifically those associated with academic, community (urban/rural), and cultural divides. The multi-stakeholder, voluntary model enables broad organizational and public engagement, and new forms of scholarship that are reinforced by academic freedom, transparent processes, and broad participation. The outcomes and impacts of specific case studies highlight the ability of RCE SK to rapidly respond to emerging regional opportunities for ESD which require multiple partners.

Keywords
Education for sustainable development · Higher education collaboration · Innovation through volunteerism · Overcoming boundaries · Regional Centre of Expertise

1 Introduction

Regional Centres of Expertise (RCE) on Education for Sustainable Development (ESD) offer a multitude of opportunities for innovative, collaborative, and interdisciplinary research having substantial impact through geopolitically appropriate governance and organizational structures. The research and investigations described in this chapter focus on the impacts and innovations that emerged during the creation and maturation of RCE Saskatchewan (RCE SK) tied to "place based" decision making, a tradition of volunteerism, and a history of communities working together to survive and thrive in isolated, low population density regions defined by extreme weather conditions and climatic effects. Whether Indigenous, settler, or recent citizens, the population of SK includes long-standing traditions of collaboration resulting in capacities for innovation tied to this diverse social fabric. Novel ESD outcomes tied to the formation of new social capital were established as goals with the creation of the RCE SK region and are examined through the narrative of this chapter.

RCE SK is geographically situated within the centre of the Prairies, otherwise known as the Great Plains of Western Canada. The province of Saskatchewan is landlocked and sparsely populated, with a 1.73 capita per km^2 population density and total land area of 651,036 km^2 (Saskatchewan Bureau of Statistics 2015). Despite economic and population growth during the past decade, Saskatchewan is one of the least densely populated regions in Canada (excepting Canada's far north territories) with a history of economic challenges including the recent collapse of global oil prices.

The vast physical distances between rural and urban communities mirrors differences in ideology, wealth distribution, and livelihoods. The economic well-being of urban, rural, and Indigenous/First Nations communities is based on disparate resources and economic activities with varying degrees of economic prosperity. Furthermore, these inequalities are magnified by varying levels of education and educational opportunities among citizen groups.

To address sustainable development challenges in the region, RCE SK has had to confront many of these regional differences. RCE SK sprung from a University of Regina collaborative network in the capital city of SK, Regina. An ad hoc committee of faculty, staff, and students worked across the departmental and perceived status barriers within the University to form the *Sustainable Campus Advisory Group*. Members of this group began the RCE engagement process by connecting with personal contacts in the two largest cities, Saskatoon and Regina, and the town of Craik, already established as a leader in sustainable development, environmental demonstration and educational activities (CSLP 2016).

The subsequent governance structure, network of expansion, project identification and development, coordination and leadership of working groups in theme areas have had a grassroots orientation, evolving organically. A wide diversity of educators, public servants, volunteers, and administrators are engaged at various levels based on their passion, and the support of their respective institutions for ESD.

This diversity of involvement is reflected in the diverse backgrounds and interests of the co-authors of this chapter who are involved with RCE SK for different reasons, each with something different to gain and contribute. Academically, we are a scientist, an engineer, and a philosopher. Personally, we are an activist and movement artist, a community volunteer and history buff, and a political analyst and board game enthusiast. Our motivations for and rewards from involvement differ based not only on our individual concerns about sustainability but also on our discipline-specific training and areas of interest. Our work with RCE SK is the true embodiment of academic goals to integrate teaching, research, and community service. The RCE SK supports a holistic approach towards becoming more integrated scholars and, more generally, people.

The RCE structure provides members with exposure to a diversity of ways to think and value ESD. Through local projects, communities in our region teach us about practical, applied research, new approaches for developing theories in our discipline, and avenues for cooperation, collaboration, and capacity building (University of Regina 2009). These experiences and opportunities enable our ongoing critical evaluation of educational processes, and regionally grounded ways of achieving the goals of ESD.

This chapter provides an assessment and analysis of the barriers RCE SK has encountered, how they have been transcended, and how our projects and activities support ESD goals while engaging the people and communities the RCE serves. The methodological approach to the review and analysis of materials, processes, and outcomes of RCE SK is presented as an organizational case study (Berg 2007, p. 296). Historical norms serve as the baseline for comparing the development and

extension of ESD activity from single institutional approaches to multi-stakeholder engagement, leadership, and cooperative action. We employ a qualitative assessment of the founding and maturation of RCE SK, constructing our narrative from early stage focus group discussions and community engagement activities, impact assessments of RCE achievements, and community involvement and activism in targeted educational projects and programming. Such an approach is challenged by coordinating multiple collaborators and partners in RCE SK to routinely report activities and impacts. However, this constraint is minimized by annual ESD recognition events and annual reporting to the UN University that not only recognize successes and innovations across the RCE, but also act as a method for record keeping and scholarly analysis of its achievements in ESD.

2 Boundaries and Barriers

Although Canada might be viewed as a relatively young country (with confederation in 1867), and Saskatchewan even younger (recognized as a province in 1905), there are deep-seated boundaries and barriers to ESD collaboration and solutions. These challenges include cultural barriers between First Nations communities and those of European descent, geographic barriers between urban and rural citizens, and academic barriers between institutions of Higher Education through competitive governance and funding structures.

Analysis of RCE SK shows that the ideals which support RCE SK along with its intentional design have helped dissolve these boundaries. A collaborative governance structure has been developed that harnesses grassroots experience and knowledge, incorporates academic discovery, and celebrates initiatives and commonly held values related to sustainability.

2.1 Traditions and Cultures

For centuries before European colonization, SK was inhabited by environmentally-integrated nomadic peoples. In the region defined by RCE SK, First Nation ethnicities include the Plains Cree, Assiniboine, Saulteaux, Dene, and Dakota. European explorers first ventured into the region in 1690 and European settlers arrived throughout the 1800s (Ray 1991; Wilson 2007); and thus began the systematic and coordinated oppression and marginalization of First Nations on the Prairies (Daschuk 2014). The Government of Canada established the North West Mounted Police in 1873 in direct response to the Cypress Hills Massacre (when Europeans attacked and killed First Nations over a missing horse) in modern day SK and to generally bring "the rule of law" to the region (Ray 1991; Hildebrandt 2006; Sauchyn 2006). In 1920, that police force became the Royal Canadian Mounted Police now headquartered in Regina (RCMP 2014). By this time, the North West Territories had been divided into the provinces of Manitoba (1870), Saskatchewan (1905) and Alberta (1905).

Rapid changes were forced upon First Nations peoples as the country was established. Early and long-lived government policies of segregation and assimilation (e.g., residential schools program terminated in 1983) and requirements of First Nations peoples to live on reserve lands defined by treaties, created continuing cultural divides. The province has a population of self-identified Indigenous people comprising nearly 16 % of the total population (Statistics Canada 2011a, b).

Saskatchewan shares Canada's role in the systematic disenfranchisement of the values, beliefs, philosophies, and customs associated with Indigenous paradigms. The principle that "the essence of life is movement" (Alfred 2005) was stifled by stagnating people within the confines of imaginary territorial boundaries during the "reservation period" of American history (Battiste 2000). The First Nations understanding of constant deformation, transformation, and restoration of the world (Alfred 2005) reflects the true meaning of sustainability, and it is critical that these ideas resurface into the collective consciousness to truly move forward. As Indigenous voice and vision are reclaimed (Battiste 2000), there is a fine balance to be struck. Any reluctance to share knowledge with institutionalized and other organizations is understandable based on the increasing intellectual property appropriation and infringements on biogenetic resources, traditional lifestyles, and knowledge of Indigenous peoples (Posey and Dutfield 1996). Knowledge is often shared if the values, customs, and principles of First Nations people are honoured and respected.

RCE SK has offered an unbiased, non-governmental opportunity to engage, celebrate and learn with First Nations and non-First Nations communities. This includes the structural incorporation of First Nations University of Canada (FNUniv) as a Higher Education partner of the RCE. Open communication and initial co-coordination of the RCE health thematic by UofR and FNUniv faculty members provided a road to advance this understanding. Health is one of the most frequent RCE themes to emerge in this context, facilitating international collaboration on health issues with common underlying themes.

Per capita, Saskatchewan has a large proportion of traditional knowledge with the potential to transform our understanding of health. RCE SK was invited to participate in a workshop on traditional medicine organized by the United Nations University (UNU) and facilitated by Dr. Barb Frazer at FNUniv, whose work assesses international Indigenous health impacts. Her contributions include working with First Nations to identify strategic ways to infuse Indigenous knowledge, in all its forms, into the provincial science curriculum. This working group also created a place where traditional medicinal knowledge is honored and introduced within biology, health, social studies, and science teachings. These initiatives set the stage for the development of an Indigenized, multidisciplinary, bicultural Medicinal Plants and Culture class in 2014 that incorporates knowledge from elders, and professors from UofR, FNUniv and Wayne State University (Alkholy et al. 2015).

A major challenge of the RCE has been to find opportunities to invite First Nations involvement in the RCE. The 2009 *Spring into Action: At the Intersections of Education, Environment, and Aboriginal Perspectives* conference at the University of Saskatchewan included strong Indigenous participation along with

that of the Saskatchewan Ministry of Education (Barrett et al. 2009). Through this exchange, Indigenous perspectives on sustainability and the environment are being incorporated into mainstream education. A regular RCE recognition event that honours innovative ESD projects has highlighted the efforts of several First Nations groups. The 2013 Recognition Event held in the town of Nipawin provided an important opportunity for the Lieutenant Governor of Saskatchewan and official patron of the RCE to honour First Nations ESD efforts in this northern community at a moment of significant tension between First Nations and non-First Nations peoples. The 2016 Recognition Event was hosted by the File Hills Tribal Council in the community of Fort Qu'Appelle and included First Nations traditions and customs through its theme of "storytelling for sustainable development". In this way the RCE continues to sustain and bridge cultures in the province.

2.2 The Rural-Urban Divide

Saskatchewan has two medium-to-large urban centres (Saskatoon and Regina), several relatively small cities, and a substantial rural population. The traditional agrarian economy, while still a vital component, has become less prominent (Sask Trends Monitor 2013). This shift in economic power and activity has led to increasingly distinct rural and urban lifestyles as well as urban population growth reflecting the shift in economic opportunities from rural to urban. Despite recent growth in rural communities, there remains a gap between rural and urban areas, substantiated by the most recent provincial election in which political party representation was split between the larger urban centres and rural constituencies (Dahms et al. 2010; Dollansky 2007). The need for rural and urban networking was appreciated early in the development of RCE SK as a process vital for its ultimate success. RCE support for emphasizing the sustainability of rural communities among representatives in urban centres (academics, government) was likely strengthened by the rural roots of many Saskatchewan city dwellers and/or their understanding of the role of prairie ecosystems in supporting regional livelihoods.

The original geographic description of RCE SK creates both a physical and virtual link between Regina and Saskatoon and with the town of Craik as its midpoint, following the Louis Riel Trail (Highway 11). This intentional choice symbolizes a bridge not only between geographic boundaries, but also cultural divides by promoting the value of our First Nations and Métis communities in the ongoing success of RCE SK. Louis Riel was a famous Métis leader who helped unite First Nations and European peoples during the founding of Manitoba. The resistance movement he led in the 1880s in Saskatchewan against the federal government advanced his people's rights and their claims to their land, livelihoods, languages, values and customs (Thomas 1982).

The physical location of RCE SK not only surrounds the Louis Riel Trail, but embodies Saskatchewan's "Mid-Lakes" Region and associated ecological bioregions. A Moist Mixed Grassland (Dahms et al. 2008), the ecoregion is bounded by Lake Diefenbaker and Last Mountain Lake. The RCE region expanded due to

participant interest while still following ecological boundaries and livelihood patterns as opposed to political boundaries. Most recently, the RCE region expanded north east as more rural communities have become interested in advancing their sustainability interests. This includes formal membership of regional colleges in this area, specifically Carlton Trail Regional College and Cumberland College. An early RCE goal was the creation of "local centres of expertise" to serve as living laboratories for ESD within the region, materialized through the grassroots creation of ecomuseums. With the assistance of postsecondary, government, and additional RCE partners, these ecomuseums integrate several rural communities to preserve and advance their cultural and ecological assets. In 2013, the *Saskatchewan Ecomuseum Initiative* received a Global RCE Award in Okayama, Japan, for these efforts (Sutter 2013).

2.3 Adversarial Academics

Two universities serve the student needs of the province. The University of Regina (UofR) and the University of Saskatchewan (UofS) were established under a single umbrella as the UofS until 1974. At that time, the Regina Campus successfully lobbied the Provincial government to approve the creation of a second autonomous university with a separate administration. To adequately serve the Saskatchewan population and to optimize resource allocation, each university was intended to have a unique perspective and to offer non-competitive educational options. Historical rivalries between the province's two largest cities, Saskatoon (UofS location) and Regina (UofR location) are analogous to those traditionally held between these two universities. The choice of Saskatoon over Regina as the site for the province's first and only university in 1909 initiated a challenging sequence of events for establishing a second full-fledged, degree-granting university 65 years later.

The UofS flourished rapidly with support from the Government of Saskatchewan and local business, and has housed several Nobel Laureates. In contrast, the UofR struggled to gain official status, especially with its beginnings as a denominational high school of the Methodist Church of Canada in 1911 and subsequently as UofS affiliated junior college in 1925 (Pitsula 2006). Facing the Great Depression of the 1930s and World War II, the UofS controlled provincial funding for both campuses. During the 1960s the Regina Campus became renowned for radicalism and community activism in direct contrast to the UofS that historically strove for political neutrality. The evolution of both campuses served to further distinguish their research and offerings. The struggle for autonomy of the Regina Campus challenged the belief that a single state university was the most effective form of Higher Education delivery for the sparsely populated province (Petry 2004), creating friction between the two universities. The University of Regina officially gained independent status as a full degree-granting institution in 1974. Now the UofS and UofR share provincial government funding allocated based on student enrolment, program type and other equalization factors (Pitsula 2006).

Despite distinct evolutionary paths, the UofS and UofR share a commitment to scholarly independence, which RCE SK has built upon by committing to free scholarly (or investigator driven) inquiry. In this way, shared curiosity and institutional commitments to academic freedom have bridged this historic divide by encouraging faculty, staff, and students to communicate and collaborate on ESD.

The role of RCE SK to allow the expression of academic freedom played a large role in a provincial nuclear debate framed by the government of Saskatchewan as the Uranium Development Partnership (UDP). The UDP report proposed a "value added" scenario for Saskatchewan in the nuclear industry, rolling together uranium mining and enrichment with nuclear power generation and waste disposal. Members of the RCE analyzed and responded to the UDP report based on the major RCE theme areas (Arbuthnott et al. 2009). The issues of public health and public versus private ownership of power generation comprised a theme that would impact rural and urban constituents equally. The RCE report was an inter-postsecondary collaboration of scholarly contributions of active and retired professors from the UofR, UofS, Campion and Luther Colleges (federated to UofR), and Saskatchewan Institute of Applied Science and Technology (SIAST; now Saskatchewan Polytechnic). The RCE, with the best interests of Saskatchewan citizens at heart, had no conflict of interest in making a stand on the issue and was non-threatening to the academic institutions that housed many of the participants. These institutions for political reasons would not have been able to form an official opinion on the issue. The UDP report by the RCE inspired further critical analysis (Dolter and Arbuthnott 2010), and the briefs were made accessible to citizens for their own critical review.

As an independent organization, RCE SK enables academic freedom when universities institutionally may not pursue hot topics, such as the UDP report. Despite contributions from many scholars, no single institution was represented, allowing an independent academic voice to be heard outside official university statements. The RCE critiqued the UDP document that had more to do with a political agenda tied to big business than an energy strategy benefiting Saskatchewan citizens. The public hearings and discussions offered a broad forum for provincial discussion and public education. The UDP hearings gave RCE SK political recognition and a subsequent invitation to participate in committee hearings of the Province's legislative assembly to address the growing energy demands of the province. This new challenge provided an opportunity and forum for further collaborative problem solving to determine the best energy alternatives and processes for implementation, and to broadly disseminate ESD principles.

Saskatchewan Polytechnic (or Sask Polytech), Saskatchewan's network of post-secondary technical institutes, is also a primary partner in RCE SK, representing further collaboration at the level of Higher Education. As with the competition for students and resources between the universities, Sask Polytech represents a third, distinct competitor for precious enrolments and financial resources. At the same time, it, along with its other Higher Education partners in the RCE, has found its own distinct niche of educational offerings and research. Since

the RCE has been facilitating regional sustainability, all of its partners, including those in Higher Education, benefit in relation to their areas of existing educational specialization.

2.3.1 Breaking Down Barriers

The advent of RCE SK has provided many benefits, including those unanticipated through: the development of non-traditional collaborations; the creation of new methods for identifying projects, people, and new sources of information; and new ways of gathering together to celebrate, learn, and share knowledge. RCE SK serves as a lightning rod for the pursuit of several projects and provided space (both physical and intellectual) for several more.

Despite their differences, scholars and other ESD practitioners have come together to share ideas and perspectives tied to common lived experiences of the RCE and local ESD projects. While we often rely on virtual networking in the RCE's governance structure, face-to-face and personal discussions are also key issues for the research process. An important catalyst for these regional discussions is scholarly visitations from other RCEs globally to the region. These have included visits from RCEs as far away as Australia and South East Asia. RCE SK also actively participates in meetings of RCEs in the Americas (having hosted the first Americas conference in 2008) as well as participating in initiatives directed at Americas' RCEs (such as the RCE Grand Rapids annual Virtual Youth Conference).

2.4 Cooperative Colleagues

Among the barriers identified, academic institutional rivalries were addressed early in the RCE. In an academic setting, these barriers are frequently between disciplines, colleges, and faculties, or types of post-secondary institution (e.g., applied technology versus university or college). While these academic barriers were the most recent to have developed historically, they were the first to be addressed by RCE SK in its development. An early and concerted effort was made toward inclusiveness among academic institutions, namely the province's two universities (UofR and UofS) and federated colleges and the provincial technical institute, Sask Polytech. This network has gradually expanded to include the regional college system (credit and non-credit adult education in rural Saskatchewan) as well as the public grade school system. The RCE includes individuals from its respective Higher Education partners on the basis of their interest in ESD and volunteered resources. As such, it enables collaborative research that builds upon this otherwise unavailable regional capacity. Those involved are already self-selected to understand the value of inter-organizational ESD collaboration. A further barrier being transcended is between the K-12 system (kindergarten to grade 12 including elementary and secondary schools) and post-secondary education. An example from 2015 was the first *Student Sustainability Expo* for schools held by the RCE's K-12 working group and hosted by the UofS in Saskatoon (RCE 2015).

By bridging various scholarly divides, tangible results are achieved by this core of individual scholars, students, and staff. Those in administrative positions within the partnering post-secondary institutions increasingly recognize the benefits of this form of cooperation, especially the mutually beneficial support of teaching, research, and community service and the useful blurring of these boundaries with ESD research.

2.5 Valuing Individual Capacities and Differences

The ability of the RCE to build capacity for ESD is, in part, connected to identifying existing capacities within the region. An early project compiled an inventory of ESD projects which was shared internationally to other RCEs, through UNU publications and RCE website communications. From a scholarly perspective, the major resource questions are either intentionally identified by participants or are those that arise when a scholar with a unique disciplinary and theoretical perspective becomes aware of the project. Since projects are classified under different thematic areas but share a common educational motive, participants are exposed to a variety of topics. For example, those involved in education for sustainable infrastructure are presented with educational ideas related to health and healthy lifestyles. In this way, each theme area can provide a source of inspiration and innovation that can be appropriated by projects in other theme areas, leading to further development.

The RCE plays a primary role as a clearinghouse of information and a vehicle for securing resources. Once a project has been developed that advances ESD within the region, other partners can then opt to provide resources for its continuation. For example, the ESD inventory project was initially sponsored by the Provincial Ministry of Environment but continued with funding from the Provincial Ministry of Education. Similarly, private sector partners are available to sponsor projects once they are tested and the risks quantified. For example, with the initial success of the first RCE SK ESD Recognition Event, business sponsors with an interest in ESD (including electricity, natural gas, telephone, and insurance companies) stepped forward to sponsor future events, including the 8th such event in 2016 (RCE Saskatchewan 2016).

The RCE is poised to leverage unanticipated opportunities based on resources and inherent redundant capacity made available by networking multiple organizations. Each organization has its own spare capacities that can be coordinated under the broad rubric of ESD. Interestingly, the broad set of value commitments related to ESD reflect a general citizen interest and engage a critical mass of partners that share these citizen commitments (e.g., governments, state/citizen enterprises, Higher Education organizations funded by citizens, and co-operatives).

Inherently, the networking structure generates a unique set of problems and opportunities. Redundant capacity is structurally built into the RCE, in which many of the working groups have co-coordinators. When one coordinator is unavailable, the other can advance a particular initiative or respond to a particular need.

Ultimately the RCE has highly flexible structures in which groups can meet as needed or remain dormant until a pertinent opportunity presents itself. The flexible structure further enables the RCE to rapidly mobilize, collapsing the time frames that could ordinarily be achieved by individual partners.

RCE leadership must respond flexibly to externally presented opportunities that involve strategic engagement of RCE members and resources; this requires a further paradigm shift. This planning capacity is mobilized to advance the ESD needs of RCE partners and in response to identified opportunities (e.g., a funding opportunity). These structures co-exist alongside the centralized thematic working groups. The willingness of RCE partners to provide resources to a planning body administered by multiple groups ultimately requires a high level of trust between the RCE and participating organizations. This trust has been built through incremental achievements (both large and small) of the RCE that have advanced ESD in the region. Annual celebrations of these successes enable further collaborative risk taking from organizational and individual partners. At the same time, having multiple RCE partners serves to share potentially adverse risks.

3 Conclusions

RCE SK has leveraged grassroots activities by employing a distinct governance structure to bridge populations and communities whose activities and educational projects had suffered from limited collaboration and recognition. This chapter offers an overview of the traditional and historical challenges shaping and challenging the people of SK to develop and share ESD knowledge and experience. Our analysis demonstrates the success and diversity of the RCE's projects, events, and engagement activities, achieved through its virtually and socially networked voluntary membership. There are clear benefits and wide-reaching, longterm ESD transformations resulting from such a multi-stakeholder scholarly network. Our analysis of RCE SK's development and maturation as an organizational case study supports the view that the structure and approaches to ESD employed by the RCE are able to transcend barriers—both historical and current—thereby unlocking substantial potential for ESD innovation. Such potential is comparable to other historic forms of innovation found in earlier scholarly networks (see Petry 2014). The flexible nature of RCE SK has permitted the involvement of interested parties according to their schedules, allowing members to move into and out of projects freely, making involvement with the RCE attractive. The holistic integration of academic rigour with community service has strengthened and lent credibility to the RCE. Through the diversity of its activities, members, and theme areas, as well as flexible commitment options, non-traditional collaborations have been struck that give rise to a significant level of ESD activity in our region.

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Crafting Pedagogical Pathways that Disrupt and Transform Anthropocentric Mindsets of Higher Education Students

Tanja Tillmanns and Charlotte Holland

Abstract

A key challenge in education for sustainable development is in enabling learners to critically review and re-orient anthropocentric (human-centric) perspectives on sustainability. Sustainability challenges are complex and fluid, and demand non-human centric thinking in constructing viable solutions. The purpose of this study was thus to explore how disruptive pedagogical interventions could be used to challenge and transform anthropocentric mindsets of higher education students. The guiding framework for these pedagogical interventions was transformative learning, which translated into exposure to disorienting dilemmas, followed by individual reflection and subsequent engagement in rational discourse on key sustainability themes. A series of 'visual cues' (comprising of disruptive imagery and critical questions) were designed to provoke participants to think more critically about human centric world-views and the interconnectedness, multiplicity and heterogeneity of sustainability. Through the use of Constructivist Grounded Theory, a framework of four conceptual categories emerged, namely, 'Emotional/cognitive disjuncture', 'Recognising principles, practices and themes of sustainability', 'Critiquing concepts and contexts of sustainability' and 'Reorienting dispositions/perspectives for sustainability'. This framework represents key elements within the process of becoming sustainability [re] oriented, and ultimately provided the evidence that the

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disruptive pedagogical framework underpinning these visual cue interventions has been effective in moving learners beyond anthropocentric views of the world, and thus, can be used to support learners in becoming sustainability [re]-oriented.

Keywords
Sustainability education · Transformative learning · Pedagogy of discomfort · Higher education · Anthropocentrism

1 Introduction: Anthropocentrism and Sustainability Education

Anthropocentrism is so deeply embedded in our mindsets that one might associate it with a dimension of the *unconscious*, making it difficult for us to grasp the interconnectedness of the world particularly with respect to non-human actors (Kopnina 2016). According to White (1967), these notions of anthropocentrism combined with dualism in dominating Western worldviews promote the growth of hierarchies, and contribute to narrow perceptions of the world as an assemblage of distinct and disconnected entities (human versus non-human; living versus non-living; built versus natural environment). Anthropocentrism presents particular problems in educating for sustainable development, as a lack of understanding of the relationships between various aspects of reality makes it difficult for learners to comprehend how changes of one element may impact and influence others. In many cases, this is manifest in low levels of understanding by learners of the wider implications of their life choices and practices. Rogers (1994) points to our systematic removal from natural habitats and origins as a key factor in this reduced capacity to recognise the interconnectedness of, and the interdependencies that exist between, people, nature, and planet earth. Rogers (1994) further contends that we tend to assume that our environment is socially created and constructed by humans, and in doing so we easily disregard our roots as natural beings: the corollary to this being the prioritization of human needs and wants over all others. According to Bonnett (2007), these anthropocentric views have resulted in nature being valued as a resource that is owned by human kind and thus one which can be exploited, polluted and manipulated to serve humans needs and more precisely *wants.*

A key challenge in education for sustainable development is in enabling learners to critically review and re-orient these human-centric perspectives on sustainability. Learners need to be engaged in pedagogic interventions that enable them to critique dominant human-centric worldviews and grasp the multiplicity and interconnectedness of sustainability challenges. The known sustainability challenges are complex and fluid, and demand non-human centric thinking in constructing viable solutions. Eernstman and Wals (2013: 1657) argue that: "*ESD* [*Education for*

Sustainable Development] *essentially starts with and revolves around re-embedding SD* [*Sustainable Development*] *in life and the act of living*". The initial step in this process involves enabling learners to recognize and re-orient anthropocentric frames of reference or mindsets. This research study set-out to explore just this—thus, this paper presents an overview and key findings from research on disruptive pedagogical interventions designed to challenge and re-orient anthropocentric frames of mind of students in higher education.

2 Transformative Learning in Higher Education

The process of transforming learners' mind-sets is a significant challenge within any discipline or indeed any level of education. With respect to sustainability education, Sterling and Thomas (2006) suggest that only by rebuilding or redesigning the higher education curricula does the outcome lead to very strong transitions towards sustainability or 'transformations' among students, and to 'wholly integrative' societal change for sustainability. However, rebuilding entire curricula to respond to sustainability is difficult (if not impossible) to implement within established universities. While there is recognition of the need to reorient higher education to become more sustainability oriented, in practice according to Corcoran (2010), the academy shows resistance to change, mainly due to the required change of curricula and pedagogy. At a pragmatic level, it would appear that higher education institutions can at best strive to infuse (build-in) sustainability into courses or programmes of study, in a manner that would enable students to develop those knowledge, skills and values (as outlined by UNESCO 2014) necessary for change agency in sustainability. Within an infused model of education for sustainable development, the theory of transformative learning holds much promise in guiding strong transitions towards sustainability (Sterling 2010).

Transformative learning is a process that enables deep change within learners; learners ultimately re-orient or change their beliefs or values bases to facilitate different worldviews, and act accordingly. Cranton (2006: 19 apud Thomas 2009) outlines that "*transformative learning occurs when people critically examine their habitual expectations*, *revise them*, *and act on the revised point of view*". Transformative learning thus primarily concentrates on the transformation of *problematic* frames of references (Mezirow 2003). Frames of references are '*meaning perspectives*', formed by two dimensions; habits of mind and resulting points of view (Mezirow 2003: 58). The holistic understanding of frames of reference acknowledges its emotional, intuitive and imaginative dimensions and includes: "*sociolinguistic*, *moral ethical*, *learning styles*, *religious*, *psychological and health aesthetic*" dimensions (Mezirow 2009: 93).

According to Mezirow (1991), transformative learning can be facilitated through a process of experiencing disorienting dilemma/s, critical reflection and rational discourse. A disorienting dilemma is a significant stimulus that triggers internal

critique of own meaning perspective, as it causes disruption or disturbance to existing frames of reference (Mezirow 1991). In this regard, Jarvis (2009: 22) highlights that "*all human learning begins with disjuncture—with either an overt question or with a sense of unknowing*". A disjuncture can occur and cause dissonance with the sense, the cognitions and the emotions and can be created within a classroom context as well as in the natural everyday life. Thus, disjuncture can be understood to happen "*whenever harmony between us and our world has been broken, so that the relationship between our present understanding and our experience of the 'now' needs to be established, or re-established*" (Jarvis 2012: 12). Zembylas (2015), writing of the pedagogy of discomfort, further highlights the role of discomforting feelings in challenging dominant habits, beliefs, values, and behaviours. The pedagogy of discomfort is based on the premise that the interplay of emotions and power are essential to the creation of social norms (Boler 1999). Both learners and educators need to be taken out of their emotional comfort zones in order to create the possibility for transformations (Zembylas and McGlynn 2012), such as advancing equity and justice in the field of sustainability education, or encompassing environmental, ecological, intergenerational justice *inter alia* (Parris and Hegtvedt 2014; Kurian and Bartlett 2009).

Once disjuncture, disruption or disorientation has been facilitated, learners can be guided towards deeper examination of pre-existing beliefs, values, and/or dispositions. Disjuncture results in a state of disequilibrium, which can only be resolved through critical reflection and engagement in a sense making process (Piaget 1932). Piaget's theory of cognitive development recognises the state of disequilibrium as an internal imbalance when being confronted with information that requires one to develop new mental schema or modify existing schema in order to return again to a state of equilibrium (Piaget 1932). Equilibrium is a neutral emotional and cognitive state, achieved through giving meaning to, and making sense of, challenging scenarios. In order to resolve this tension with an existing frame/s of reference, learners can be guided within the process of transformative learning towards critical reflection of self and society, through individual reflection and engagement in discourse with peers and others.

3 Disruptive Pedagogy Intervention

From September to November 2014, a research study was undertaken to explore ways in which students' frames of reference could be disrupted and re-oriented towards more critical (non-human centric) examinations of the world we live in. This study comprised interventions with two different groups: twenty-five part-time students (mainly direct entrants from post-primary education) and thirty full-time students (education practitioners and professionals) undertaking an undergraduate education and training degree in a higher education setting.

Three 30-min pedagogic activities were designed, each opening with the presentation of an image and a critical question (referred to as a 'visual cue' heretofore). Each of these visual cues was intended to challenge students into thinking critically about anthropocentric world-views and Western dualisms, and other concepts and contexts of sustainability. The pedagogical design of the visual cue intervention was based on the core elements of transformative learning, namely, disorienting dilemma, critical reflection and rational discourse. The visual cue interventions began with an individual phase in which a disorienting dilemma was presented, that required critical reflection by self. This was followed by a discussion focused phase which entailed paired discussions and a whole group discussion to stimulate engagement in higher order discourse and to challenge existing frames of reference with regards to sustainability.

The visual cues were designed to create disequilibrium within participants' frames of mind; thus, emotional and/or cognitive disjuncture was expected to result from exposure to and/or consideration of unfamiliar contexts or practices connected to sustainability. The selection process of the visual elements was inspired by the pedagogy of discomfort with the aim of choosing images that would be likely to cause dissonance or disorientation. The chosen imagery was used to stimulate and challenge ways of thinking or feeling, within the context of sustainability. The trigger question for each visual cue was crafted to stimulate imaginative, critical thought processes, and to encourage the consideration of differing perspectives. The overall visual cue (combining image with a critical question, addressed to oneself), aimed to provoke thoughts and criticality, and through this, encourage reflective engagement and discourse about the complex and interconnected nature of sustainability.

The chosen visual cues comprised three different scenarios: the first required students to critically consider the context of human tissue or human organ growth on animals, for the benefit of humans—Vacanti visual cue; the second of which asked students to consider the reverse scenario (animal tissue or organ growth on humans, for the benefit of animals)—Horse visual cue; and the third involved students having to critically consider whether they would engage in a particular tribal cultural practice to save vulnerable animal species (in this case, consider whether they would breastfeed a baboon, a cultural practice among the Yanomami tribe in South America)—Baboon visual cue. See Fig. 1.

The sequencing of the visual cue activities was chosen to facilitate a gradual exposure to differing (and arguably increasingly challenging) scenarios, each of which would, in theory, prompt learners to critically reflect on their own perspectives in the context of sustainability. In this regard, a conscious decision was made to begin with what was considered to be the least challenging visual cue (or 'discomforting' visual cue from an emotional perspective), and progress to more challenging visual cues. Through the use of these visual cue interventions, students were expected to engage in examination and criticality of interconnectedness, heterogeneity, multiplicities, interdependencies and complexities within sustainability.

Visual Cue 1	Visual Cue 2	Visual Cue 3
Vacanti visual cue	**Horse visual cue**	**Baboon visual cue**
Description of image: The image shows a mouse with a human ear growing on its back – more commonly known as the Vacanti mouse (Cao et al. 1997), on the shoulder of a young woman.	**Description of image:** The image shows a young man with the legs of a horse.	**Description of image:** The image shows a woman from the Yanomami tribe breastfeeding both a human baby and a baby baboon (Mark Edwards, Hard Rain project).
Trigger Question: *Would you allow a body part to be grown on an animal to improve your appearance?*	**Trigger Question:** *Would you grow an animal body part for the well-being of an animal?*	**Trigger Question:** W*ould you breastfeed a baboon?*
Image accessed from: https://bendinggenre.files.wordpress.com/2013/11/girl-with-ear.jpg	Derivative image only available offline.	Image accessed from: http://www.hardrainproject.com/admin_images/yanomami800.jpg

Fig. 1 Visual cues

4 Research Methodology

A Constructivist Grounded Theory (CGT) approach as outlined by Charmaz (2006) guided this research study. CGT was selected as it is situated within a constructivist-interpretive paradigm that enables "*researchers to remain close to their studied worlds*" (Charmaz 2005: 508), and facilitates the mapping of processes or practices across the data-sets. Furthermore, this method of inquiry is particularly suitable within frontier research domains, such as education for sustainable development, as it enables deep interrogation of processes and scaffolds the evolution of theories grounded in the data-sets. Therefore, in the context of this research, CGT was applied to identify and map pedagogic processes that enable learners to become sustainability [re]oriented.

The research study was guided by the questions:

- What impact do these pedagogic interventions have on participants' frames of reference (thoughts and/or feelings)?
- Which elements of these interventions challenge participants' frames of reference, and to what extent? and,
- To what extent do these interventions enable participants to critically review the self in the context of sustainability?

Participants' perspectives were documented using survey-type research tools that were used to allow students to self-document the extent to which their thoughts or feelings were challenged, and to identify influential elements of the visual cue

activity. Thus, directly after the completion of each activity, participants were asked to complete a reflective tool to explain if and when their ways of thinking or feeling had been challenged while engaged in the activity. Furthermore, the sessions were audio-recorded with the aim of ascertaining the extent to which the cohort of students critically engaged with sustainability theme/s under examination. Upon completion of the three sequential visual cue activities, participants were asked to rate the extent to which each visual cue activity disrupted their emotional and cognitive states when compared with overall activities. The musings in the researcher's reflective diary (critical thoughts on concepts, contexts, processes and practices of the visual cue interventions and research process) were also used to inform the analysis process.

Three coding phases, open, focus and theoretical coding, were deployed in line with Charmaz's (2006) constructivist grounded theory. The analysis began with initial line-by-line open coding of participants' responses, constantly questioning what the data set revealed about the impact of the visual cue activities on participants' thoughts and feelings. The open codes were then were categorised into focus codes. The use of Charmaz's (2006) constant comparison of codes method, while recording detailed memos about the observation of such comparisons, resulted in formation of conceptual categories. For example:

- ***Sample Participant response***: '[*Baboon*] *made me feel uncomfortable*'; ***Open Code***: *Feeling uncomfortable;* ***Focus Code***: *Experiencing Discomfort;* ***Theoretical Code***: *Emotional and Cognitive Disjuncture*
- ***Sample Participant response***: '*I didn't like the image* [*Vacanti mouse*]'; ***Open Code***: *Disliking image;* ***Focus Code***: *Experiencing Dissonance;* ***Theoretical Code***: *Emotional and Cognitive Disjuncture*

Four theoretical codes emerged: *Emotional and cognitive disjuncture*, *Recognising principles*, *practices and themes of sustainability*, *Critiquing concepts and contexts of sustainability and Reorienting disposition/perspectives for sustainability*. These theoretical codes became conceptual categories that formed the basis for continuous theoretical sampling, and ultimately provided the evidence that the disruptive pedagogical framework employed within these visual cue interventions can be used to support learners in becoming sustainability [re]-oriented.

To conclude, a limitation of this study is that none of the selected data collection tools providing data that gave an insight into the extent to which these interventions enable participants to critically review the self in the context of sustainability (third research question). Future research aims to address this by including additional data collection tools in the form of reflective diaries and follow-up interviews for participants. In this way, the role of visual cues in enabling students to critically review the self and become change agents for sustainability can be fully explored.

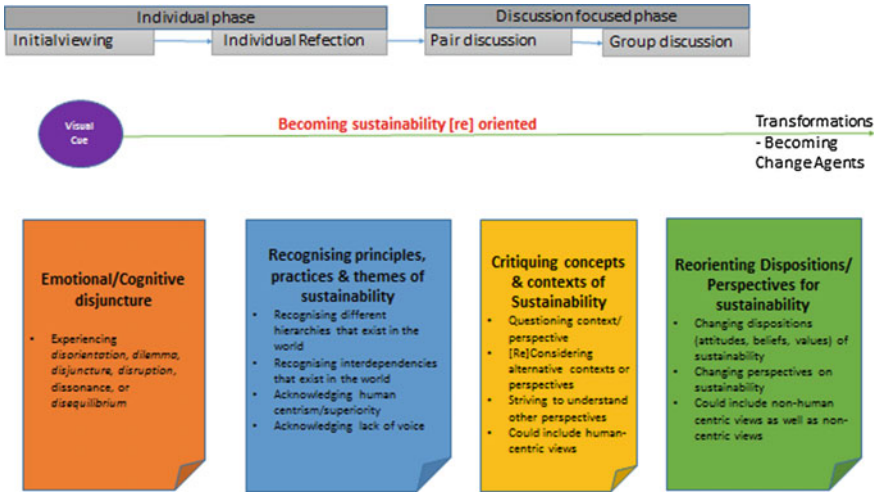

Fig. 2 Pathway to becoming sustainability [re] oriented

5 Discussion of Findings

This study set out to explore ways in which participants' frames of reference could be re-oriented towards more critical (non-human centric) examinations of the world we live in. The findings indicate that the guiding framework of transformative learning (facilitated through a process of exposure to disorienting dilemma/s, critical reflection and rational discourse) was effective in progressing participants towards becoming sustainability-oriented.

As can be seen from Fig. 2, four conceptual categories emerged from this exploratory study, namely, 'Emotional/cognitive disjuncture', 'Recognising principles, practices and themes of sustainability', 'Critiquing concepts and contexts of sustainability' and 'Reorienting dispositions/perspectives for sustainability'. These conceptual categories contain evidence of specific cognitive processes (and emotional states) evoked within those participants who were on the pathway to becoming sustainability oriented/re-oriented. Furthermore, it was evident that those who experienced disjuncture at the outset, were very likely to move into critiquing concepts and contexts of sustainability, and vice versa.

5.1 Emotional and Cognitive Disjuncture

Mezirow (1997) argues that deep reflection can be stimulated through a disorienting dilemma, one that promotes dissonance or dis-satisfaction with an existing meaning structure of a learner. This study has shown that the majority of participants were emotionally and/or cognitively challenged on first sight of and/or individual reflection on the visual cues, with many participants recording strong emotional

and/or cognitive disruption. The Baboon visual cue was rated most disruptive (24 participants rated a high cognitive disruption and 20 participants rated a high emotional disruption), followed by the Vacanti visual cue (14 participants rated a high cognitive disruption and 11 participants rated a high emotional disruption). The Horse visual cue was rated least disruptive (10 participants rated a high cognitive disruption and 9 participants rated a high emotional disruption).

There was evidence that some participants could not rely on their existing frames of reference to make sense of the visual cue under review. Within the Vacanti visual cue, the participants recorded feeling disturbed, weird, and strange, indicating a state of disequilibrium and some discomfort caused by this visual cue. Within the Horse visual cue, amusement and laughter comprised the initial reaction of the majority (indicating unfamiliarity and a sense of disjuncture with the scenario). In the case of the Baboon visual cue, the dominating reaction was of feeling shocked and uncomfortable and of perceiving the cultural practice of breastfeeding baboons as '*sick*' or '*unhygienic*', indicating disjuncture or discomfort with the scenario. These emotional and cognitive reactions of participants are indicative of visual cues being effective as tools to enable disjuncture, discomfort, disequilibrium, and/or as disorienting dilemmas.

There was also evidence that disjuncture (in viewing the visual cue) caused some participants to seek out new frames of reference or alter existing frames of reference in order to be able to give meaning to the stimulus. In the Vacanti visual cue, some participants moved beyond initial reactions of liking or disliking the image, to consider scenarios when it might be okay to engage in the practice (such as to correct facial disfigurements), while others moved into a more critical space (highlighting for example the lack of voice of animals in these scenarios). Similarly, within the Horse visual cue, many participants moved beyond initial laughter to record, in their individual reflections, a willingness to engage in this action for a beloved pet suffering with a disfigurement. This suggests that even at this initial level of viewing and individually reflecting, visual cues can enable participants to gain a foothold on the pathway of becoming sustainability (re-) oriented.

Some participants (relying on existing 'narrow' frames of reference to make sense of the visual cue) were initially 'emotionally' or 'cognitively' blocked from engaging critically in particular visual cue interventions. In the Vacanti visual cue, negative pre-dispositions towards the animal (perceived as a rat) were recorded by many of the participants, which triggered an initial rejection or disliking of the image. Consequently, many students recorded feeling disturbed, weird, strange, disgusted or offended by the animal used, and didn't initially engage critically with the scenario. Similarly, in the Baboon visual cue, one participant noted how personally disliking the image limited her individual reflections on the scenario —'*didn't like the image and felt embarrassed… I was closed minded when it came to my personal reflection*'. Furthermore, within the Baboon visual cue, some participants were blocked by their own narrow cognitive framing of the scenario, thus, they limited their responses to comments like: '*it was the norm there*' and '*would not happen in Western society*', demonstrating low levels of reasoning with the scenario (at the initial stage in this intervention).

It is interesting to note that the discussion-focused phases of all three visual cue activities also provide evidence of emotional or cognitive reactions. Participants commented on being '*surprised*' or '*shocked*' at others' responses. Thus, discussions could also act as a catalyst in creating disjuncture beyond initial viewing and reflecting stages of visual cue interventions.

5.2 Recognising Principles, Practices, Issues and/or Themes of Sustainability

The category of recognising principles, practices, issues and/or themes of sustainability refers to evidence of recognition by participants of different hierarchies that exist in the world; interdependencies that exist in the world; issues of human centrism/superiority, and/or a lack of 'voice' of animals, across the two phases of 'individually viewing and reflecting', and the 'paired and group discussion' of the visual cue interventions. In total, 18 of the 55 participants recognised issues or themes of sustainability; for the majority, the recognition is evident within a single visual cue, with just 4 participants recognising issues or theme of sustainability across two or more visual cues.

In the initial stages of viewing and reflecting on the visual cues, there was very limited evidence that participants had specific knowledge of, or recognised, key principles, practices, issues and/or themes of sustainability. However, in those few cases where it emerged, the participants recognised the issue of superiority of human beings (in the Vacanti and Horse visual cues)—'*Humans think less of other living things*, *we are always most important*'. Furthermore, they recognized that animals don't have a say in what happens to them.

On the other hand, the comments following the paired and group discussions presented much more evidence of recognition of various principles, practices, issues and/or themes of sustainability, such as: Human centrism, Interdependencies, Human Superiority, Western Dualism, etc. After discussion on the Vacanti visual cue, many participants repeatedly acknowledged the lack of voice of the animal and highlighted the cruelty and suffering of animals in this scenario. Participants felt '*sorry*, *sad* or *bad*' for the mistreatment of the animal in this way, recognising that it has no voice to be subjected to this practice. However, only one participant connected to the thematic area of anthropocentrism, or human-centrism, within the Vacanti visual cue, and considered '*humans' attitude to nature* as *selfish and greedy and damaging*'.

Interestingly, after discussion on the next visual cue (Horse), a large number of participants recognised that issue of animals lacking a voice in what happens to them—'*humans can say no and animals can't*', while a few more recognised humans' assumed superiority over other living things—'*we can get an animal to do this for us but wouldn't do it for them*'. Furthermore, a few participants recognised interdependencies that exist in the world, evident through statements reflecting a realisation that '*the ecosystem is effected by human interventions*'. Other participants show awareness that '*upsetting nature will have consequences*' and noted that

they were '*worried and upset with human* [*im*]*print on the planet*'. Similarly, a few participants recognised different hierarchies existing in the world following deliberations on the Baboon visual cue, with one participant further commenting that the tribal woman in the visual cue lives '*in harmony with nature*', and wisely concluding that the '*harmony of human and nature is a sustainable eco-system*'. After discussions of the Baboon visual cue, the majority of participants recognised the interdependencies that exist in the world, with participants connecting to far reaching consequences of our unsustainable ways of living—'*it was us that caused the mother* [*baboon*] *to die*' and '*Western civilisation destroying their future and our own*'. Interestingly, a minority of participants also highlighted Westerners assumed superiority to other cultures when acknowledging that '*we don't think or consider others around the world*'.

5.3 Critiquing Concepts and Contexts of Sustainability

The category of 'critiquing concepts and contexts of sustainability' encompasses the critical engagement of students with the subject matter presented in the respective visual cues. Students questioned contexts or perspectives, (re-) considered alternative contexts or perspectives and/or strove to understand other viewpoints (including human centric views). In total, 28 of the 55 participants critiqued concepts and contexts of sustainability, for the majority critiquing is evident within a single visual cue, with evidence of critiquing within two or more visual cues in just eight participants.

There is limited evidence of participants' critiquing concepts and contexts of sustainability within the initial viewing or reflecting phase. In one or two cases, participants record critical questions on the specific sustainability context—'*Why was she breastfeeding an animal? Is human breast milk enough to keep the baboon nourished? What is the story behind it?*', and make interesting observations about tensions between differing cultural contexts—'*This impacted the way I think in the sense that a woman in Dublin will never have/want to do this. A woman there feels compelled. Animals are her neighbours*'.

There is more evidence of participants' critiquing concepts and contexts of sustainability in the paired and group discussion phase. The Vacanti visual cue resulted in a reasonable degree of critical discourse with consideration of a range of contexts in which the use of animals in this way may be permissible, such as: disfigurement caused by an accident, medical conditions, and the closeness of the victim (family member), while ruling out its use for cosmetic reasons. The critiquing of the Vacanti visual cue generally followed a human-centric line of thinking, concentrating on the benefit of changing a human life for the better. Only a few participants strongly condemned the use of animals in this process—'*It made me wonder about animal rights and why it is accepted that they are exploited. Also made me think about issue of consent*.'

During the Horse visual cue, participants took into account the possibility of aiding an endangered or physically deformed animal. More frequently, however, students considered the Horse scenario in the context of growing a body part only for an '*animal one cared for*', such as pets. Others critically considered their response to facilitating this for '*different animals*'. As with the Vacanti visual cue, human-centric views dominated the critical considerations of participants. Participants who questioned the given context, thought about '*cruelty to the human race*, *the health implication of it*', and recognised that this scenario could well '*cause more pain*' to the animal. Only a minority strove to understand the broader implication of this scenario, evident in statements that said the Horse scenario had promoted thinking '*...about power*, *control*, *humans*, *animals*' and '*that true sustainability would mean this* [humans growing a body part for an animal] *should be a consideration*'.

The Baboon visual cue offered opportunities for critical consideration of Western norms and practices, in light of particular cultural practices among a specific tribe in South America. For some, the primate factor (baboon being human-like) within the visual cue enabled critical consideration of the scenario—with one participant noting that the '*response to monkeys* [*baboon*] *is different from response to other animals (maybe rats)*'. For others, it was the story of the tribal cultural practice, of helping vulnerable animals survive, that stimulated consideration of the baboon scenario. The aspect of breastfeeding the baboon was a major issue for most, with concerns around the notion and act of having skin-to-skin contact in this process. Besides the fact that most participants expressed human-centric views, the majority of critiquing was supportive of the practice once it did not breach dominating cultural norms. In this regard, the preference was for human milk to be expressed into a bottle for the baboon to feed on, rather than to directly breastfeed the baboon. The majority of participants strove to understand cultural differences, recognising the value of learning from other cultures, with a minority of participants considering both the well-being of the child and the well-being of the baboon.

5.4 Reorienting Dispositions/Perspectives for Sustainability

This category covers changing dispositions (attitudes, beliefs, values) of, or perspectives on, sustainability. For this category, there needed to be evidence of participants re-orienting perspectives to include non-human centric views and/or non-centric views over the course of each intervention. In total, 16 of the 55 participants showed changes to their disposition/perspectives with respect to sustainability; for the majority the change is evident within a single visual cue, with just three participants showing change across all three visual cues. In terms of visual cues, the Baboon visual cue led to the most re-orientations, followed by the Vacanti visual cue, and the Horse visual cue. It is important to note that for a small number of participants, who already held non human-centric, sustainability-oriented views at the outset, the use of these visual cues in re-orienting dispositions or worldviews towards sustainability was not relevant.

Eight participants showed changes to their dispositions within the Vacanti visual cue intervention. This resulted in deeper understanding of own beliefs, in some cases '*realising that they* [*sustainable or unsustainable oriented beliefs*] *are corruptible*' exemplifies such a reorientation of dispositions. Furthermore, some of these participants' dispositional changes resulted when differences between 'needs and wants' became clearer.

Six participants showed dispositional changes within the visual horse cue. Participants commented on having their values-bases confronted—'*overall beliefs opened up*', by listening to others reasoning and critiquing the scenario. The comments recorded for the horse visual cue also indicate changing perspectives within and across participants. Some changed their view on the horse scenario, initially closed to the idea of growing an animal part on a human, then switching to consider the implications of doing this in the spirit of sustainability, and then resting with the viewpoint that interfering with nature (in all its forms—human or animal) is not a good trajectory to follow—'it *made me think of the potential damage to nature by perverting science in this way*'. A few changed their perspective when considering that it could be beneficial to an endangered species and realising that it may be considered '*very selfish not to return the favour* as one recognised that *they are also living creatures*'.

With regards to the Baboon visual cue, ten participants showed changes in their disposition towards breastfeeding the baboon. The re-telling of the back-story to the visual cue by a participant prompted the realisation that '*Westerners created this problem*, *that the baboon would otherwise die*', and this appears to have contributed to some of the dispositional changes. This becomes evident through statements such as '[the tribal cultural practice of breast feeding vulnerable animals] *made me feel humble by what someone would do*, *my feelings changed a bit*', and as one participant recorded to '*feel a little less superior to the animal*'. Furthermore, the exposure of male participants to viewpoints of female participants during the discussion phase has been mentioned as effecting change in dispositions towards the woman breastfeeding the baboon.

6 Conclusions

This research study set-out to explore the potential of disruptive pedagogic interventions (visual cues scenarios) in reorienting anthropocentric frames of reference within sustainability. So, what impact did these pedagogic interventions have on learners' frames of references (how they think and/or feel)?

The findings indicate that the guiding framework of transformative learning was effective in progressing participants towards becoming sustainability-oriented. The participants displayed differing cognitive skills-sets—with some primarily engaging lower cognitive skills, such as: identifying key principles, practices and themes of sustainability, and others engaging higher order cognitive skills in critiquing anthropocentric views and other concepts and contexts of sustainability. There is

also evidence of a correlation between those who experienced emotional or cognitive disjuncture on viewing and reflecting on the visual cue at the outset, and the subsequent reorientation of the dispositions/human-centric perspectives of these participants towards sustainability. Furthermore, the discussion was pivotal in promoting deep thinking on various principles, practices, issues and/or themes of sustainability, such as: human centrism, interdependencies within sustainability, and western dualisms.

The research study further sought to explore which elements of the intervention challenged participants' frames of reference. In this regard, the findings indicated that those who experienced disruption or dissonance during the initial viewing stage [disorienting dilemma] displayed more evidence of critical engagement during the latter stages of the intervention. However, being emotionally or cognitively disrupted at the outset, did not by itself guarantee reorientations of dispositions/perspectives for sustainability. These findings also highlight that discussions could also act as a catalyst in creating disjuncture beyond initial viewing and reflecting stages of visual cue interventions. Therefore, visual cue activities need to include opportunities for discourse and discussion. This enables engagement with cognitive processes facilitating the identification, recognition and/or critique of key themes, concepts, contexts or issues within sustainability. The discussion focused phase within the pedagogic framework of visual cue interventions thus further supports the reorientation of dispositions or perspectives for sustainability.

The design of the visual cue itself is very important in stimulating learners to critically reflect on their own dispositions and perspectives with respect to sustainable development. In this respect, the choice of image and trigger question is pivotal in disrupting or triggering dissonance within learners' frames of mind at the outset. Visual cues have the potential to stimulate emotional and cognitive reactions that are deeply embedded in frames of references, and which activate and signal a disequilibrium/disjuncture/disorienting dilemma, triggering the search for new meanings. Indeed, the majority of participants in this study experienced emotional or cognitive disjuncture on first sight of at least one of the visual cues, indicating that they could not rely on their existing frames of reference to make sense of the visual cue. However, the imagery for the visual cues needs to be carefully chosen so that it does not cause 'emotional' or 'cognitive' blockage, preventing the learner from engaging critically in the overall intervention. Furthermore, visual cues need to rely on real sustainability scenarios, using media that lead to disruption rather than disturbance of frames of reference. Consequently, future visual cues activities need to make use of art portraying real sustainability scenarios, with the added benefit of the protection offered by these artworks already being in the public sphere. In conclusion, evaluative frameworks for assessment of appropriateness of visual cue imagery should be extended to include consideration of gender responsiveness, strive to include authentic 'real-world' contexts, and should avoid imagery that could lead to polarisation or disturbance of learners.

While this study has been effective in identifying a pedagogic framework and key cognitive processes in the pathway to becoming sustainability re-oriented, more research is needed to uncover pedagogic strategies that enable learners to fully

transform into change agents for sustainability. Future research also needs to identify the key factors influencing learners' initial reactions to the visual cues, so that changes to learners' frames of reference with respect to sustainability can be fully explored.

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Rethinking Thinking About Sustainable Development Curriculum

Christopher A. Haines

"*You cannot solve a problem with the same level of thinking that created it*." *Albert Einstein*.

If a snap of the fingers could reverse the environmental destruction of the past 350 years, society would start repeating its mistakes tomorrow, **unless it has changed**. The environmental crisis is a symptom of human thinking and people need to think differently to resolve it.

Abstract

This paper discusses split brain science and presents major findings from "The Master and his Emissary: The Divided Brain and the Making of the Western World" (2009, Yale University Press), by psychiatrist and clinical psychologist Iain McGilchrist, who provides profound insight into the workings of the human brain by combining clinical research in split brain science with its evidence in western history and philosophy. This remarkable book explains how dominant thinking has deluded society into its current predicament, warns of the dangers involved and what Einstein meant. The paper then discusses implementing these insights into higher education curriculum on sustainable development, with examples from the author's experience. This paper will be interesting to anyone concerned with environmental curriculum that will effectively address problems.

Keywords

Split brain · Right & left hemisphere · Sustainable development · Curriculum

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1 Introduction

This paper presents the findings of psychiatrist and clinical psychologist McGilchrist (2009) "The Master and his Emissary – The Divided Brain and the Making of the Western World" (Yale University Press), as he provides penetrating insight into the functioning of the two hemispheres of the human brain and their impact on society and the ecological crisis. This is the most comprehensive scientific documentation to date, yet it confirms what some have known for centuries, i.e. Einstein above. This paper then discusses how this new insight could inform curriculum for sustainable development in higher education. While this author makes no claims to being a psychologist or neurophysiologist, as a student of sustainability, he recognizes the critical nature and urgency of implementing these findings into society for the benefit of our students and their future.

While many brain researchers have published their work, they have generally stuck to personal stories, descriptions of experiments and important findings and within specialties, seemingly unaware of related material (Czerner 2001; Gazzaniga 2015; Haidt 2012; Ledoux 1996, 2002; Newberg and Waldman 2010; Ratey 2002; Schwartz and Begley 2002). McGilchrist provides an impressive integration of clinical work and scientific research on brain behavior with history, philosophy, culture and societal impacts, so the whole is much more than the sum of the parts. If there could be a critique of his work it would be that by largely sticking to western society, he has not eliminated the possibility of cultural bias.

While the Greeks theorized on the split brain nearly 2500 years ago, modern split brain science was born with the work of Roger Sperry in the 1950s, and popularized by Edwards (1979) just two years before Sperry won a Nobel Prize.

Research has focused on three main sources. The first is a fairly small number of individuals who have had their corpus callosum; the nerve fibers connecting the two brain hemispheres, severed to relieve them of severe seizures. Gazzaniga (2015) one of Sperry's most influential students and mentor to many others, apparently spent his entire career studying these patients. The second source includes accident victims and stroke patients who have sustained damage to some part of their brain. The third source is carefully designed experiments around the ability to temporarily disable specific brain areas without causing long term damage. The use of MRI's and more recently fMRI's has assisted this research.

2 The Divided Brain

> for us as human beings there are two fundamentally opposed realities, two different modes of experience; that each is of ultimate importance in bringing about the recognizably human world; and that their difference is rooted in the bi-hemispheric structure of the brain. It follows that the hemispheres need to cooperate, but I believe they are in fact involved in a sort of power struggle, and that this explains many aspects of contemporary Western culture. (McGilchrist 2009: 3)

Researchers have long searched for what the two hemispheres do that is different. McGilchrist speaks not about 'what' they do but 'how' they do it. "*The most fundamental difference between the hemispheres lies in the type of attention they give to the world*." (2009: 4) The major characteristics of the two hemispheres of the brain are outlined in Fig. 1.

> It may be the right hemisphere that also keeps the hemispheres together, in the interest of a whole world experience, rather than allowing the left hemisphere willfully to go its own way. (McGilchrist 2009: 46)

> Denial, a tendency to conformism, a willingness to disregard the evidence, a habit of ducking responsibility, a blindness to mere experience in the face of overwhelming evidence of theory: these might sound ominously familiar to observers of contemporary Western life. (McGilchrist 2009: 235)

It is important to remember that people have whole brains, designed to provide an integrated and balanced perspective. While cultural impact can effect what is seen as 'balanced', as McGilchrist makes clear, it is not the use of the left hemisphere that is the problem, indeed it is a very powerful tool for good when integrated with the right hemisphere, it is the excessive dependence on the left hemisphere's perspective, the de-humanizing of society with rigid rules and structure, the lack of empathy for real people and their needs and desires and the creation of 'a hall of mirrors' that is the problem. It is raising the emissary to the status of master, accepting the left brain conclusions to be the real world. Many individuals manage this well, but when reviewing a list of left brain limitations, many will recognize people they have known that do not.

McGilchrist sums this up with a warning, "*We need the ability to make fine discriminations, and to use reason appropriately* (*left brain science*). *But these contributions need to be made in the service of something else, that only the right hemisphere* (*the master*) *can bring*. ***Alone they are destructive*** (*emphasis added*). *And right now they may be bringing us close to forfeiting the civilization they helped to create*." (2009: 93)

In the 'struggle' between the hemispheres, there is an ontological asymmetry in favor of the right hemisphere as the primary mediator of experience, from which the left hemisphere's re-presented and conceptualized world derives and on which it depends. "*Only the right hemisphere is in touch with primary experience, with life and the left hemisphere can only ever be a staging post…*" (McGilchrist 2009: 219)

There is also an asymmetry of function, as the products of the left hemisphere must be returned to the right hemisphere in order to 'live'. "*it is essential that what the left hemisphere yields is returned to the realm of the right hemisphere where it can once again live….Much that marks us out….. as human beings requires the intervention of the left hemisphere as long as it is acting in concert with the right hemisphere…In the absence of such concerted action, the left hemisphere comes to believe its territory actually is the world*." (McGilchrist 2009: 219)

Left Hemisphere	Right Hemisphere
"A closed system which cannot reach outside itself to whatever it is that exists apart from itself." (McGilchrist, 2009: 330)	Grounded in the senses, receptive to environmental stimuli, with context.
Deals in perfect, re-presented abstractions, ignoring context and living qualities.	Deals in individuality with its unique, messy, imprecise and limited realities.
Manipulates fixed, static, images, dislikes change.	Accepting of change, movement and the unknown.
Knows, but does not believe.	Believes, but does not know.
Goal focused and competitive, it seeks power and control.	Concerned with life and relationships.
Principal concern is utility, it sees the world as a resource to be exploited.	It lives in implicitness and between-ness.
Unconcerned about others and their feelings.	The source of empathy, sympathy and morality.
It craves certainty, makes the implicit, explicit and mistrusts that which is not clear and direct	Embraces implicitness and duality; the source of metaphor, poetry, humor and artistic creations.
Vocal, the source of language and logic.	Non-vocal, yet plays some part in language.
Builds systems and arguments logically and linearly, with bifurcate choices.	Intuitive and wise, operating almost subconsciously from experience and moral concerns.
Divides and sub-divides elements and organizes them into categories.	
It values its own creations and dismisses anything not of its own making or that it cannot control.	
It values that which can be measured, but is more concerned with precision than accuracy.	
The whole as merely the sum of the parts.	The whole as a dynamic, living system.
Arrogant of its abilities, not only blind to its weaknesses but willfully denies them and overly optimistic of its prospects.	Realistic, maybe melancholy due to mortality and empathy, but open to wonder and awe.
Unable/ unwilling to admit ignorance and perfectly willing to fabricate stories even in the face of overwhelming evidence to the contrary.	
Not keen on taking responsibility. "Evidence of failure does not mean we are going in the wrong direction, only that we have not gone far enough in the direction we are already headed." (McGilchrist, 2009: 234)	Re-integrates and humanizes the creations of the left hemisphere back into the living world.

Fig. 1 The differing characteristics of the brain hemispheres

There are however, several powerful asymmetries in favor of the left hemisphere. "*The Master makes himself vulnerable to the emissary and the emissary can choose to take advantage of the situation, to ignore the Master. It seems that its nature is such that it is prone to do so*." (McGilchrist 2009: 219).

The left hemisphere's ready accessibility through language and logic produces an advantage in an asymmetry of means. The left hemisphere builds systems on certainty, piece by piece so the facts and arguments are coherent and transferable to another individual. It is far more difficult to transfer the instantaneous and holistic thinking of the right hemisphere.

As language and logic discount that which stands outside themselves, the left hemisphere also benefits from an asymmetry of structure, building self-enclosed systems, a 'hall of mirrors'. You may 'know' something is wrong with an argument but are left with only intuition and experience to refute it. McGilchrist sees this as intentional. "*this unwillingness to allow escape…appears willed by the left hemisphere*." (2009: 230)

The two hemispheres could maintain balance as the pendulum swings between them, but an asymmetry of interaction occurs when the pendulum swings too far and 'rebalances the clock'. McGilchrist believes this has now happened in favor of the left hemisphere and "*Despite the primacy of the right hemisphere, it is the left hemisphere that has all the cards, and from this standpoint looks to win the game*." (2009: 232)

3 The Split Brain in History

> the relationship between the hemispheres is … highly significant for the type of world we find ourselves living in. (McGilchrist 2009: 209)

For a fascinating, well researched and presented, but incendiary historical perspective see Saul (1992) where he complements and exemplifies many of McGilchrist's conclusions.

Platonic philosophy cemented left hemisphere abstract truth into western thought.

> It is this respect for context that underlies the sense in the Renaissance of the interconnectedness of knowledge and understanding. (McGilchrist 2009: 312)

> The Reformation pursued the use of explicit words…these different ways of looking at the world – 'proclamation' of the word versus 'manifestation' of the divine are aligned with hemisphere differences." (McGilchrist 2009: 319) "the reformers cut away the basis of religious worship, in metaphors, music, rituals and works of art and replaced them with ideas, theories and statements." (McGilchrist 2009: 444)

The Enlightenment began with a shift in thinking to a more atomistic, ambitious and competitive individuality. "*The left hemisphere misunderstands the importance of implicitness…. certain logically desirable goals simply cannot be directly pursued, because direct pursuit changes their nature and they flee from approach: thus*

the direct pursuit of liberty, *equality and fraternity - ...is problematic*." (McGilchrist 2009: 345) As seen by "*the way in which the ideals of liberty*, *justice and fraternity led to the illiberal*, *unjust and far from fraternal*, *guillotine*." (McGilchrist 2009: 347)

> Romanticism demonstrates an affinity for everything we know about the workings of the right hemisphere." (McGilchrist 2009: 379) McGilchrist sees its seeds in the Renaissance. "the right hemisphere is grappling with experience, which is multiple in nature, in principle unknowable in its totality, changing, infinite, full of individual differences, while the left hemisphere sees only a version or representation of that experience, in which, by contrast, the world is single, knowable, consistent, certain, fixed, therefore ultimately finite, generalized across experience, a world that we can master – the Enlightenment world, in other words…" (McGilchrist 2009: 352)

> "It is not just that this movement (the Industrial Revolution) was obviously, colossally, man's most brazen bid for power over the natural world, the grasping left hemisphere's long-term agenda. It was also the creating of a world in the left hemisphere's own likeness." (McGilchrist 2009: 386) "Capitalism and consumerism, ways of conceiving human relationships on little more than utility, greed and competition came to supplant those based on felt connections and cultural continuity." (McGilchrist 2009: 390)

> What if Fascism and Stalinism were facets of the same mental world as modernism, both of them expressions of the deep structure of the left hemisphere's world? (McGilchrist 2009: 392. quoting Toulmin) McGilchrist considers extended discussions on the origins of boredom and anxiety, the impacts of broken bonds of place and community and the creation of a culture of winners and losers, before answering this question in the affirmative. He provides pages of clinical similarities between schizophrenia and those with damaged right hemispheres, shows how schizophrenia is increasing with modernism and quotes others also suggesting this. He then describes how a societal shift to the left hemisphere skews our perception of 'normal' increasing extreme behavior, then follows, "people with schizoid and schizotypal traits will be attracted to, and deemed especially well suitable for, employment in the areas of science, technology and administration which have …been immensely influential in shaping the world we live in… (2009: 408)

4 Building Balanced Thinking into Sustainable Development Curriculum

Thus, western culture is moving ever closer to a left hemisphere model, plundering the planet while nagged by health problems, rampant social injustice and hardening of political arteries while skirmishing with extremism and terrorism, to name a few that are integral with this model. He posits science and technology will not save society and have not improved happiness, or reduced stress, unease or emptiness.

Traditionally, students became proficient in their profession to become useful members of society. Today these professions are increasingly specialized and the economy is increasingly dominated by business interests that are profit driven, regimented, competitive, and who view the earth as a resource to be 'used'. In

addition, left hemisphere values impact significantly on human relations within these companies, thus conflict, stress, anxiety and emptiness are on the rise making working conditions far less pleasant. Higher education is not immune to these issues.

As the world has become more aware of and more concerned about ecological issues, more and more students have chosen careers in 'sustainable' professions to make contributions to these problems. That is commendable. Many colleges, universities and commercial businesses are also improving operations to be part of the 'solution'. 'Green' and 'sustainable' have become fashionable with some being sincere and others seeking to appear so. It is also true, that these commercial interests control a large resource base and as they improve operations they are 'doing less harm'. However, when working in, even achieving results in, a system designed and controlled by the left hemisphere they are only 'doing less harm'.

To borrow a term from the Living Building Challenge, "What does Good Look Like? What is the society that is able to maintain itself indefinitely (Haines 2011)? What is the curriculum that will help create that society? Those are question of discovery, not of fabrication.

There are still universities that offer classical curriculum, dedicated to creating the 'Renaissance Man'. While this is considered extreme and illogical in today's world, perhaps it is time to recognize that today's world is extreme and illogical; as it is destroying the source of its own existence. Perhaps it is time for colleges and universities to devote themselves to a new model of education to address climate change and sustainable development. If society does not solve this problem, it will not have to worry about solving many others. This would include the creation of a curriculum that fully addresses the problems created by a dominant left hemisphere in all aspects of society and training students for the re-emerging world of a balanced brain. This would not directly train students for jobs in the capitalist system, however, those trained as thinkers; able to see the big picture and understand the forces at work, would likely be well qualified for many positions in society.

The first step in instituting coursework in split brain science is an introductory course "The Human Brain and Our World" or some such title. As McGilchrist is long and dense it would be a full semester or even two semesters by splitting off the history. Adding comparison material would be beneficial but would increase the workload. If understanding the asymmetries in favor of the left hemisphere can provide a force for right hemisphere integration, then perhaps those asymmetries can be re-balanced.

McGilchrist cites three specific items that threaten the left hemisphere world; because it cannot understand or control them. "*What ultimately unites the three realms of escape from the left hemisphere's world which it has attacked in our time – the body, the spirit and art – is that they are all vehicles of love*." (2009: 445). It is love that makes us human and provides a bonding influence to art and culture; the basis of civilization. "*cruelty does not exist in 'nature': only humans with their left prefrontal cortex have the capacity for deliberate malice. But then only humans,*

with their right prefrontal cortex, are capable of compassion." (McGilchrist 2009: 86)

The body is seen as a mechanistic 'thing', yet "*It is the meaning of the body to be transcended and forgotten in the life for which it serves. It is the most essential characteristic of the body that it disappears as an independent thing the more it fulfills its service*" (McGilchrist 2009: 339. quoting Martin Foss). It is intuitive vs rational, implicit vs explicit, moving vs static, changing vs fixed, mortal vs optimistic, real vs controllable, messy, imprecise and limited, vs perfect. McGilchrist notes, "*It is significant that the 'normal' scientific, materialistic view of the body is similar to that found in schizophrenia*." (2009: 439) Schizophrenia is an issue McGilchrist returns to throughout the book as it correlates strongly with the characteristics of the left hemisphere.

> "We need metaphor or mythos to understand the world. Such mythos or metaphors are not dispensable luxuries…they are fundamental and essential to the process." (McGilchrist 2009: 441) And it follows that "When we decide not to worship divinity, we do not stop worshipping: we merely find something else less worthy to worship." (McGilchrist 2009: 441)

Appreciation of the arts is a major route to the right hemisphere. "*The left hemisphere… has here set about neutralizing or neutering the power of art*." (McGilchrist 2009: 442) McGilchrist believes classical music "*convince(s) us that there is something beyond the self-enclosed, self-invented space of the left hemisphere's world*." (2009: 442) Then, while it has become somewhat unsophisticated to talk of beauty, "*We cannot get rid of the power of beauty by a decision in theory*." (2009: 443)

Thus focusing coursework on the body, spirit and the arts will increase leverage on left hemisphere weaknesses and exercise right hemisphere functions. Of course this coursework exists in university curriculum, but finding new meaning and value in this material, perhaps expanding it, re-thinking who takes these courses and how they fit into the curriculum, has merit.

The next problem McGilchrist identifies is that the left hemisphere comes to believe that its material *is* the world. Can higher education implement a biomimicry lesson from the structure of the human brain? Can academia organize itself so that left hemisphere material is released into a peer process that operates as a surrogate right hemisphere? Can degrees and programs be paired or grouped so that those inherently different in their brain processes work together to exercise both hemispheres of students' thinking? Can art and design students work with engineers, lawyers or doctors? Can biologists work with physicists or other groups? Some of this is already happening. The possibilities are nearly endless and the specifics would not matter as long as the result was a raised awareness and appreciation for the workings of the human brain. Experimentation would assist determining how the different groups worked best and what processes were most effective. It will be crucial to create an atmosphere where those involved appreciate the approach and find themselves benefitting from these experiences.

Teamwork for brainstorming and projects is not new. Yet normal teamwork is a left hemisphere solution to its own failing. While many have found brainstorming and teamwork effective, it can become a group of Emissaries without a Master. This process would be designed to focus on the integrative function of the right hemisphere, harnessing an understanding of brain science to create success.

Economics is another issue deriving from the left hemisphere model. This paper will not digress into the history of growth economics, but both Adam Smith and John Stuart Mill said growth was not necessary, nor desirable. Very few economists are willing to discuss it; however, it is beginning to gain recognition in the popular press. One economist said "In order to believe that you can have a growth-economy inside a finite planet, you have to be either stupid, or an economist" (Kenneth Boulding). Usury; charging interest; a main source of growth, was a sin in Christianity for over a 1000 years but somehow that has been forgotten. If society reframed its economic ideals to the pursuit of 'Social Progress' and 'Happiness' instead of 'growth' it would provide a greater chance of a sustainable future. While the changes required for a zero-growth economy could be dramatic, they might also be good news (Haines 2013).

Another system created in the left hemisphere's image is technology. Proponents argue for the benefits of 'virtual' space replacing energy and all that goes-on on social media. They are not completely wrong, but it seems they misjudge the impact of their own actions. The quality of that communication and the basis of the relationships on which it is based are all channeled through left hemisphere systems. This has led Turkle (2015) to bemoan the loss of conversation. While an enormous amount of energy, expertise and admittedly brilliance, has gone into developing these technologies, its energy use, material pollution and social ramifications leave seriously questions.

While there is great value in building a curriculum that fully addresses the left hemisphere's dominance, it need not be all or nothing. Many smaller options would be beneficial. Consider the issues of the left hemisphere. Education needs to be broader, less specialized and maybe less 'utilitarian', needs to promote 'living a life, more than 'making a living', considering where that has led. Admittedly, students need to recognize the value of that education in a society that does not. There are likely also issues around how universities fund themselves in a sustainable society.

Universities also face realities of certifications and program accreditation. In the long term this information may permeate accreditation boards and perhaps things will change. However, in the near to moderate term schools will have to abide by the requirements they face. It is also true that degrees, particularly in technical fields are rigorous and students do not have much leeway for 'superfluous' coursework. Schools will have to decide what leeway is available and how they wish to institute requirements on course loads. While this is a real issue, unless a school decides that Business-As-Usual is acceptable, action will be required to create curriculum that addresses the damaging effects of left hemisphere dominance in society.

5 Sustainable Development Curriculum Examples

Specialization, a long suit of the left hemisphere, is tied to the nature of education. What is learning? And therefore, what is education? Those discussions have been ongoing for centuries and will not be resolved here. On the other hand, while McGilchrist does not address it, brain science supports arguments that learning is an 'insight'. Teaching is therefore creating experiences most likely to produce 'insights' (Rock 2006; Jacobs 2009). An insight cannot be 'canned' and passed out to a class. In his excellent book, "Teaching with Your Mouth Shut" Finkel (2000) while initiating a discussion on teaching, provides many excellent examples of how doing less talking provides more opportunities for students to gain 'insights'.

This is important, because specialization tends to produce 'teaching by telling'. It supposes that professors teach classes in the details of their specialty, which requires expertise for which universities usually require doctorates. While this will continue to be the case in many circumstances, it nearly determines that the professor will not have a wide background outside of his/her specialty. This is problematic when faced with broad, integrative issues such as sustainability. Team teaching may help, but it does not really address the problem of integrated knowledge.

From a contextual perspective that views education as integrative, a professor may teach a topic across academic silos. This allows 'let the books do the talking' and other options. It is antithetical to modern practice, because it is a right hemisphere perspective. It values the 'Renaissance Man' and requires a breadth of knowledge and not a depth of it, fully appropriate for sustainability curriculum.

Examples of sustainable development coursework are provided from the author's experience (Haines 2010). He is a registered Architect with many years in energy, resource management and sustainability, values Architecture's tradition as a 'generalist', has long experience, broad interests and has read widely. An Architect 'reframes a problem so that a solution is possible'.

While he has taught architectural structures, his first experience teaching outside of Architecture was a course on Global Environmental Management, on the ISO 14001 standard in an MBA program, which he has also taught at the undergraduate level. It was an interdisciplinary course on social consumption and the built environment and how to recognize and address environmental problems in business. Topics included the Six Environmental Crises, Ecological footprinting, Energy resources, Energy auditing, the Built Environment, and Social Justice, with course books on Water, Food & Agriculture, Consumption & Waste and, Triple Bottom Line accounting plus the ISO 14001 Environmental Management Standard. If, in the future, one of the students runs across an environmental issue and thinks, "I remember this is important and I had better get some assistance or I could mess up in a big way" he will have done his job.

His second experience was in a Liberal Arts department where he taught a course on Urban Design for Sustainability mostly to biology students. Again, he integrated a range of topics to consider urbanism as design, not planning; right vs

left hemisphere. The class covered Societal decline & sustainability, energy, urban sprawl, the Cuban special period (A "peak oil" event triggered by the collapse of the Soviet Union), building technology, urban settings and density, deep energy retrofits, transportation, urban agriculture and rooftop gardens, water and the hydrological cycle, and consumption and waste. While architectural issues were covered, the focus was on the integration. This was even more successful than the first.

The evidence is that these courses forced students to think in different ways. The coursework was not readily categorized. The professor was from outside their field. They addressed context and resource limits. By focusing on integration, they demonstrated the range of issues involved and the synergies that generate 'more than the sum of the parts'. They also highlight the difference between multiple specialists and broad knowledge. They valued design as 'three dimensional problem solving'. These processes could be improved; however, they represent steps towards education in sustainable development becoming more effective by recognizing the imbalance of the modern western brain. The tendencies of the left hemisphere will not change, but hopefully, students can learn to do a better job of engaging their right hemisphere as it was intended.

6 Conclusion

Split brain science has provided a roadmap of human thinking, explained the struggle between the hemispheres and demonstrated the impact of that struggle on society. It has documented the source of many problems society faces, and explained why and how they are intertwined. It also explains why many efforts fall short.

Society now has the opportunity to use this understanding to reverse direction, although it will not be easy or quick. Academics owe it to the youth to implement this understanding into academic institutions to begin resolving the ecological crisis being left to them.

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Higher Education Strategic Planning for Sustainable Development: A Global Perspective

Zena Harris, Holly Moynahan, Heather Vickery, Heather Henriksen, Eugenio Morello and Bernd Kasemir

Abstract

Strategic planning in higher education provides insight on the sustainability priorities of many colleges and universities worldwide. Researchers from the International Sustainable Campus Network (ISCN), a global forum for leading universities to exchange ideas and best practices for integrating sustainability into campus operations, research, and teaching, investigated the trending themes in strategic planning found in scholarly literature and 24 of its member colleges and universities. This paper aims to outline the common themes and trends ISCN researchers observed in scholarly literature focused on strategic sustainability planning and sample ISCN colleges and universities. The methodology approach was based in theoretical literature background and empirical evidence noted on

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college and university websites. Common themes observed included climate change resiliency and adaptation, collaboration, health and wellbeing, and urban planning, among others. While overall there was a significant degree of similarity between strategic plans in different regions, ISCN researchers also observed some regional differences in strategic planning in higher education. For example, strategic planning in North America includes energy, education, and health as topics of particular emphasis, while in Europe focus topics in planning tend to emphasize innovation and urban planning. Additionally, ISCN researchers assessed the time frame of publicly stated strategic sustainability plans, with planning horizon being most often mid-term with a 4–6 year planning period. Due to the scope of the study and the nature of the methodological approach, these results should not be regarded as representative of all strategic planning in higher education and scholarly literature. This research is meant to provide a basis for trends in strategic planning during the timeframe in which the research was conducted.

Keywords
Strategic planning · Higher education · Sustainability · Geography · Resiliency · Vulnerabilities · Adaptation · Collaboration · Sustainable development

1 Background and Introduction

Founded in 2007, the International Sustainable Campus Network (ISCN) is a nonprofit, global forum that supports leading colleges, universities, and corporate campuses in exchanging information, ideas, and best practices for achieving sustainable campus operations and integrating sustainability into research and teaching (International Sustainable Campus Network, n.d.). As of March 2016, the ISCN had 75 member schools and universities spanning six continents. Member institutions vary in size from small universities with approximately 1,000 students to large universities with 90,000+ students, and each school shows a breadth and depth of knowledge on sustainability, as well as unique perspectives and opportunities for innovation.

To exercise and implement its mission to help colleges and universities fulfill their leadership role in advancing knowledge, technology, and tools to create a sustainable future, the ISCN has four organized working groups. One of these groups, the Campus-Wide Planning and Target Setting group, focuses on the strategic planning and implementation of sustainability goals and initiatives in higher education. To accomplish this, the group actively engages with ISCN's geographically diverse members to gather information on the trends and

collaborative sustainability planning efforts currently taking place in colleges and on campuses worldwide.

Colleges and universities demonstrate sustainability innovation and leadership in many areas (Owen et al. 2013), including their approach to strategic planning. While strategic sustainability plans by nature heavily emphasize the physical aspects of the campus, their goals and execution set important preconditions for demonstrating sustainability research findings on campus, and using the campus as a teaching tool to expose students to sustainability issues and teach specific skills. Strategic sustainability planning within institutions also serves as a testbed for innovation, and allows campuses to become living labs where students, researchers, teachers, and operations can collaborate on a shared sustainability target. As a core component of campus sustainability, strategic planning comes in many forms, from campus-specific sustainability plans to climate action plans and/or integrated university-wide strategic plans that include the broader community. Most colleges and universities with strategic sustainability plans take an inclusive, campus-wide approach to developing their goals and initiatives (White 2014), exhibiting the collaborative, synergistic nature of this kind of strategic planning.

Such plans also span various time frames, and while sustainability strategic planning is now common at universities worldwide, it varies in nature due to the influence of institutional and region-specific factors. Observing and investigating these different plans provides insight on campuses' resiliencies, vulnerabilities, and adaptations as they strive to reduce their short- and long-term environmental impacts. The purpose of this paper is to observe trends in strategic planning in higher education worldwide based on common themes in literature on this subject and information from ISCN's members' strategic plans. This research serves as a baseline understanding of how strategic planning varies regionally as well as within scholarly literature.

2 Process and Investigation

To uncover how sustainability strategic planning in higher education is currently discussed in scholarly journals, ISCN researchers reviewed literature on campus and higher education sustainability and pinpointed 33 scholarly journals that publish a variety of campus sustainability topics. Four journals in particular, the *International Journal of Higher Education and Sustainability* (*IJHES*), *Strategic Planning for Energy and the Environment*, the *Journal of Record Sustainability*, and *Sustainable Facility*, publish extensively on strategic sustainability planning, and these journals serve as a foundation for the observed strategic planning trends in colleges and universities. After thorough review, ISCN researchers performed a qualitative assessment of the observations noted in these scholarly journals. This qualitative analysis was meant to draw connections between the various journals investigated.

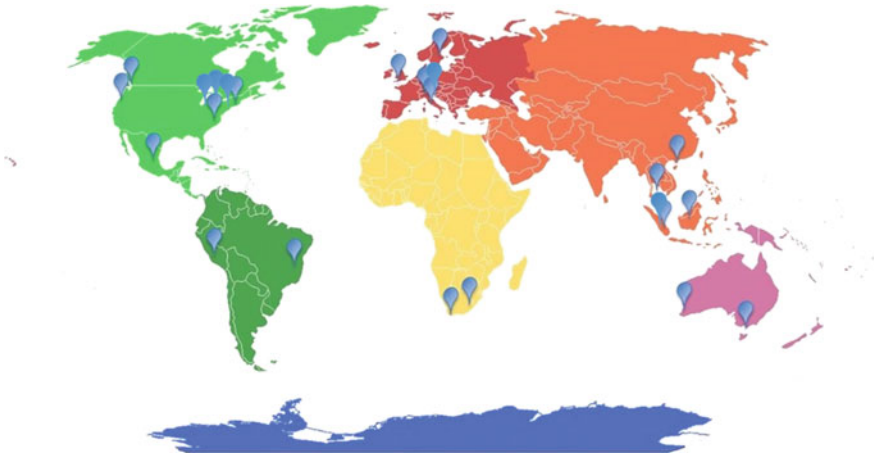

Fig. 1 Location of ISCN member universities reviewed for sustainability strategic plans

ISCN researchers also reviewed its member universities, looking at their public websites, sustainability reports, and strategic plans specifically. Ultimately, 24 ISCN schools from six continents were highlighted based on regional comparability and engagement with a strategic plan. These members are listed below by region and Fig. 1 displays their geographic location.

- North America
  - Ball State University
  - Harvard University
  - Massachusetts Institute of Technology
  - Stanford University
  - University of British Columbia
  - University of Pennsylvania
  - Yale University
- Central and South America
  - Federal University of Rio de Janeiro
  - Monterrey Institute for Technology and Higher Education
  - Pontifical Catholic University of Peru
- Africa
  - Stellenbosch University
  - University of Cape Town
- Europe
  - École Polytechnique Fédérale de Lausanne
  - KTH, Royal Institute of Technology
  - Oxford University
  - Politecnico di Milano
  - Swiss Federal Institute of Technology
- Asia
  - Chulalongkorn University
  - National University of Singapore
  - The University of Hong Kong
  - University of Malaya
  - Universiti Malaysia Sabah
- Australia
  - University of Melbourne
  - The University of Western Australia

ISCN researchers cross-referenced key words and phrases in scholarly journals and specific initiatives and frameworks found in campus plans of sample universities. Common themes and trends in the literature were also analyzed as well as the

regional differences in structure and focus of sustainability strategies in institutions of higher education. To explore the collaborative nature of strategic planning in higher education, ISCN researchers also observed engagement between various academic researchers from different universities that work together on sustainable development and strategic planning. Similar to their assessment of scholarly journals focusing on strategic sustainability planning and the trends and themes noted in each, ISCN researchers assessed ISCN sample schools via qualitative analysis in an effort to gain an understanding of the current trends and themes taking place in higher education strategic sustainability planning worldwide.

3 Observations on Strategic Planning in Literature

After careful examination of literature focused on sustainability in higher education and strategic planning specifically, clear trends and themes appear. Out of 33 journals that focus on sustainability in higher education, four have a high percentage of scholarly articles on strategic planning. These four journals, the *International Journal of Higher Education and Sustainability* (*IJHES*), *Strategic Planning for Energy and the Environment*, the *Journal of Record Sustainability*, and *Sustainable Facility*, provide key words and phrases that highlight their work and content. For example, *Strategic Planning for Energy and the Environment* provides articles on energy management, energy planning, and campus energy cost savings. Similarly, the IJHES offers information and research on university sustainability, campus and community sustainability, university transformation toward sustainability, and climate change adaptation planning for universities and colleges. The common themes that exist within articles in these journals include:

- Campus planning and strategies
- Resilient communities
- Climate adaptation
- Greenhouse gas (GHG) reduction
- Energy management; energy savings
- Case studies
- Use of technologies in sustainable adaptation
- Sustainable development; finance
- Health; built environment
- Transforming universities/curriculum

The sections that follow provide brief overviews of areas within strategic planning noted in the literature research and review of scholarly journals.

Addressing Vulnerabilities: In order to move forward with sustainability initiatives, many institutions recognize the need to understand their vulnerabilities, especially regarding climate change. Research in the *IJHES* defines this kind of vulnerability as “the degree to which a system is susceptible to, and unable to cope

with, adverse effects of climate change, including climate variability and extremes" (Owen et al. 2013). It is also thought of as "a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its objectives, and strategies" (Owen et al. 2013). As a result, a number of strategic plans noted in journals such as the *IJHES* and *Strategic Planning for Energy and the Environment* address vulnerability, adaptation, and resiliency in their planning frameworks so that campuses may respond to the dynamic conditions beyond college and university borders (Schubbe 2013; Coffman 2009).

Collaboration and Integration: Literature suggests that in order to promote sustainability decisions and behaviors within all levels of an organization, sustainability must be incorporated into the organization's overall strategic management process (Galpin et al. 2015). For some universities, such as Yale University, this integration of sustainability and strategic planning often creates goals across all operational divisions and establishes systems of accountability that ensure that sustainability goals are measured, tracked, and reported publicly (Newman 2012). Furthermore, colleges and universities integrate strategic sustainability plans at an educational level as well as at community and regional levels. It is thought that university sustainability initiatives should foster respect for the environment and integrate the challenge of sustainability into undergraduate and postgraduate education, while also involving the overall networks in which colleges and universities reside (Ferrer-Balas 2004).

For example, some universities are collaborating with other colleges and universities as well as neighborhoods and surrounding regions to promote campus, urban, and state sustainable development (Segovia and Galang 2002; Morello and Piga 2013). ISCN researchers also observed this trend when they found researchers from multiple universities working together on sustainability research and planning. For instance, Dr. Ariane König of the University of Luxembourg has worked with researchers from the University of Cambridge and Clark University on a variety of sustainability research topics. The goal for this sort of collaborative strategic planning is to open participation, encourage innovation, and support researchers, students, and surrounding inhabitants in the effort to increase sustainability awareness and help reduce impact (Morello and Piga 2013). Sharing impactful practices and resources can be a powerful result of sustainability-oriented higher education collaboration (Thomashow et al. 2011). For example, Heather Henriksen, Director of Harvard University's Office for Sustainability, noted that Harvard is "working with three other regional universities, the state of Massachusetts, and companies on a shared energy-efficient data center in Holyoke, Massachussetts" (Thomashow et al. 2011). Overall, multi-stakeholder, collaborative partnerships in higher education institutions can provide knowledge distribution for developing tailored solutions to complex issues, participation from a variety of experts, and collaboration on special or niche topics that require adaptive capacity (Goodall 2015).

4 Observations on Strategic Planning Among ISCN Members

ISCN researchers also observed themes and trends in strategic planning among select ISCN colleges and universities. Commonalities between selected members include the prioritization of built environment, energy, water, mobility, waste, and integration of research and education. However, beyond the globally common themes adopted by most institutions, schools in different regions of the world emphasize particular topics more prominently than others, and approach sustainability differently. For example, strategic planning for schools in Europe includes a particular focus on innovation and urban planning. In comparison, in North America, ISCN researchers observed a more pronounced focus on energy, education, and health, compared to other regions. Moreover, in Southeast Asia, issues revolving around technology, ecotourism, and policy are trending in college and university strategic planning. Figure 2 outlines the overall regional trends of topics with particular regional focus in strategic sustainability planning for the 24 sample ISCN members.

The following sections highlight additional emerging areas of focus in ISCN members' strategic sustainability planning.

Planning for Climate Adaptation and Resiliency: Similar to the trends found in literature on strategic planning, climate adaptation and resiliency were also noted as common themes for multiple ISCN sample members' strategic plans. For example, Harvard University is partnering with the cities of Cambridge and Boston to actively prepare for sea level rise, extreme weather events, and other impacts that climate change will have on its campus, buildings, and surrounding communities (Preparedness and Resiliency, n.d.). The Harvard Climate Preparedness Working Group focuses on preparing the Harvard campus for the impacts of climate change,

Fig. 2 Strategic planning themes by region from ISCN member universities

and does so by assessing the vulnerability of its campus and communities, establishing preparedness policies and standards for facilities and infrastructure in high-risk areas, and enacting severe weather emergency preparedness initiatives (Preparedness and Resiliency, n.d.). The Harvard Climate Preparedness Working Group also defines connection points with local, state, and federal agencies, and regional higher education institutions (Preparedness and Resiliency, n.d.). By incorporating climate adaptation and resiliency into strategic planning, colleges and universities are engaging with their sustainability efforts beyond the borders of their campuses.

Urban Planning: An additional theme in ISCN members' strategic planning revolves around urban planning and modeling, particularly in the form of campus-community engagement. Politecnico di Milano (POLIMI), for example, teamed up with the Universita degli Studi di Milano (UNIMI) to launch a project called "Citta Studi Campus Sostenibile" (Morello and Piga 2013). This project promotes a new vision of a sustainable campus in Milan, and creates a framework to transform campus neighborhoods into urban areas that respect life quality and environmental sustainability (Morello and Piga 2013). This project hopes to "experiment [with] innovation developed by scientific research; to promote lifestyle transformation and more livable spaces; to become a good example for the whole city; and to cope with the international network of sustainable campuses" (Morello and Piga 2013). Similar to the trends of climate adaptation and resiliency noted in many strategic sustainability plans, urban planning connects and engages colleges and surrounding communities in sustainability initiatives.

Health and Wellbeing: For a number of ISCN members, health and wellbeing are emerging as priorities in sustainability strategic planning. Five of the 24 member schools reviewed in this study incorporate health and wellbeing in their planning. These include three schools in North America (Harvard University, Yale University, and the University of British Columbia [UBC]), one in Europe (Politecnico di Milano [POLIMI]), and one in Asia (The University of Hong Kong [HKU]). UBC, for example, outlines health and wellbeing in a Charter drafted at its Okanagan campus. This Okanagan Charter, which was signed by delegates from 45 countries in 2015 (Promising Paths: Research, Practice & Policy for Healthy and Sustainable Campuses, 2015), supports health-promoting universities and colleges in an effort to "transform the health and sustainability of our current and future societies, strengthen communities and contribute to the well-being of people, places and the planet" (Okanagan Charter: An International Charter for Health Promoting Universities and Colleges 2015). The charter emphasizes the need to "embed health into all aspects of campus culture, across administration, operations, and academic mandates" as well as an effort to "lead health promotion action and collaboration locally and globally" (Okanagan Charter: An International Charter for Health Promoting Universities and Colleges 2015). Health and wellbeing, a growing theme for universities' strategic planning, reflects the collaborative, holistic nature of sustainability initiatives for many institutions.

5 Additional Observations on Strategic Planning Among ISCN Members: Time Horizons

Duration: ISCN member results also depict differing time horizons for sustainability plans, with mid-term time frames of around five years being most common. Specifically, seven of the 24 colleges and universities had strategic plans that were 1–3 years, and 15 universities had plans that were 4–6 years. None of the 24 schools sampled had strategic plans between seven and nine years, but two of the 24 had strategic planning periods of ten years or more. This data reveals a strong trend in mid-length strategic planning periods. Figure 3 portrays these differences.

The ways in which the 24 ISCN sample member schools discuss their goal and timeframes also varies. For example, universities with strategic plans that are one to three years in length often describe their initiatives and goals in absolute terms. Yale University, for instance, developed stormwater management and water management plans for the years 2013–2016. These plans described specific information on the benefits of managing water as a resource as well as particular measures to be taken.

Conversely, colleges and universities implementing plans between four and six years described their initiatives in more general terms. For example, the Monterrey Institute for Technology and Higher Education created a strategic plan for the years 2015–2020 that, according to Monterrey, aims to function as "a living, working instrument; a compass to guide decision-making with the aim of achieving our set ideals and goals" and an effort to "align vision," "align organization," and "align culture." Similarly, the University of Malaya created a strategic sustainability plan for 2011–2015 that discussed goals in categorical terms with overarching strategies. These goals revolve around topics that include: teaching and learning; research, faculty and staff recruitment, development, and reward; globalization; infrastructure planning, development, and review; leadership, culture, and image; and financial sustainability and wealth creation.

ISCN researchers found that sustainability strategic plans that are 10 years or more outline strategies in primarily general terms, however they incorporate a variety of goals that span multiple departments and topics. As an example, the

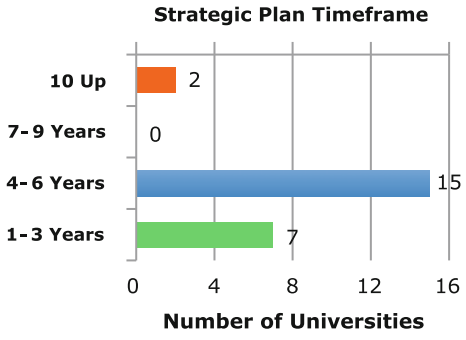

Fig. 3 Strategic planning periods for 24 sample ISCN colleges and universities

University of British Columbia's 20-year plan highlights overarching goals, but also describes particular strategies within each goal category. The overarching goal topics include teaching, learning, and research; operations and infrastructure; and University of British Columbia Community. However, unlike other strategic plans, this strategic plan also describes the initiatives taken to create its goals, including a description of the 2,000 people involved in goal development over a period of eight months.

In general, ISCN researchers observed that strategic plans appear to mostly follow general terms for goal and strategy descriptions for most of the universities reviewed. However, time frame and duration in which strategic goals are established vary, as well as the particular goals themselves. It is important to also note that these trends may change as sustainability goals and strategies continue to develop in higher education worldwide.

6 Conclusion: Strategic Planning for the Future

Review of literature and ISCN's sample members' sustainability planning reveals a trend to move beyond energy and waste reduction and instead move toward resiliency, university-city planning and modeling, health and wellness, and an overall wider scope of engagement and collaboration for region-specific and universal sustainability efforts. Transferable initiatives include resiliency and connection to place, particularly through adaptation strategies for climate change, as well as a shift in approach from focusing solely on individual institutions to collaborating with multiple colleges, universities, and communities.

There are also opportunities to learn from other sectors. For example, in the public sector, the European Union Covenant of Mayors Initiative on Adaptation and Climate Change created a comprehensive framework that provides funding to help Member States build up adaptive capacity and take action (Taking Action 2015). By following supportive frameworks, members of such networks and institutions are encouraged to adhere to a shared and clear roadmap, thus overcoming the limits imposed by local governance responsibilities. The role of international networks and institutions may also be helpful in diffusing protocols of commitments for the long term. Therefore, this is a possible opportunity for higher education institutions to extend their mid-term strategic sustainability plan horizons.

The private sector also provides learning opportunities for sustainability planning. For instance, private sector organizations have started determining and committing to long-term, quantitative, "science-based" targets in their strategic plans through efforts such as the Science Based Targets Initiative, a partnership between the Carbon Disclosure Project (CDP), United Nations Global Compact, World Resources Institute (WRI), and World Wildlife Fund (WWF), which "helps companies determine how much they must cut emissions to prevent the worst impacts of climate change" (About Us, n.d.). According to the Science Based Targets Initiative, "targets adopted by companies to reduce greenhouse gas emissions are considered

"science-based" if they are in line with the level of decarbonization required to keep global temperature increase below 2 °C compared to pre-industrial temperatures, as described in the Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (Commit to Setting Science-Based Targets, n.d.). A review of the differing approaches to strategic planning between the higher education sector and private sector is an area for future research that could help develop an understanding of the most effective approaches and goals in strategic sustainability planning.

ISCN researchers recognize that this paper only observed sustainability planning in 24 higher education institutions, and that there are many other examples of innovative sustainability planning strategies and trends in other colleges and universities. A limitation to this research includes its research period. ISCN researchers conducted this research during the year 2016 and longitudinal studies on strategic planning could outline themes and trends more thoroughly as they change or develop over time. Furthermore, this research was limited to ISCN sample schools. Additional research could incorporate institutions outside of this sample pool. The ISCN hopes to continue observing the growing developments and accomplishments of strategic sustainability planning in higher education globally and the trends and lessons learned from strategic planning in other sectors.

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Establishing Science-Society Networks for Transdisciplinary Teaching in Higher Education: The Case of Albania and Kosovo

Jonas Meyer, Friedrich M. Zimmermann and Audrey O'Grady

Abstract

The two Western Balkan countries Albania and Kosovo are in a phase of economic, social and environmental transformation for many years. This implies tremendous sustainability challenges such as air pollution, insufficient waste management and rural-urban migration tendencies. A lot of local stakeholder groups and civil society actors are searching for ways to tackle this situation. A new coalition between higher education institutions, society, and especially businesses can play a key role when developing transdisciplinary collaboration for education, training and knowledge exchange. This paper tries to argue about the role of transdisciplinarity in higher education in terms of networks as frameworks to develop long-term and impactful collaboration between science and society. The discussion is based on the results of the EU-funded TEMPUS project ConSus (Connecting science-society collaboration for sustainability innovations) where partner institutions from Albania, Kosovo and three EU countries are establishing a regional transdisciplinary network for sustainable development. Therefore, the network's statutes framework will be presented. It will be the basis for a discussion of possible opportunities and challenges when establishing such a network. As a result, the authors point out that regional transdisciplinary networks are of great importance in order to significantly tackle sustainability challenges. This is necessary when it comes to establish collaboration efficiently and to raise

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awareness within society as well as to propose and apply joint sustainability solutions.

Keywords
Transdisciplinarity · Albania · Kosovo · Science-society-networks · Sustainable development

1 Introduction

Transdisciplinary teaching and learning in higher education is a crucial prerequisite when aiming at tackling real world sustainability challenges. Students get in direct contact with societal stakeholders and organizations, become familiar with hands-on challenges and try to resolve them jointly in a scientific way.

Although exposed to environmental, societal and economical challenges, the two Western Balkan countries are lacking in transdisciplinary higher education experiences. The EU-Tempus funded project "ConSus" is an attempt to establish a transdisciplinary network in both countries. This network functions as an incubator of scientific and societal stakeholders in order to develop both sustainability innovations as well as transdisciplinary co-operations in higher education teaching and learning.

The objectives of this paper are to (1) outline the role of transdisciplinary teaching in higher education and networks as incubators for transdisciplinary collaboration; (2) review successes and challenges of higher education in Albania and Kosovo regarding science-society collaboration; and (3) draw future prospects for strategic transdisciplinary collaboration networks with the ConSus science-society network as a good practice example.

Consequently, the authors would like to answer the following research questions:

- How can higher education promote sustainable development through transdisciplinary teaching?
- What is the state of art regarding transdisciplinary collaboration on sustainable development in higher education teaching in Albania and Kosovo?
- Which strategies can contribute to science-society collaboration in higher education teaching with regards to sustainable development?

1.1 Higher Education Institutions as Key Institutions to Promote Sustainable Development in Society

Sustainable Development is understood as a learning process in order to bring change on environmental, social and economic challenges society is faced with (c.f. three types of sustainable development approaches by Scott and Gough 2003).

These learning processes need to be facilitated and promoted by education in order to build capacities, to think critically and to equip learners with skills for action. However, education for sustainable development also needs direct interactions with society (as stated as one of the six general goals of the UNESCO Decade for Education for Sustainable Development, UNESCO 2005). Higher education institutions and especially their educators and scientists have to fulfill the role as a bridging actor with society: Firstly, their expertise is crucial to tackle sustainability related challenges. Secondly, they function as learning facilitators for their students. Thirdly, they act as academic contact points for collaboration with societal stakeholders.

For this kind of collaboration between higher education institutions, students as well as societal stakeholders, transdisciplinary approaches became more and more important. Jahn et al. (2012) developed a conceptual model consisting of three phases where collaboration between scientific and societal stakeholders take place. Shortly described, these steps consist firstly of a problem transformation by forming a common research object. Secondly, new knowledge will be produced together. The third phase is dedicated to the evaluation of this new knowledge and its contribution to scientific and societal progress (transdisciplinary integration). The results will be implemented in each community (scientific and societal) by developing strategies, concepts (societal) or methodical and theoretical innovations (scientific). This will lead to new problems in both communities and the recurrent formation of a common research object. Such collaboration is seen as mutual learning processes and is not intended to replace established disciplinary practices. It is rather seen as complementary ways of extending viewpoints by integrating knowledge from societal stakeholders. As this concept is understood rather as a research approach than a theory or methodology, transdisciplinarity in teaching and learning needs a lot of additional theoretical, methodological and practical pre-requisites and skills incorporated by the academic staff. Furthermore, collaboration with external stakeholders needs to be established in order to create case studies (Balsiger 2015; Scholz et al. 2006).

1.2 Networks Functioning as Incubators for Strategic Transdisciplinary Collaboration

Networks play an important role and have already been discussed regarding their potentials in teaching and learning on sustainable development (e.g. c.f. Special issue of the Journal of Cleaner Production on “Learning for sustainable development in regional networks”, Dlouhá et al. 2013a). The establishment of networks in times of the knowledge society are crucial in order to reflect the demands of facilitating learning processes, co-producing resources and knowledge as well as maintaining cooperation and communication efforts. Additionally, they have the advantage of reaching a wider audience and promoting innovative learning approaches to stakeholders of different backgrounds and expertise (Dlouhá et al. 2013b). Within such transdisciplinary networks combining stakeholders from science and society the

level of interaction is emphasized by putting the learner at the center of attention. For this, it needs an open but structured communication and participation among all stakeholders.

2 The Case of Albania and Kosovo

The two Western Balkan states Albania and Kosovo face considerable environmental challenges. Among others, they consist of rising greenhouse gas emissions, contamination of water resources and insufficient wastewater collection. In addition, socio-economic challenges have seen only some improvement. For example, there is success with reducing poverty and reasonable economic growth. Also educational issues (quality and access) as well as healthcare have been improved in both countries (UNDESA and UNDP 2012; World Bank 2015). However, rural migration, causing brain drain as well as unemployment, especially amongst the youth, are still critical challenges to be tackled.

2.1 Higher Education Institutions in Albania and Kosovo and Transdisciplinary Networks

The role of regional higher education institutions in contributing to solutions is getting more and more important. Their scientific and methodological knowledge is crucial in order to tackle environmental, social and economic challenges. Overall, there are 59 higher education institutions (46 private) with 132.213 students in Albania and 26 universities (22 private) with 120.921 students in Kosovo (EACEA 2012). With regards to Albania only a few universities implemented strategic plans or structured initiatives regarding the promotion of education for sustainable development (e.g. University of Tirana, University of Durres, European University of Tirana, Polis University and Agricultural University of Tirana) (Dlouhá et al. 2014). Also in Kosovo only a few initiatives on education for sustainable development exist. E.g. a course on "Strategies of Education for Sustainable Development", provided at the University of Prishtina at the faculty of education (Beka 2015; Kabashi-Hima 2011). Apart from that, the University of Peja, the Riinvest College and the Universum College as partners within the ConSus project are now setting initiatives on implementing education for sustainable development, e.g. in specific programs and courses.

However, networks promoting education for sustainable development or even fostering on transdisciplinary collaboration do not seem to exist in both countries yet, although there is still interest from both scientific and societal institutions (Dlouhá et al. 2014). As a result of an identification and evaluation mapping conducted by the Albanian and Kosovar partner institutions of the ConSus project regional stakeholders were identified and listed as promising partners for a future science-society network on sustainability innovations (ConSus 2014). In this first

attempt 15 organizations from Albania and 24 from Kosovo have been identified as potential partners for transdisciplinary collaboration in sustainability related teaching and learning. According to a short survey conducted by the same partners they seem to have some experience in initiating activities and collaboration although not based on strategic guidelines.

2.2 The ConSus Project: Initial Situation and Goals

Started in December 2013 the EU funded ConSus project ("Connecting Science-Society Collaboration for Sustainability Innovations"; www.consus-tempus.com) is a first attempt to tackle sustainability challenges in Albania and Kosovo by (1) identifying and mapping sustainability related key players and networks in Albania and Kosovo; (2) establishing a regional network with members from both higher education, research as well as society; (3) developing and describing teaching methods and materials for higher education aiming at science-society collaboration and (4) providing professional development activities through training sessions on different sustainability related topics.

These specific objectives are driven by the motivation to strengthen the connection of different increasingly interdependent stakeholders of higher education institutions, research and society. Additionally, one of the main goals of this project is to promote mutual learning opportunities in order to acquire systemic and holistic thinking necessary for establishing transdisciplinary collaboration.

13 partner institutions from Albania, Kosovo and three European Union countries are working together in order to accomplish these objectives. Partner institutions from Albania are the European University of Tirana, Polis University, Agricultural University of Tirana and the Centre for International and Comparative Studies (all Tirana), as well as the University of Durres "Aleksander Moisiu". The partner institutions from Kosovo are the Universum College, Riinvest College and the Institute for Development Policy (INDEP) from Prishtina, as well as the University of Peja "Haxhi Zeka". Finally, the partner institutions from the EU countries are the University of Limerick (Ireland), the Leuphana University of Luneburg (Germany), the University of Natural Resources and Life Sciences Vienna, as well as the lead partner University of Graz (both Austria).

2.3 Activities of the ConSus Project

The main activities of the ConSus project are related to the specific objectives introduced above. Therefore, the first year was dedicated to the identification of the regional key players and networks of science, research and society dealing with sustainability challenges in Albania and Kosovo. The outcomes will be presented in a later stage of this paper as a pre-requisite of the establishment of a future transdisciplinary network. In the second year, the training activities as well as the development and description of teaching resources were conducted.

The **teaching resources** are seen as an essential outcome of the project. These are either *teaching methods* describing didactical and methodical processes, or *teaching materials* which impart sustainability topics in teaching and learning. More than 20 *teaching methods* have been described during the project. All of them share the aim to impart topics in a structured, participative and cooperative way. They are also characterized by different group sizes, social settings, integration of stakeholders and lengths. Some examples are World Café, Model CANVAS or Interactive Backcasting.

The teaching *materials* were developed and described by the academic staff of the Albanian and Kosovar partner universities. This type of resource is characterized by tackling a specific sustainability challenge in the respective countries and by the integration of external stakeholders from society. They consist of a detailed description, and a handout or presentation if applicable. Out of the more than 80 teaching materials examples include agriculture field trips, ecotourism case studies, corporate social responsibility workshops, teaching sustainable development to children training, development of social entrepreneurship business models or brain storming of specific social challenges. All teaching resources will be published on a web platform on the project website, with free access for those interested in these topics.

In order to provide mutual learning opportunities for the academic staff of the Albanian and Kosovar partner institutions six **training sessions** were conducted on different sustainability related topics with a strong relationship to Albanian and Kosovar challenges. The contents reach from multi-stakeholder learning and sustainability communication, regional development processes, ecology education elements, creative and transdisciplinary methods, strategy development to ecological sustainability and global change. All training sessions share a similar structure starting with a theoretical introduction and discussion of sustainability elements followed by in depth process with practical seminars using participative methods. Additionally, field trips to organizations or companies were conducted to enhance the knowledge and to discuss possibilities for interaction as a basis for science society collaboration or as good practice examples of science-society collaboration. As an added value, the participants (which mostly also were the authors of teaching resources) got the opportunity of a structured exchange and discussion of their teaching resource ideas and consequently were able to implement the feedback and hence improve the resources.

3 Methodology

A literature review on the role of higher education institutions in sustainable development, on networks and transdisciplinary approaches was conducted at first in order to build up a theoretical framework. Moreover, a survey was conducted during the project to identify possible industry and institutional partners from Albania and Kosovo for transdisciplinary collaborations in teaching and learning

(ConSus 2014). Results of this needs analysis are the basis and the structural elements for the development of the ConSus network (ConSus 2016). The establishment of this regional science-society network on sustainable development is the most crucial part of the ConSus project. This relates to its structure, its introduction and implementation, as well as the question how this network can gain strategic importance for future sustainability challenges as well as opportunities. Despite of the fact that each region has its specific sustainability challenges, institutional structures and network frameworks, the results of ConSus are essential for scaling up processes, e.g. as best practice cases for establishing transdisciplinary networks in other countries or/and regions.

4 Results and Discussion

The statutes of the ConSus-network consist of three pillars, Organization, Governance and Program (c.f. Table 1). The structure and the content was agreed by the project representatives of the partner institutions at the biannual management meetings, in Skype conferences and discussions via E-Mail. As a result of these communication channels the terms of references have been developed and agreed on.

The starting point of the establishment of a transdisciplinary network in this project was a survey among interested organizations (those identified in ConSus 2014) asking for their specific needs and benefits. Members from scientific institutions answered that they expect a better integration of sustainability related topics in higher education, a better exchange of information among stakeholders from science and society in order to understand the market as well as research papers addressing transdisciplinary and sustainability related topics. On the other hand, stakeholders from society expect stronger cooperation with research institutions and more expertise on specific topics for use and application in businesses and companies. One crucial topic which remains open is the challenge of funding such collaboration networks (ConSus 2016).

Table 1 The ConSus network statutes framework

Statutes of the ConSus network				
Organization				
Vision	Mission	Objectives		
Governance				
Members	Steering Committee	Secretariat		
Program				
Networking	Education & Training	Research	Dissemination Activities	Policy influencing

Keeping these needs in mind, the project partners tried to develop a concept of a network's framework (ConSus 2016 and Table 1):

In terms of "**Organization**" the *vision* of this network is to enable collaboration between actors from science and society towards a more sustainable social, economic and environmental development. This leads to the *mission* which is to empower partner's collaboration through education, research, training, knowledge transfer and encouraging partnerships promoting sustainable development. Thus, the main *objective* is to connect experienced stakeholders and those new to sustainable development and to increase their impact, to share information and to enhance sustainability. Four specific objectives were agreed on:

- "To foster education and learning for sustainable development in Albania and Kosovo and in the broader region of the Balkans"
- "To strengthen the collaboration between HE institutions and regional stakeholders (research institutions, NGOs, enterprises, regional development agencies, etc.) in Albania, Kosovo and in the broader region of the Balkans";
- "To be inclusive, i.e. open for everyone who is interested, develop strong relationships and shared responsibilities among the stakeholders, better connection between people and organizations from different disciplines";
- "Thematic focus on sustainability related issues in order to address regional challenges and demands" (ConSus 2016).

The "**Governance**" of the ConSus network will be provided by the members, the steering committee and the secretariat. All *members* meet regularly in order to adopt the report of the steering committee and to elect it for a new period. They also comment on and adopt the strategic directions and policies of the network. The members and target groups consist of diverse backgrounds:

- Scientific sector:
  - Higher Education Institutions
  - Research institutes
  - Think Tanks
  - NGOs affiliated to Universities or dealing with scientific research

- Societal sector
  - NGOs (which do not focus on scientific research)
  - Networks operating in the field of sustainable development
  - Enterprises (and networks)
  - Practitioners and experts in the field of sustainable development
  - Initiatives in the field of sustainable development

– Public sector/others:
  - Government officials responsible for sustainable development strategies and policies
  - Representatives of institutions of the European Union
  - International organisations (e.g. UN, OECD, GIZ, etc.)
  - Members of National Sustainable Development Councils
  - Other sustainable development networks in Europe
  - Stakeholders outside the traditional sustainable development community, but with a strong interest

The tasks of the *steering committee* are to develop the policy of the network and appoint other committees or working groups when necessary. It also establishes links with other networks and stakeholders, supports the members in exchanging knowledge and good practices as well as developing collaboration. The steering committee will also present a yearly activity report and convene the member's meeting regularly. It consists of a chair who is representing the network. In order to manage such a network a *secretariat* will be established. The secretariat keeps the network-website updated, organizes the ConSus member's meeting, national meetings as well as the workshops, training sessions, other outreach activities and research projects. It will facilitate the knowledge exchange and foster joint projects among the network members.

The "**Program**" consists of five pillars. Its aim is both to serve the needs of the members and to tackle sustainability challenges in the respective project countries.

(1) *Networking* will enable the members to get access to other members, networks, information, databases and activities. Specifically, there will be a transnational ConSus conference every two years, annual national ConSus seminars, as well as a member support desk at the secretariat
(2) *Education and training* activities will provide transdisciplinary teaching and training opportunities in sustainable development. They will be offered by the resource platform and already developed workshop and training concepts. Case studies and the involvement of regional stakeholders will be part of university courses
(3) *Research* will be conducted by the ConSus members through research studies, journals, policy papers and project reports on regional sustainable development issues.
(4) *Dissemination activities* will help to publish the outcomes of the network, to connect to the society and to attract future members of the network. This will be achieved by the website as a platform for information exchange and the provision of teaching resources. Furthermore, workshops at higher education institutions will support the dissemination of the network outcomes to teaching staff and students.

(5) *Policy influencing* aims at raising influence in the relevant public decision and policy making sectors of both countries. This will be done by promoting the importance of sustainable development to society through reports, policy briefs, discussions as well as expertise on priority issues. Furthermore, annual conferences and workshops should be conducted.

5 Future Prospective

By developing and applying this framework in the first period the partner institutions expect a proper start of the ConSus network (Table 2). The program should be filled in order to attract more interested stakeholders to participate at the network. Therefore, the concepts of the training sessions and workshops will be used for further activities. Also the resource platform will be part of the network in order to provide a range of teaching resources to be applied in higher education teaching but

Table 2 Possible opportunities and challenges of the ConSus network

	Organization	Governance	Program
Opportunities	• Wide range of members with different background can lead to promising cooperation opportunities • Scalability opportunities through memberships of public authorities	• Membership is open to each institution interested • Participation opportunities open for members • Members can attract a wide range of other institutions/individuals	• Different fields of expertise can be used to tackle a range of sustainability challenges • Concepts of training sessions, workshops and teaching resources are already existent, easy to implement • To inspire students with sustainable development through workshops and teaching resources • Establishment of transdisciplinary collaboration
Challenges	• Fill mission, vision and objectives with activities relevant to the needs of members and target groups • Need for both long-term strategy and mid- and short-term view	• Dependent on the willingness of the member institutions (to take over the secretariat, lead of steering committee, etc.) • Active and committed leadership of the steering committee • Secretariat has to commit to an appropriate facilitation	• Is up to the efforts of the member institutions • Financial challenges to organize activities • Need for an establishment of a consistent and sustained program to be established

also in continuing education. A very promising opportunity includes memberships of public authorities. They can help to scale up the network and to connect more intensively to relevant national or transnational stakeholders.

6 Conclusion

The establishment of a transdisciplinary network on sustainable development in Albania and Kosovo is a key objective of the ConSus project. Its aim is to conserve and further develop the outcomes of the projects as well as to act as an incubator of ideas and collaboration of scientific and societal stakeholders. These aims will be supported by the following conclusions:

6.1 Transdisciplinary Collaboration in Higher Education as Essential Requirements to Tackle Sustainability Challenges

Firstly, there is a need for participatory and transdisciplinary developed solutions including all relevant stakeholders and actors in order to tackle regional sustainability challenges. Higher education institutions and their educators are key actors with their international and intraregional network, their expertise and teaching skills in order to create and promote transdisciplinary collaboration for teaching, learning, training and continuing education. Consequently, students will get the opportunity to learn hands-on with transdisciplinary case studies and participative methods together with concerned societal organizations and companies—the focus is on interactive, reflexive and social learning.

Currently, but especially in the case of Albania and Kosovo such collaboration is not yet well established, but is already—close to the end of the project—seen as a promising way to build up collaboration, especially on socio-ecological issues. Thus, the ConSus project encouraged educators from the partner institutions in Albania and Kosovo to develop such collaboration and create research-based teaching materials based on innovative and interactive concepts tackling actual sustainability challenges, and integrating societal stakeholders by using new participatory methods.

6.2 Science-Society Networks Help to Establish Strategic Collaboration and Activities

Regional networks are the perfect instrument to overcome the lack of science-society collaboration in higher education teaching and learning (Dlouhá 2013b). They aim to raise awareness of sustainability related issues, challenges and opportunities and are able to tackle diverse aspects through transdisciplinary collaboration between

science and society. By embedding them strategically using specific forms of organization, governance and programs such networks can generate a lot of opportunities by making advantage of the wide range of members (individuals and institutions, private and public sector, NGOs and international organizations etc.) with different interests and expertise, as well as different forms of participation and commitment opportunities. The developed and available ConSus concepts of training sessions and workshops are an essential basis for the work in and the functioning of the networks. There are still challenges to be met and to be overcome, consisting of e.g. the proactive engagement of network members, the need for a long-term vision and mission, a reliable leadership of the steering committee and—in many cases most important—the lack of funding opportunities for the network and its activities. This crucial last point needs to be solved by applying new forms of public-private partnerships, by improving cooperation focusing on trust and by mutual learning processes—these approaches are promising frame conditions for further national and transnational funding (e.g. Erasmus + applications, funding for specific topics by ministries and by foundations).

6.3 The ConSus Network as a Good Practice Example for Regional Transdisciplinary Collaboration

The experiences gained in the three-year project with its goals and activities in professional development training for university educators, in the development of transdisciplinary teaching resources and in the mapping of relevant stakeholders from science and society are a good pre-requisite for the final step: the establishment of a transdisciplinary teaching and learning network connecting higher education institutions with its wide spectrum of knowledge and research, education and training with key stakeholders, companies and institutions from the civil society. This transdisciplinary network will connect the key actors for economic, social and ecological change and would be to think tank for sustainable development in Albania and Kosovo.

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Sustainability Integration Approaches in Higher Education Institutions. A Case Study

M.O. Bernaldo and G. Fernández-Sánchez

Abstract

This chapter focuses on the importance of Education for Sustainable Development in Higher Education Institutions. Two are the main objectives. First what is a sustainable university? Tools and approaches to assess the integrated contribution of universities towards sustainability are discussed. The ideal sustainable university, from each approach, is identified. But also the areas with the greatest contribution to sustainability according with the literature reviewed. Sustainability curricula and other academic activities (such as service learning or cooperation for development) are essential in this context. The second objective is how to stablish sustainability strategies towards an Education for Sustainable Development at an institutional level and at academic level. In this sense, it is developed an evaluation of a case study with sustainability in mind since many years (Universidad Europea de Madrid, Spain) based on the existing assessment proposals for a more real and practical understanding and to analyze the usefulness of these tools to propose a strategic plan towards an Education for Sustainable Development of any Higher Education Institution.

Keywords

Education for sustainable development · Sustainability assessment tools · Higher education institutions

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1 Introduction

At the World Conference on Higher Education held in Paris in July 2009 it is targeted towards new dynamics of Higher Education Institutions (HEI) and the need for research for social change for achieving Sustainable Development (SD). HEIs have the social responsibility to advance our understanding of multifaceted problems with social, economic, scientific and cultural dimensions and our ability to cope. Higher education should assume social leadership in global knowledge creation to address global challenges, which include food security, climate change, water management, intercultural dialogue, renewable energy, public health and DS but also training future professionals and decision-makers. Already in the Stockholm Declaration (1972), even though the concept was not yet fully defined, the necessary interconnection between education and SS.

In the literature there is a substantial consensus on the crucial role of HEIs to reach the SD (Calder and Clugston 2003; Fernández et al. 2014a, b; Mochizuki and Fadeeva 2008; UNESCO 2009).

HEIs, in carrying out its primary functions (research, teaching and community service) in a context of institutional autonomy and academic freedom, should focus even more on the interdisciplinary aspects and promote critical thinking and active citizenship, thereby contributing to sustainable development, peace and welfare, as well as to human rights, including gender equality (UNESCO 2009). There are many statements concerning sustainability in higher education, as Tallories Declaration, Halifax Declaration or Copernicus Charter. Lozano et al. (2013) performed a review of these statements or agreements related to Education for Sustainable Development (ESD).

ESD, for some authors imply a complete paradigm shift in education, since the current is considered part of the problem by giving importance to individualism, to behavior patterns and unsustainable consumption, etc. (Wade 2008). ESD could be, therefore, a new paradigm in curriculum development in the future (Pavlova 2009). The network EDS defines it as: "the process of acquiring the knowledge, skills and attitudes needed to build local and global societies that are just, equitable, and living within environmental limits of our planet, both now and in the future" (EAUC 2013).

Many universities have begun to incorporate provisions of the SD, but the lack of consensus on the way forward, with excessively abstract and new concepts (Lozano 2012; Ferrer-Balas et al. 2010; Jones et al. 2010) it is far from complete integration in university activities or curriculum (Hannover Research 2011; Waas et al. 2010; Wrigt and Wilton 2012). It is noteworthy that only about 15 of the more than 14,000 universities worldwide carry out regular sustainability reports (Lozano 2011), although there is no doubt about the importance of inclusion in the ESD. For Yasin and Rahman (2011) higher education is an important transformation of behaviors and practices towards SD.

The University is a complex system that interacts with many actors and in different areas. ESD should not only stick to the curriculum, it is essential to integrate sustainability in all its activities (Lee et al. 2013). According Lidgren et al.

(2006) and Lozano (2010) sustainability must be integrated in the areas of education, research, campus activities and the relationship with third parties (management, purchasing, etc.). It is logical that he has given special importance to plans and programs, trying to integrate knowledge, skills and related to sustainability (Segalás et al. 2009) values, but there are studies that reflect the importance of institutional support in the process, example by establishing their interest in the mission and vision of the University as well as at each school or faculty and degree (Lee et al. 2013).

For this reason it is considered very important to evaluate the universities to propose strategies to enhance their contribution to SD as an institution and as a center of education. Therefore it is essential to involve students in the assessment and the proposed improvements and actions by integrating projects both inside the classroom and outside it. It is considered particularly important the use of assessment tools that allow discern the degree of involvement of the institution in SD from the so-called "triple bottom line", i.e. the triple bottom line that includes economic, social and environmental aspects based on a continuous dialogue between the parties concerned (stakeholders). In this sense the Universities, in their integration within the University Social Responsibility (USR) in every area of activity, as representatives of the link between society and business, transmitters of knowledge and trainers of people and therefore future professionals whose activity impacts on the environment, must lead the incorporation of sustainability in the governance of the organization, planning and management of the university at all levels itself.

In this line, no less important is the academic field and therefore the development of strong skills in students that contributes to the formation of citizens endowed with ethical principles, committed to building peace, the defense of human rights and the values of democracy (UNESCO 2009). Therefore educational processes have to establish closer links between theoretical academic learning, implementation and different social needs. A focus on skills development approach, according to which the central element of training is not what the student finds out in his college but what he can do with what you know at the end of it, i.e. it calls for training professionals able to respond to social demands (Aguilera et al. 2010).

The process of European convergence is to influence the need to develop generic and transversal competences that integrate three types of knowledge, conceptual (to know), procedural (to knowhow) and attitudinal (to be) with competencies understood as elements develop knowledge, skills, attitudes and values in the educational process (Stevens 2008).

New educational models in the formation of global citizens committed to the eradication of poverty and sustainable development in a generation prone to critical consciousness, to encourage the individual's responsibility and commitment process is promoted. Educational processes facilitate personal transformation and allow changes in student's world view (Ortega 2014). Therefore, the development of transversal competences through academic and non-academic projects and problems with SD content, would favor awareness and professional and personal development of the student, while allowing the incorporation of new elements to improve the curriculum and identify new needs and research interests.

In this context it seems a priority to establish, on the one hand, a tool to assess the degree of implementation of sustainability at the institutional level and, on the other hand, the development of a competency model that favors the implementation of sustainability at the academic level, integrating the concepts of sustainability in all areas of organization, from specific programs to the general functioning of the university.

2 Objectives, Scope and Methodology

Two are the main objectives of this chapter. The first one is to know what is understood for being a sustainable university. It is intended to address the sustainability of HEIs in all related areas: campus operations, community outreach, assessment and reporting, institutional framework, research, and education. The second objective is to apply different approaches to a case study in both levels, institutional and academic level, to let others integrate sustainability strategies into their scope.

To reach these objectives, it is planned to do the following. To give a first analysis and review of the literature related, and the main approaches for assessing sustainability in universities. In this sense, it will be reached the first objective. To be able for generating a strategic plan based on sustainability issues towards an ESD in both levels, institutionally and academically, a case study is developed. Universidad Europea de Madrid, Spain, is used for gathering all the information and data required and the main approaches are used to analyze the viability and their capacity for creating such a strategy. The methodology used for analyzing different indicators was to measure and contact all stakeholders. Different tools and approaches refer to their own methodology that was followed to reach different indicator values.

The case study in a specific degree (BSc Civil Engineering) in the same HEI was selected. The application of sustainability issues was applied in two different senses. First, an important approach in sustainability curricula (skills, competences, knowledge and values related with SD), where the focus is in the class or in activities related with the courses of a degree. The second approach is service-learning based on cooperation for development (related or not with a specific course) as volunteer programs or projects. Its direct and indirect impact towards a SD is showed.

In this study there are some limitations, since there are some new proposals that are still not applied, so the main approaches from the literature are considered. In the case study, specific data are not provided since it is considered not important for the aim of the chapter since there are not applicable for other contexts. So in here the text is focused in the lessons learned and the possible replication in other HEIs or in other degrees, citing important references where more in depth results can be retrieved.

3 Sustainability Assessment Tools for Universities

Sustainability assessment for a particular organization such as universities is a complex task that requires establishing a common scope and procedures to make comparisons between different organizations on an even abstract and a delimited sustainability concept.

Although there are different methodologies to assess specific aspects of sustainability (GHG Protocol and ISO 14064 for carbon footprints, GRI CSR reports, OSHAS for labor rights etc.), currently there is no agreed methodology for assessing sustainability as a whole, but multiple proposals. These proposals, which originate either from specific research and doctoral thesis or from the universities in collaboration with other organizations involved in the promotion of sustainable development have proliferated in recent years and are constantly evolving.

The main difficulty arises from the fact that universities, like other schools, differ with other organizations that have a clear influence on the society of the future given its mission: training professionals at the high education level. It is therefore that cannot be limited only to be sustainable as an organization, but it should also include all these aspects within the curriculum to instill in tomorrow's society sustainable values.

For the evaluation of sustainability at the university, trying to compare similar parameters easily and affordably, it has been identified some tools and methodologies, with different scoring systems, questionnaires and, in some cases, weighting, taking into account both sustainability at the organizational level and at the level of curriculum. In this section, we present five of the main tools used for assessment of sustainability at the University, highlighting its main characteristics, scope and mechanisms to promote an improvement in the performance of the university evaluated.

- AISHE (Auditing Instrument for Sustainability in Higher Education), develop by Niko Roorda (Avans University, Países Bajos) as part of its strategy to implement "System Integration of Sustainable Development" (SISD) in universities (AISHE 2014; Roorda et al. 2009), in order to monitor progress in sustainability in each area by defining 20 evaluation criteria.
- SAQ (Sustainability Assessment Questionnaire), developed by the association University Leaders for a Sustainable Future (ULSF) for the analysis of the current situation of the institution and future planning on sustainability issues by studying seven critical dimensions of the university.
- USAT (Unit-based Sustainability Assessment Tool) develops doctoral thesis Muchaiteyi Togo, supervised and supported by Heila Lotz-Sisitka at Rhodes University, for use in the "Swedish/Africa International Training Programme (ITP) on Education for Sustainable Development in Higher Education" program promoted and funded by UNEP (United Nations Program for the Environment), to assess the presence of sustainable practices at the departmental level and get a more accurate assessment of the institution as a whole.

Table 1 Approches and scope of five sustainability assessment tools

Tool	Scopus
AISHE	Check progress in sustainability in every area
SAQ	Current situation of the institution and future planning in sustainability
USAT	Independently evaluate each department for more accurate evaluation of the institution as a whole
STARS	Publication of reports between universities
SUSTAINTOOL	Plans, lines of action or sustainability programs at the institution

- STARS (Sustainability Tracking Assessment & Rating System), developed by the Association for the Advancement of Sustainability in Higher Education (AASHE), designed for publishing reports of universities and the issuance of the relevant certificate in a format comparable between universities.
- SUSTAIN TOOL (Program Sustainability Assessment Tool), developed by the Washington University (St. Louis) for use with different programs and in different fields, assess the sustainability of different areas of activity of organizations.

The identification and analysis of these tools has highlighted the lack of an unambiguous and specific definition for university sustainability and the existence of a multitude of applicable methodologies in higher education. As biggest differences worth noting the approach applied in the data collection, the accuracy thereof and the need for documentary support is required. This lack of consensus on sustainability assessment methodologies in universities makes difficult to choose valid indicators for any university. In the following Table 1, it is showed the scope of these approaches.

The companies are currently using the memory GRI (Global Reporting Initiative) as an alternative tool for the preparation of sustainability reports, with the aim of increasing the quality, rigor and utility of sustainability reports. Companies of all sectors applied to evaluate the three pillars of sustainability, as well as some universities, thus assess their contribution to society with a perspective of the "triple bottom line" related to sustainable development, but now there are only some attempts (Bernaldo et al. 2016).

4 Curriculum Sustainability and Service Learning

The process of education convergence (e.g. in Europe with Bologna process) stresses the need to develop generic and transversal competences, understood as elements to develop knowledge, skills, attitudes and values in the educational process (Stevens 2008).

In the pedagogical approach of the USAT tool, there are integrated five skills in the curriculum: decision-making, critical thinking, sense of responsibility, respect for the opinions of others and problem solving. Therefore, the competence-based

model is considered relevant when it contributes to SD. Curriculum sustainability is considered a strategy that tends to facilitate the achievement of training objectives related to core competencies for sustainability in university graduates (Aznar 2009). Currently the process of implementing sustainability curriculum in HEIs is at an early stage (Fernandez et al. 2014a, b). Students are aware that the professional activities that they will develop throughout his professional activity cause direct impacts on the sustainability of the planet, from social, economic and environmental point of view. It is needed that professors provide tools, and knowledge, but also develop skills and values in their courses to contribute to SD. Professors training and a bottom-up approach are needed for the integration of sustainability at this level.

These competences are required to be implemented in the curriculum of all degrees, and it would help to solve the gap between theory and practice, forming sensitive students with sustainability criteria in mind, and to have the ability to make decisions and propose solutions according to these criteria. The development of transversal competences in class is considered an important contribution towards the ESD (Gijón and Hernandez 2010). In this sense the student participation in cooperation for development processes and projects is essential for learning in real scenarios while helping others in basic needs from their knowledge and direct action (Terrón et al. 2015).

Therefore, implementation of a competence-based model that favors the inclusion of the SD in the HEIs along with out-of-class educational activities that combine SD skills with projects based on service learning promote solidarity, mutual respect, human values and intercultural dialogue. Both approaches allow a better integration towards a real ESD in HEIs.

5 Application to a Case Study

In this section it is intended to apply some of the previous approaches to a case study, Universidad Europea de Madrid (UEM), Spain. This case covers two different scopes: institutional level and academic degree level. The main objective of this case study is to show the applicability and the application of different tools and approaches, and the utility for making strategic plans based on a common sustainability tool.

5.1 Institutional Level

The study conducted at UEM to assess the sustainability of the institution has been carried out from a research group with all stakeholders (Bernaldo et al. 2016). Departments and divisions from the institutions were involved to assess and apply these approaches. In this sesse, it has been developed the following action to obtain a first diagnostic of UEM sustainability:

- Segmented surveys by profile, assessing all items by different stakeholders with consensus.
- Personal interviews with experts and different members of the organization with the information needed. This stage has allowed to rethink some indicators and to identify in a deeper way all key stakeholders with the key information and data. The reflection during interviews and surveys is considered essential for the transformation process. Everyone is immediately involved because of the theme of contributing to SD from their part.
- Expert meeting, with a facilitator, in order to apply AISHE tool to reach a necessary consensus in this and other approaches.

In the graph shown in the Fig. 1, it can be seen UEM results for different tools and the What if scenario by implementing ten improvements to assess the improvement range. The score is near 40–50 % in every approach of what it is considered as an ideal sustainable university. From this initial picture, a strategic plan focused on sustainability issues at an institutional level, it would be viable to reach a score between 60–80 %, close to a great sustainable university. In the SustainTool tool there is a potential for improvement in relative terms of 109 %; SAQ 93 %; USAT 80 %; and AISHE 77 %.

These data are indicative of the strengths and weaknesses and allow creating an action plan by proposing measures to improve their score and therefore the contribution of the university to sustainability.

It has also performed the analysis of the University Social Responsibility (USR) on the basis of the last two GRI reports for the same case study but also compared with other six universities at an European level. From this assessment, in Table 2 is shown the response level for all mandatory indicators (48 major social and environmental indicators divided into 5 categories).

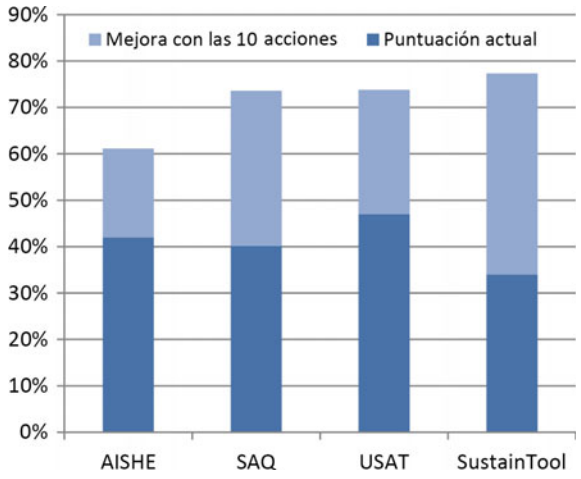

Fig. 1 UEM scoring following four approaches and with the scenario of a focused ESD action plan

Table 2 Response levels GRI report in USR

Response level percentage to mandatory indicators						
University	Total	Labor practices	Human rights	Society	Product responsibility	Environmental
Carl von Ossietzky	**54.2**	70	44.4	37.5	25	70.6
Eth Zürich	**33.3**	40	0.0	25	25	58.8
Hogeschool University Brussels	**16.7**	20	0.0	0	25	35.3
University of Cádiz	**35.4**	70	11.1	25	25	35.3
University do Minho	**39.6**	40	44.4	50	25	41.2
University Politécnica de Madrid	**14.6**	10	0.0	12.5	25	29.4
Universidad Europea	**72.9**	100	77.8	75	50	58.8
Average	**38.10**	**50.00**	**25.40**	**32.14**	**28.57**	**47.06**

When analyzing the results by categories it is clear that some categories had significantly higher response rates than others. Labor practices and environmental categories were significantly higher than the rest of the categories. These differences offer interesting interpretations of the way in which universities face and prioritize their responsibilities. The fact that the environmental category has a high response rate should not be surprising, as it is probably the area with more advanced legislation, besides being a subject of growing concern to the general public. Besides, action in this area often carries rapid and clear cost reductions. Additionally, most environmental indicators affect factors directly related to a university's operations and therefore directly controlled, whereas in other categories, many indicators relate to secondary factors or even issues outside the organization direct control. For example, in the category of human rights several indicators relate to how suppliers measure their own human rights performance, which while possible, it is not always easy to know how and how far up the supply chain this question should reach. From this assessment approaches (GRI reports), it is easy to check the status of any university and to implement an action plan. But this approach is closer to business organizations more than HEIs, where sustainability assessment tools have borned directly for the activity of teaching, learning, researching, definitely more focused in academic activity.

5.2 Academic Degree Level

Most institutions are currently at an early stage in the implementation of a sustainability curriculum. This implementation begins, in most cases, with the introduction of these concepts in different courses, usually by competences and integrating new knowledge and different teaching-learning techniques. In this sense, a literature review and a research study was conducted in some degrees at UEM, by implementing a curricular sustainability strategy. As an example, here it is shown the

case of Civil Engineering degree and the creation and implementation of a sustainability competence-based model in the curriculum (Fernandez et al. 2014a, b).

The methodology used for the creation and implementation of this competence model was to have identified all sustainability related competences from the literature, to classify and categorize those competences, values and knowledge and to create a participatory technique to reach a consensus among all stakeholders (students, professors, employers, staff and alumni). A core of sustainability competences has reached based on five transversal competences for the Civil Engineering degree, with their potential contribution towards SD, and the desired level of acquisition in this bachelor academic level (based on Bloom Taxonomy):

- Critical Thinking, 25 %, acquisition level of analysis.
- Problem solving, 18 %, acquisition level of analysis.
- Decision making, 12 %, acquisition level of application.
- Multidisciplinary teamwork, 22 %, acquisition level of application.
- Adaptation to change, 23 %, acquisition level of application.

The integration of these transversal competences is focused to be implemented by project based learning. In this degree, there is an annual project every year, finishing with a final degree project. So, two competences are integrated in each year project, including in the final project the five competences to be assessed. Specific competences and knowledge related with sustainability issues is also identified and implemented by surveying professors and experts in different fields of the degree and new themes are integrated in each course. A final survey after the degree is proposed to assess how these degree students are improving their sustainability skills, values and knowledge.

5.3 Extracurricular Academic Level

In 2009 the School of Architecture and Engineering at UEM initiated an international volunteer program in Ethiopia until 2012, and it has been started another volunteer project in Honduras which started in 2013 until now (Terrón et al. 2015). These cooperation for development projects are been utilized as a service learning methodology focused in the ESD context. During three years, students, professors, and Fundacion Cerro Verde as the NGO and local population have been working in synergic working lines. First, this project serves as a way of cooperating with local people in their basic needs (water, sanitation, buildings, and accessibility). But it also helps to our students in knowing a very different context, to apply their own specific knowledge, while developing transversal competences out-of-the-class (critical thinking, problem solving, decision-making, teamwork, and adaptation to change). An assessment was developed to know the potential of this kind of service-learning towards SD:

- Objective impact: to analyze the actual contribution of the project. This was clear after three years. In fact, a national award in Honduras was given to this project in Choluteca (Cerro Verde, Honduras). In this sense, the project in these three years has finished the installation of a water supply network, an electricity supply for 30 % of the people, some road improvements to access, and some improvements in the local school building. But there is still much to do.
- Subjective impact: it has been analyzed the perceived impact for local people of the intervention by surveys and interviews; and it has also been analyzed the volunteers' skills acquisition level compared with those students that were not involved in this kind of projects (with the scope of the Civil Engineering degree). Results show that for local population there is an apparent widespread public satisfaction with the project, improving their quality of life in some extent. About 70 % notes with enthusiasm the new opportunities generated. The results for volunteer students were clearly higher compared with those non-volunteers, in terms of level acquired of each sustainability competence. Qualitative data shows that the impact on personal lives of all volunteer students was unquantifiable, since they look to their professional contribution with a different view compared with their vision before the project. Indeed, some students are now civil engineering professionals working in cooperation for development in third countries.

All these results indicate that volunteering and cooperation for development projects may promote awareness and professional and personal development of the student, with the acquisition of new knowledge and skills, while the quality of life of the communities where it is involved is improved.

6 Conclusions

The Society of the XXI Century has the need and obligation to consider the future from the perspective of the SD. The space where it can be undertook a change of this magnitude with guarantees of efficiency and effectiveness is Education. This makes HEIs to be at the epicenter of change. To raise such a significant change in the development model means setting changes to institutional and academic level at each HEI. The particular characteristics of education and its institutions generate great difficulties in their full implementation.

The implementation of an ESD strategy at HEIs has been analyzed from different approaches. A review of some of the most important sustainability assessment tools is developed, showing their scopes, and checking their use in a case study. The lack of uniformity of the tools and scopes makes difficult to compare efforts and to select the best one. There is a for standardization at least in some issues to make possible the comparison and sharing good practices. However, existing approaches can be very useful for having an individual action plan for implementing improvements to

start the walk towards an ideal sustainability university. Now, there is no excuse for any institution to start measuring their efforts.

The implementation of ESD academically means to give continuity to the new teaching and learning methodologies, incorporating the new transversal competences in actual courses based on sustainability issues, but integrating also specific knowledge and skills of each degree. Specific projects, based on service-learning are considered essential and complementary for any action plan towards a sustainable university. In these projects, students put their knowledge at the service of people; enhance their specific skills (technical knowledge) in its practical application while developing their transversal skills and sensitivity towards sustainable human development through collaboration with third parties in a globalized world.

This chapter wants to contribute and enhance to other institutions, and academicians to change the world towards SD by integrating different measures in their institutions, but also to integrate different competences academically for adding value to future decision makers.

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What Do We Imagine the Campuses of Tomorrow Will Be like? Universities' Transition Toward Sustainability in the Light of the *Transition Initiatives*

Mª Ángeles Murga-Menoyo, Ángela Espinosa and María Novo

Abstract

Growing numbers of schools of higher education are seeking not only to improve the quality of teaching but also to reduce their own vulnerability to the environmental crisis; and in this effort they are taking advantage of any synergies they can get from the contributions of pro-sustainability citizen movements and groups. This paper looks at one such movement, the *Transition Initiatives*, with the aim of finding synergies that could help consolidate a kind of university campus where greening is not restricted to management, but also pervades degree, class and subject curricula. The objective of the paper is to identify the traits of the *Transition Initiatives*, its similarities with universities' vision of sustainable development and the steps it proposes for generating the kind of institutional management in continuous innovation that optimises the change toward sustainability. A hermeneutic methodology is used. The sources are bibliography and documents, reports and manifestos. The main contribution is to show where the *Transition Initiatives* and the university share parallels in their visions of sustainability and, based on that affinity, to point out the potential interest of a bottom-up organisational model for university management in

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continuous innovation and the optimisation of the change toward sustainability. The results leave open a path for future work to find empirical proof of the proposal's feasibility.

Keywords
Higher education · Sustainability · Organisational change · *Transition initiatives* · Self-organised communities · *Transition movement*

1 Introduction: Time for Change

The plentiful literature available on sustainability and higher education leaves no room for doubt about the growing importance of the issue on the international research agenda. Interesting reviews and overviews of the situation can be found in highly reputed specialised journals (e.g., Karatzoglou 2013; Lee et al. 2013; Amaral et al. 2015; Ceulemans et al. 2015; Lozano et al. 2013, 2015; Ramos et al. 2015).

The search for new ways of adapting to the demands of sustainable development has ceased to be a question of rhetorical talk for universities. It is now an increasingly pressing line of strategic action. There are many institutions of higher education that have begun to walk in this direction. Sometimes they are recognised with awards and mentions (in the United Kingdom, the Universities of Exeter, Lancaster and York were singled out for the Green Flag Award 2015; and Manchester Metropolitan University, the University of Plymouth and the University of Gloucestershire received the People and Planet Green League First Class Award 2013). But the problem is so urgent that the progress thus far can only be seen as slow and glaringly short of the mark (UN 2015a). We must renew the push and move more quickly and effectively toward the goal (Leal Filho et al. 2015).

Most of the time action in favour of change is driven by institutional policy decisions, whose efficacy is restricted by pre-existing institutional culture. The report on the UN Decade of Education for Sustainable Development (2005–2014) commissioned by UNESCO (Tilbury 2011) reveals that, despite the fact that the university community's sensitivity to sustainability issues has improved and there is even a rising trend in the indicators tracking sensitivity, the level of engagement, commitment and active participation of all members of the university community in the change toward sustainability is still clearly insufficient. This is a weakness, an urgent challenge, that must be addressed in order to comply with the post-2015 global agenda (UN 2015b, 4.7). It is vital to find new formulas that engage all members of the university community—teachers, students, managers, administration staff and service staff—in the difficult collective task of the change toward sustainability.

Different aspects of many different types (Leal Filho 2015; Barth et al. 2015), all reciprocally interconnected, are mixed up in the problem. They include contextual, axiological, cultural, institutional and organisational aspects. This paper concentrates on the organisational aspects. The conventional organisational models predominant in today's universities need to become more effective if they are to promote the change toward sustainability. And an effort of creativity is also required to find new alternative or complementary structures of organisational management to turn universities into smart organisations in transition steered by the principles and values of sustainable development (UN 1987; European Commission 2012; UN 2015b). As Espinosa and Jackson (2002) declare, educational reform processes (and the process in which universities are immersed is a process of educational reform) are sometimes using the wrong methodological focuses on organisational management, and that is one of the reasons why the change is proving ineffectual. Accordingly, the purpose of this paper is to explore the possibilities of non-formal, bottom-up organisational models for environmental management and curriculum management at institutions of higher education.

2 Background. Initial Framework and Premises

Publications on environmental management at universities are not in short supply. Some of them offer general literature reviews (e.g., Schmitt Figueiro and Emmanuel Raufflet 2015); others focus on aspects such as the dynamics of organisational change (Brinkhurst et al. 2011; Hoover and Harder 2015), management director issues (Lee and Schaltegger 2014; Wright and Wilton 2012; Wright 2010) and evaluation (Santini et al. 2016). More narrowly-focused research and case studies have also been published in all these categories. There also appears to be an incipient line of research addressing new ways of management to make the traditional borders between academic and non-academic functions permeable. The point of this new line of research is to tackle the complex interdisciplinary and multidisciplinary challenges posed by sustainability (Chambers and Walker 2016).

Among these new ways of management are the bottom-up organisational models. They open up an innovative line of work highly consistent with "a social learning and organisational learning perspective" and what are recognised as "linkages between participation and sustainability implementation" (Disterheft et al. 2012, 2015, p. 763). Bottom-up models have quite a tradition behind them in social and community spheres but have hardly made a dent at universities. There is a gap that it is hoped this paper will help lessen. We consider that good non-formal organisational practices that work in the social sphere could contribute elements to improve the management of institutions of higher education. We propose to draw attention to this possibility by looking more closely at one such case whose significance in the realm of sustainable development is well recognised.

Our attention is focused on the *Transition Initiatives (Transition Movement)*, a robust social experiment in the paradigmatic framework of sustainable development, which in December 2012 received the Civil Society Prize of the European Economic and Social Council (EESC). It is made up of a wide range of diverse grass-roots initiatives, all sharing a bottom-up organisational structure. We consider that, with the right adaptations, the innovative organisational dynamic of the *Transition Initiatives* could be transferred to the university context; that it moreover could be considered an effective complement to the organisational dynamic currently prevailing in traditional university institutions.

An initial premise of the research is the necessity to foster a "bottom-up" organisational change in which all the members of the university community, especially academic staff, must be involved (UN 2015b, 4.c). The hypothesis is that the *Transition Initiatives* set the benchmark by virtue of its organisational model, which favours resilience and community ties, and other characteristics (e.g., its holistic focus, openness and flexibility, commitment to ecology, innovation and creativity, participation, transdisciplinarity, bond with the environment, networking). All these features are covered in detail in the literature available (Barr and Devine-Wright 2012; Barry and Quilley 2009; Bay 2013; Callaghan and Colton 2008; Connors and McDonald 2011; Smith 2011; Taylor 2012).

The following research questions were asked: Are there points where the vision and principles of both the university and the *Transition Initiatives* agree with respect to sustainability? Is a bottom-up organisational structure consistent with the vision and principles universities have declared in connection with sustainability? Theoretically speaking, could this type of organisational structure be compatible with and complementary to the traditional organisational structure of institutions of higher education? This paper aims to answer these questions using a hermeneutic methodology. First, a bibliographic review spells out the characteristics, defining traits and the organisational model of the *Transition Initiatives*. This is followed by an analysis of significant institutional documents (manifestos) issued by universities and a synoptic look at the traditional top-down organisational model. Lastly, the similarities that form the basis for the conclusions are established.

3 A Model Based on Self-organisation: Transition Initiatives

In *Great Transition,* the well-known report on the years of prospective research done by the Global Scenario Group (GSG) with the sponsorship of the United Nations Environment Programme (UNEP), Raskin et al. (2002) asserted at the dawn of the century that a great change of uncertain outcome had begun, a change toward a planetary society. And one of the possible future scenarios from the various ones that the report analyses, emphasizes the priority of *being* over *having*, material sufficiency, global equity and the consideration of the human being as an

eco-dependent being deeply linked to nature and to the community of life that is the biosphere. Many initiatives that have arisen spontaneously the world over to make up the *Transition Initiatives* fall within this option.

3.1 From the Transition Movement to Transition Initiatives

The term "transition" is taken from the movement that Hopkins (2008) began in the town of Totnes, UK, based on a pilot experience, the Energy Descent Action Plan in Kinsale, Ireland. It designates a process of social transformation, a deep change through which communities adopt new frameworks of behaviour (Goude 2011; Goude and Strong 2013) consistent with the demands, principles and values of sustainable development declared by the UN (1987, 2015b).

To describe the movement, different terms have been coined. The first initiatives emerged in small towns that called themselves *Transition Towns*, and they mostly involved all the population. But soon initiatives joined the movement that were made by self-organized and self-regulated groups of people within conventional cities or even institutions. Hence the name of *Transition Initiatives* arises. Generically, the term normally used is *Transition Movement.*

The foundation of the movement lies in permaculture, a focus that arose in the 1970s in Tasmania, Australia, at the time of the first oil crisis. Its mission: to build sustainable human settlements. Although permaculture does not overlook any of the many aspects of daily life (housing, transport, clothing, etc.), its main focus of attention is food, and more specifically the artisanal production of foodstuffs through ecological farming (organic farming). Permaculture is a holistic, systemic focus directly aimed at sustainable development (Mollison and Holmgren 1978; Holmgren 2011; Smith and Dawborn 2012). The *Transition Initiatives* share the same features.

The principles of Transition as described by the movement's founder (Hopkins 2011, p. 78) are: "(1) Positive visioning. (2) Help people access good information and trust them to make good decisions. (3) Inclusion and openness. (4) Enable sharing and networking. (5) Build resilience. (6) Inner and outer Transition. (6) Subsidiarity: self-organisation and decision making at the appropriate level".

The five hundred initiatives "transition" are networked together all over the globe, as shown in Fig. 1. Not only are they numerous; they are diverse. However, they all share the common denominator of building communities "bottom-up" that are meeting the situation to come head-on and are prepared to face the inevitable widespread descent in the material standard of living. This descent, which is already in sight, is caused by the combined action of two strong socially destabilising factors: climate change and the rising price of energy due to the exhaustion of fossil reserves. Three reciprocally interdependent concepts make up the tripod at the movement's base: resilience, adaptability and transforming change (Hopkins 2008). These are also the paramount abilities that each initiative seeks to enhance in its community by means of individual and collective change.

Fig. 1 Map of *Transition Initiatives.* https://www.transitionnetwork.org/initiatives/map (October 2015)

One characteristic trait that differentiates *Transition Initiatives* from seemingly similar experiences is that they are self-generating. In *Transition Initiatives* the initiative comes spontaneously from the group without being triggered by any outside agent. The participants have a strong sense of identity and a strong bond with their context. *Transition Initiatives* proposals are not experiences foreign to the life of the pre-existing community, but in fact arise precisely from the life of the pre-existing community, within its everyday reality, and are highly inclusive and integrating.

Citizens organise themselves democratically to cope with what they feel to be a need, and they do so spontaneously. Thus there arises a dynamic that is the consequence and at the same time the cause of a self-regulated organisational structure. One key aspect at the outset is that there must be a critical threshold of awareness. This threshold may be triggered by multiple factors, such as awareness of a problem situation, roused by communication about needs, problems, new ideas and ways of dealing with them. The organisational dynamic is one that is highly favoured by transparency and good governance.

3.2 A Tripod at the Base of the Transition Initiatives

The common denominator of all the initiatives in the movement is their aspiration to build a community based on the three interdependent capabilities of resilience, adaptability and transforming change. None of these concepts was originally forged

by the movement, but it has certainly taken them to its heart and given them a sense of achievement.

The concept of resilience was developed in the fields of ecology and mathematics, although early on it was transplanted into other scientific fields. For example, from psychology, resilience has been defined as "a dynamic process encompassing positive adaptation within the context of significant adversity" (Luthar et al. 2000, p. 543). This perspective is useful for understanding the personal dimension of resilience, which *Transition Initiatives* never overlook (Prentice 2012).

At all events, the concept is a transdisciplinary one and has not yet been exhausted from the semantic point of view. But due to its vast potential, it has become quite widespread. And it has given rise to a new paradigm that is closely linked to sustainability (Holling 1973; Folke 2006; Carpenter et al. 2001; Janssen et al. 2005; Lebel et al. 2006; Berkes and Seixas 2005).

From this latter standpoint, priority goes to the systemic social and community dimension of the concept. Resilience is understood, widely and foremost, as the capacity of the system/group to anticipate, deal with, withstand and recover from extreme impact. It has been defined by the Resilience Alliance (2015) as

> the capacity of a social-ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions. It describes the degree to which the system is capable of self-organization, learning and adaptation (based on Holling 1973. Gunderson and Holling 2002; Walker et al. 2004).

Complementarily, to set the concept in context within the framework of the *Transition Initiatives*, the suggestive psychological thesis enunciated by Masten (2001) must also be taken into consideration. Masten claims that resilience is a "normal" adaptive process for humans but requires group support and satisfactory intra-group relations (support and protection systems, systems for communication and creation of emotional ties, systems of intrinsic motivation; systems very much like what are called "adaptive systems" in children: attachments, democratic child rearing, etc.). This approach is in tune with the potential for fostering member resilience that can be found in the kind of organisational structure that *Transition Initiatives* have.

Sometimes the concept of resilience has been compared with the concept of sustainability, although "sustainability" has a positive connotation of a desirable state or quality that "resilience" lacks. The numerous definitions of "resilience" in academic literature suggest applying the term to the response to an aggressive external change of negative connotations that must necessarily be dealt with if the system is to survive. The standard pattern defines "resilience" as the capacity to self-organise in response to a change while maintaining the same function, structure identity and feedback (Berkes et al. 2002). At all events, a resilient system, whether it is an individual or a group, is a dynamic system that owes its survival to transformations resulting from the internal changes the system is capable of making in

adaptive response to external changes. And in these changes the characteristics of the organisational model that is managing the system play a decisive role.

Closely related with the concept of resilience is the concept of adaptability, which can also be applied to individuals as well as communities in the *Transition Initiatives*. "Adaptability" is defined as a system's ability to regulate itself, i.e., to adjust its structure or its processes, to experiment and to learn. These are changes that happen either to counteract aggressions from the outside and their attendant potential harm or else to seize opportunities to benefit the system, for optimisation and evolution. A system's adaptability stands in inverse relation to its vulnerability.

The third concept, transforming change, characterises the type of adaptation that communities in transition toward sustainability promote. It is a radical change in individual and collective attitudes and values that leads the group's members to behave in new ways that are consistent with what biological, social and economic systems can do to respond to the needs of human life on the planet now and in the future. In short, it is a transforming change that leads to the consolidation of a new sociocultural pattern and its corresponding lifestyle. As the Resilience Alliance (2015) correctly asserts:

> Transformation involves fundamental change, which in the context of sustainability, requires radical, systemic shifts in values and beliefs, patterns of social behaviour, and multilevel governance and management regimes (quoting Olsson et al. 2014).

And, drawing on Walker and Salt (2006), the Resilience Alliance defines transformability as:

> the capacity to create a fundamentally new system (including new state variables, excluding one or more existing state variables, and usually operating at different scales) when ecological, economic, and/or social conditions make the existing system untenable.

Being resilient, adapting and transforming make sustainability possible in natural and social systems alike and in the people who are the system's components. All three capacities are things that *Transition Initiatives* seek to encourage in their members, considered individually and collectively. All three are closely linked to the organisational structure model that is characteristic of the movement.

3.3 The Organisational Management Model

The characteristic peculiar to all the initiatives adhering to the *Transition Initiatives* is their pattern of organisational behaviour: self-organised, self-regulated group behaviour. This is one of the most significant differences between *Transition Initiatives* and conventional environmental groups (Hopkins 2008, p. 135) and the source of the model's organisational advantages.

Initiatives rest on an organisational model that is conventionally classified as "informal". What makes it different is that it develops organically and spontaneously according to the social dynamics of its members: personal relationships, social networks, common interests, sources of emotional motivation, etc.

(Castells 2012). In this peculiar feature lies the potential of *Transition Initiatives*' organisational model to foster endogenous development (as sustainable development must be), thoroughly contextualised, linked at the roots to the socio-ecological environment of the persons who lead it and focused on the needs, interests and priorities which those involved take to heart (Novo 2006). It is an organisational model that facilitates a process of change "seen from the South", to use a geographical metaphor of inclusion; a process of change whose main capital is the web of relationships woven by the community, which is in turn itself a builder of community. As Fuente Carrasco (2012, p. 10) neatly puts it, the notion and construction of autonomy play a fundamental role in defining the directionality of this community ethos and its chances in confrontations with social exclusion and unsustainability.

Furthermore, in the self-organised behaviour of the community in transition, which involves autonomous processes of structuring and restructuring, learning and organisational change happen for adaptive, optimising purposes. This is a model that permits a type of organisational management that is oriented toward improvement, as was shown by Espinosa et al. (2011) and later by Espinosa and Walker (2013), when they applied the Viable System Model (Beer 1979) to non-formal organisations of this type.

To facilitate these processes, there is an open sequence for each initiative's project to follow in its implementation. The group's steps forward are adapted to fit the dynamics determined by the particular context in question. However, as shown in Table 1, there are guidelines, rather like steps facilitating good results, which roughly steer the process.

This first process sequence, was later streamlined by the author himself to just five steps (starting out, deepening, connecting, building and daring to dream) (Hopkins 2011, p. 14). Resilience Alliance (2015) recommends following three stages: "(1) preparing for change, (2) navigating the transition, and (3) building resilience of the new trajectory of development". They are conceived as a road map, a suggestion, a starting place for initiatives. But could this road map be used at

Table 1 The Twelve steps to pull off an initiative

1	Set up a steering group (temporary)
2	Raise awareness
3	Lay the foundations
4	Organise a great unleashing
5	Form groups
6	Use open space
7	Develop visible practical manifestations of the project
8	Facilitate the great re-skilling
9	Build a bridge to local government
10	Honour the elders
11	Let it go where it wants to go
12	Create an action plan

Source Hopkins 2008

universities? Do such proposals fit into the framework of institutions of higher education? Is the bottom-up organisational structure compatible with the traditional structure of the university as an institution? Can it contribute to the re-tooled mission that universities must fulfil now that they have accepted sustainability as a core element of their vision?

4 Universities: Smart Organisations Transitioning Toward Sustainability

For decades now universities have been accepting the challenge of sustainable development and taking steps in the direction of sustainability. In the 1990s, while Agenda 21 was being passed at the historic United Nations Earth Summit on Environment and Development (Rio 92), important university forums were held that outlined the role of universities as facilitators of sustainable development: Talloires (ULSF 1990), Halifax (IAU et al. 1991), Swansea (ACU 1993), Kyoto (IAU 1993), San José de Costa Rica (OIUDSMA 1995), Thessaloniki (Unesco 1997), Paris (Unesco 1998). The following example is drawn from the Copernicus Charter signed by 328 universities and centres of higher education in 38 European countries (Copernicus Campus 2005, p. 38):

> Universities shall incorporate an environmental perspective in all their work and set up environmental education programmes involving both teachers and researchers as well as students - all of whom should be exposed to the global challenges of environment and development, irrespective of their field of study (CRE-Copernicus 1994, p. 37).

There was also a widespread movement to create associations and networks to generate facilitating synergies. And the process gathered speed as universities created their own versions of Agenda 21, all of which necessarily upheld four principle lines of action (UN 1992):

1. To make institutional management sustainable.
2. To raise the university community's awareness of the goals, principles and values of sustainable development.
3. To teach students green competences and competences for sustainability, as an explicit objective in all degrees and programmes.
4. To include sustainability as a framework paradigm for research.

Numerous institutions have been implementing actions with this focus for decades, mainly on two fronts. The first is the greening of management, a realm in which universities, like any other actor in social life, are called upon to pursue significant goals such as efficient resource use, the reduction of waste and pollutant emissions, participative governance, the practice of diversity and inclusion and the introduction of ethical criteria in their relations with suppliers (e.g. Larran Jorge et al. 2015; Geng et al. 2013; Lozano 2011). The second front is mainstreaming sustainability through curricula, a process directly related to the inherent

idiosyncrasy of universities as educators. Because universities are specifically dedicated by society to performing the function of training citizens at the highest educational level, their challenge consists in introducing the principles and values inspiring the sustainability focus into the curricula they teach. And they must do this in such a way as to effect a change in the awareness of individuals, and such that everyone leaving university will have acquired the capacities and competences necessary to contribute responsibly and in an active commitment to the consolidation of sustainable societies (e.g. Aznar Minguet et al. 2016; Can et al. 2015; Dlouha and Burandt 2015; Azeiteiro et al. 2015; Pappas, Pierrakos and Nagel 2013; Aktas et al. 2015).

On both fronts, management greening and the mainstreaming of sustainability in curricula, there are, as mentioned before, examples of good practices that show the wisdom of some of the institutional policies behind them. But they are not significant enough to consolidate a widespread change. As was argued before, this change would require innovative forms of environmental and curriculum management guaranteed not to clash with universities' vision and mission statement.

4.1 Vision and Mission Statement

The universities that have gradually allied their institutional policies with the change for sustainability are not few in number. Their public manifestos, statements and other ad hoc documents reflect their vision of sustainable development, their adherence to the principles and values that characterise sustainable development and the role they see themselves as holding. For a closer look at this view, we have chosen to concentrate on a significant worldwide network of institutions of higher education, namely the Global Higher Education for Sustainability Partnership (GHESP), made up of all kinds of universities, with their different branches of studies. It is a network of universities created in 2002,[1] a recognised partner of the United Nations in issues referring to higher education for sustainable development. It is an amalgam of two longstanding previous networks, the worldwide Association of University Leaders for Sustainable Future (USLF), known as the Talloires Network, headquartered in Washington, and the European Copernicus-Campus University Network for Sustainability, supported by the Association of European Universities (CRE). The two were joined by the International Association of Universities and United Nations University to form the worldwide partnership. They have UNESCO's support.

GHESP is a member of the Partnerships for SDGs, an on-line, open-access platform that will be fully operational in 2016, conceived as a tool for international information and communication about goals, progress and innovative ideas concerning the United Nations' 2030 Agenda for Sustainable Development (UN 2015b). We will analyse the objectives that the GHESP assumed when it joined the

[1] http://www.iau-hesd.net/en/actions/2276/global-higher-education-sustainability-partnership-ghesp.html.

Table 2 General objectives of the partnerships for SDGs

1. Promote better understanding, and more effective implementation of strategies for the incorporation of sustainable development in universities and other higher education institutions. Emphasis is put on the need for interdisciplinary approaches to teaching and research
2. Identify, share and disseminate widely effective strategies, models and good practices for promoting higher education for sustainable development (HESD)
3. Make recommendations on Higher Education for Sustainable Development (HESD) in consultation with key Northern and Southern stakeholders
4. Work closely with the UN system to develop and implement this joint action plan addressed to achieve common goals; and analyse and evaluate this experience as an international demonstration project

Source GHESP: https://sustainabledevelopment.un.org/partnership/?p=1534

platform and the vision and mission its member universities recognise in their own manifestos.

The general objectives of the Platform, which answers the needs of the High-level Political Forum on Sustainable Development,[2] are presented in Table 2. These objectives express a specific operational statement of a vision consistent with the manifestos subscribed to by member universities of all continents and countries [Talloires Declaration (USLF 1990); Copernicus Charter (European Commitment to Higher Education for Sustainable Development 1994); International Association of Universities (IAU 1959, 2013); United Nations University Charter (UN 1973)].

Analysis of the objectives on the list highlights four especially signal aspects of the text: (a) the commitment to change toward sustainability; (b) the need for interdisciplinary approaches; (c) the urgent need to contact key actors, in what might be interpreted as a summons to join; (d) institutional leadership. They are all in turn dealt with in the manifestos that reflect the vision of the member institutions of the GHESP network. Here are some examples:

- "Universities shall encourage interdisciplinary and collaborative education and research programmes related to sustainable development as part of the institution's central mission" (Copernicus Charter).
- "Encourage involvement of government, foundations, and industry in supporting interdisciplinary research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with community and nongovernmental organizations to assist in finding solutions to environmental problems" (Talloires Declaration).

[2]Forum created to replace the former Commission on Sustainable Development (CSD) of the United Nations Division for Sustainable Development.

- "The University shall disseminate the knowledge gained in its activities to the United Nations and its agencies, to scholars and to the public, in order to increase dynamic interaction in the worldwide community of learning and research" (United Nations University Charter).
- "Universities shall take the initiative in forging partnerships with other concerned sectors of society, in order to design and implement coordinated approaches, strategies and action plans" (Copernicus Charter).
- "Universities are increasingly called upon to play a leading role in developing a multidisciplinary and ethically-oriented form of education in order to devise solutions for the problems linked to sustainable development" (Copernicus Charter).
- "Use every opportunity to raise public, government, industry, foundation, and university awareness by openly addressing the urgent need to move toward an environmentally sustainable future" (Talloires Declaration).

The manifestos themselves also mention the need for: (a) the promotion of capacities; (b) lifelong education; and (c) the overall social responsibility that it is the university's duty to honour in connection with sustainable development:

- "Create programs to develop the capability of university faculty to teach environmental literacy to all undergraduate, graduate, and professional students" (Talloires Declaration).
- "Universities shall demonstrate real commitment to the principle and practice of environmental protection and sustainable development within the academic milieu (…) Programmes to develop the capacities of the academic staff to teach environmental literacy" (Copernicus Charter).
- "Institutions of higher education pay particular attention to their role(s) in realising processes of lifelong learning for sustainable development by involving formal, non-formal and informal learning in this direction" (Copernicus Charter 2.0).

The principles and values reflected in the manifestos require their subscribers to employ an innovative focus consistent with those same principles and values. Member universities take on a very important social commitment, one that requires a systemic restructuring of the institution to integrate the new focus points with the university's traditional missions. As a result, member universities are forced to re-consider their organisational structure and management model, which are by their very nature dependent on the institutional vision and mission.

4.2 The Traditional Organizational Management Model of Universities

While the university has experienced changes in its functions since its creation in the Middle Ages, it has always changed more slowly than social demands, and

without significantly affecting its organisational management model, which is characterised by its vertical structure.

In recent decades, the trend toward change has accelerated exponentially in, among other aspects, governance and institutional management. Traditional universities used to be characterised by a hierarchically organised government devoted to teaching and research and little interested in forms of management or the institutional organisation structure. However, since the seventies, the democratization of western societies, with the resulting pressure towards higher accountability and quality levels, has reoriented the attention focus towards factors and elements that impact the organizational efficiency. The management of universities has now greater importance, as well as the objective of identifying the institutional behaviours that foster a good education of the students, an adequate academic organization and a balanced and transparent use of the financial resources.

However, from an organizational point of view, the typical operations of the university institution are still structured in different areas that act mostly as completely isolated. And there also still exists a strong teaching autonomy. The universities maintain as a sign of identity the academic freedom of their members (intellectual autonomy), which is supposed to foster the creation of knowledge, critical thinking and innovation. Teachers continue to enjoy full powers to plan and implement the teaching processes in the classrooms.

The teaching practice is an activity with very high levels of independency, and is subject to what is known as "teacher isolation" (Descombe 1985; Murray 2007), with its advantages and disadvantages. This is a phenomenon defined by ERIC-Thesaurus as "a condition of professional individuals or groups characterized by lack of communication or interaction with colleagues, the relevant professional community, or related professional organizations".[3]

This feature, which coexists with a hierarchized organizational structure, is a barrier to the implementation of top-down institutional innovation processes. Theories and studies on higher education emphasize that, in universities, the implementation of the key decisions depends on the academics, since it is they who carry out the teaching and the research, both of which are the more genuine functions of the institution. For this reason, any institutional transformation needs necessarily the commitment and support of teachers. Consequently, the university has been classified as a special or exceptional form of organization (De Vries and Ibarra Colado 2004).

These circumstances, which are present in the top-down university management model, reveal the difficulty of enacting any deep-reaching transformation such as the one required by the new vision and mission of institutions of higher education. The emergence of bottom-up networks committed to change needs to be facilitated. And in this strategic action, the experience of the *Transition Initiatives* seems to be of significant import. The points covered so far, will now be analysed with regard to the theoretical consistency and possible synergies between the two agents that both have declared their commitment to sustainability.

[3] http://eric.ed.gov/?ti=Professional+Isolation.

5 Universities *Versus* the *Transition Initiatives*. Complementary Features and Parallels

Analysis of documents and manifestos shows that, of the various points where universities and the *Transition Initiatives* are dissimilar, there are three main differences. These differences are logically reflected in the way in which each addresses the challenge of sustainability from the organisational standpoint. The first and perhaps most significant difference is that *Transition Initiatives* proposals lie entirely within the framework of sustainable development. They were born there. Universities committed to the new paradigm of sustainability, on the other hand, are forced to change their whole institutional direction, sometimes in a complete about-face.

The second difference is that the *Transition Initiatives* have highly specific, well-drawn goals that are easily made operational and moreover are established via participative community-wide processes. However, universities have multiple functions, as might be expected of any institution that has lasted for centuries, and these functions are sometimes difficult to balance evenly with one another. They require large-scale organisational management, which hampers participative decision making and the ranking of priorities.

Furthermore, while universities see themselves as actors in a globalised world (the very etymological roots of the word "university" are a permanent reminder of their aspiration to universality), *Transition Initiatives* are strongly tied to the local context (Felicetti 2013), bound to the culture of their site and uninterested in what is happening outside; they have greater flexibility and capacity to manage participation.

However, parallels may also be drawn, and complementary features may be found. Table 3 indicates certain elements and points where the two agree, after recognising the radical differences between their organisational model, one top-down and the other bottom-up.

The points where the analysed texts clearly agree are: the interdisciplinary focus (although for universities this continues to be a decades-old aspiration rather than a consummated fact); lifelong learning; the promotion of capacities and transforming change; the wish to share and spread good practices; and the commitment to act for sustainability.

But there are also five traits solidly instilled in the *Transition Initiatives* that universities do not explicitly embrace in their manifestos. Judging from the texts, community commitment (by the individual and the group), distributed leadership, the search for resilience and adaptability and informal organisation seem foreign to the university tradition. They are, however, constants in the good practices of the *Transition Initiatives* that have significantly succeeded at re-routing communities' patterns of conduct, use and social customs toward sustainability. These traits are closely related to the movement's bottom-up organisational model. In these traits, and in the underlying organisational model, universities could find some inspiring ideas for the two paths that sustainability requires it to travel: that of mindset and that of organisation.

Table 3 Transition Initiatives versus University, similarities and differences

Trait		Transition initiatives	University
Structure	Hierarchical		✓
	Non-formal (and networked)	✓	
Principles	Interdisciplinary focus	✓	✓
	Top-down leadership		✓
	Bottom-up leadership	✓	
	Lifelong learning	✓	✓
	Community commitment (by the individual and the group)	✓	
Objectives	To promote capacities	✓	✓
	To promote resilience	✓	
	To promote adaptability	✓	
	To promote change (sustainability)	✓	✓
	Overall social responsibility		✓
	To take comprehensive, integrated action for sustainability	✓	✓
	To share and spread good practices	✓	✓

Source Authors

6 Conclusions

When this research began, the idea was to examine the relevance of the *Transition Initiatives* as a reference for organisational innovation at universities. In the light of the literature, it may be re-asserted that this innovative social experience (which is internationally recognised for its consistency and efficacy in social change toward sustainability) provides proof that culture and community participation are key variables on the road to sustainability.

Analysis has revealed the affinities in the vision and principles of universities and the *Transition Initiatives*. We may then deduce that the bottom-up structure characteristic of the movement, whose efficacy for reaching sustainability goals is proven, could help reach the same goals in the context of higher education, where there is still a long way to go on the road to sustainability. This is especially so because the cornerstone of the bottom-up organisational model is participation, and participation is repeatedly called for in the documents to which universities subscribe.

It must be acknowledged, however, that for universities the bottom-up model would be a manufactured structure, not a natural outgrowth. Its emergence would require participative dynamics that would have to overcome the institutional inertia of centuries of top-down operation. The process would have a systemic effect on the entire institution, with ensuing difficulties. However, it should not for that reason be considered unfeasible. This research is limited in that it has not analysed the

difficulties, but the door stands open to future research for the empirical exploration of the bottom-up model's viability in universities.

Furthermore, the literature has shown that *Transition Initiatives* also provide an example of how informal networks are a natural mechanism for strengthening inter-peer commitment and ties, which are crucial for making sustainable development the social norm. Making these kinds of networks compatible with universities' traditional organisational structures would be a shot in the arm for the university culture, and the synergies thereby produced would infuse the institution's possibilities for innovation with fresh energy. Above all, the implementation of *non-hierarchical* structures peculiar to complexity management would facilitate the community's learning process in the development of awareness and self-regulation for critical sustainability issues.

The task is difficult, yet universities must nevertheless undertake to accomplish it. The bottom-up organisational management models characteristic of the *Transition Initiatives* have proved to be a factor that facilitates the learning process, self-awareness (empowerment) and community self-regulation in those critical issues of sustainable development whose roots lie in the community context itself. If this same dynamic could be self-generated in universities, it could help propel universities toward resilience, adaptability and transforming change.

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Part II
National, Regional and Local Initiatives

Working for Sustainability Transformation in an Academic Environment: The Case of itdUPM

Carlos Mataix, Sara Romero, Javier Mazorra, Jaime Moreno, Xosé Ramil, Javier Carrasco, Leda Stott and Julio Lumbreras

Abstract

The Innovation and Technology for Development Centre at the Technical University of Madrid (itdUPM) in Spain is a collaborative network of lecturers, research students and non-academic professionals with a common interest in promoting action research for sustainable development. This paper is based on an in-depth analysis of itdUPM's co-evolutionary design process. The study is

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presented as an example of an inter-disciplinary environment that has been established for the co-creation of innovative technical and organisational solutions to address sustainable development challenges. The aim of this paper is to offer a case study of a collaborative technology and sustainability centre at the Technical University of Madrid (UPM), in Spain. Two focus areas are emphasised: the action research process chosen for the establishment and development of a networked centre, the Innovation and Technology for Development Centre (itdUPM), within the dominant disciplinary culture of a University organised along traditional lines and; the Centre's organisational design features which have proven to be appropriate for the inter-disciplinary and multi-actor action research processes necessary for addressing the challenges of creating a more sustainable society. The methodology used draws on theory to explore the Centre's development which is conceived as an evolutionary, participative, and action research process. The paper presents the context, background, design, and launch features of the itdUPM. The main lessons learnt refer to five organisational design issues that were critical for the success of the Centre and its activities. The paper describes the issues and challenges faced by the Centre as a "niche" operating in a dissimilar "regime". Although the findings are specific to the UPM context, we believe that they can inspire and stimulate other Universities interested in the development of sustainability initiatives.

Keywords
Sustainability transformation · University · Innovation · Transdisciplinary research · Co-design

1 Introduction. Universities and Transformation for Sustainability. *Beyond* "*Greening*" *the Campus*

The Sustainable Development Goals (SDGs) approved by the UN in September 2015 represent an ambitious and universal international commitment: ambitious, because their achievement implies a process of transformation that extends to all facets of human activity, at individual, social, productive, regulatory and governance levels; universal, because the goals demand responsibility from each and every individual, organisation and government throughout the world (United Nations 2014).

The SDGs follow in the wake of the Millennium Development Goals (MDGs) that were approved in 2000. The MDGs demonstrated that governments are able to set common and measurable development objectives and collaborate for their achievement. The agreement around the 17 SDGs and their 169 targets thus seems to be an appropriate way to promote a renewed sense of common direction and action. However, setting objectives to fight the effects of poverty in the way that the MDGs did (for example in terms of reduction of hunger or the promotion of access

to clean water), is not the same as changing the direction of human development in order to achieve a sustainable future, particularly as sustainability is embraced as a very wide concept in the SDGs. A transformation for sustainability implies going beyond business as usual. This is not just a matter of increasing aid flows from "developed" to "developing" countries (Nicolai et al. 2015); it is a complex process that demands rethinking technical and economic infrastructures, values and practices. In this context, higher education institutions have an important role to play.

Interest in the role of higher education institutions in the transition towards sustainability is not new. The "GUNi" (Global University Network for innovation) annual reports, for example, show an evolution in focus from education for development towards action for effective change. In line with this increasing awareness of "transformation for sustainability", many universities have introduced research, education and action programmes aimed at contributing to sustainability transformation. As a result, a range of integrated and holistic sustainability programmes are being put in place. This trend has been reinforced by the encouragement of academic networks such as the International Sustainable Campus Network (ISCN).

Many of these programmes are, however, too narrow and represent isolated "greening" initiatives. While largely due to the predominant view that sustainability is a concept limited primarily to its environmental dimension, this is also coupled with a traditional and strongly established approach that promotes unidisciplinary knowledge in both research and teaching. Moreover, sustainability efforts usually emerge in isolation and remain so because they are unable to generate sufficient interest within current university systems.

While there are clearly important challenges that limit university engagement in the sustainability agenda, it is also true that universities are well-suited to offer spaces that encourage the inter-disciplinary and multi-actor collaboration needed to support transformation. Indeed, both inter-disciplinary and multi-actor collaboration have seemingly been prevalent in the sustainability initiatives and strategies boosted by universities. This is, in fact, the sort of language that is widely applauded in formal academic discourse and appears to be a key element in the symbolic exercises that organisations and universities engage in (Alvesson 2013). However, the practical reality tends to be somewhat different. As Stirling has recently pointed out, the intensity with which inter-disciplinary initiatives are proclaimed is not often matched by the reality of how research organisations operate and the incentives for working in this way (Stirling 2015).

The "implementability" or conditions that enable the change process towards the practical realisation of genuine inter-disciplinarity cannot rest on "top-down" institutional agreements; they require a process of integration (Bursztyn 2013). In our experience two complementary and connected change processes are needed: one that moves away from a conventional "silo structure" towards an inter-disciplinary environment; and another that shifts the campus towards diverse open "communities" suitable for co-production and the transfer of new kinds of practical knowledge that the SDG agenda requires. The possibility of accomplishing both pathways is dependent upon a range of organisational and cultural

factors within universities. These include: the existence of personal purpose and leadership (at least from a few faculty members); an open-minded culture; organisational flexibility and cooperation skills.

In this context, the purpose of this paper is to share the experience of the Innovation and Technology for Development Centre at the Technical University of Madrid (itdUPM) in Spain, in implementing the kind of collaboration that we believe is necessary for the achievement of the SDGs. More specifically, its aim is to discuss the application of sustainability in the UPM, emphasising two key focus areas: the action research process chosen for the establishment and development of a networked centre within the dominant disciplinary culture of a University organised along traditional lines and; the Centre's organisational design features which have proven to be appropriate for the inter-disciplinary and multi-actor action research processes necessary for addressing sustainability challenges in a collaborative and diverse environment.

2 Methodology

Yin (2013) points out that "a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its reallife context, especially when the boundaries between phenomenon and context are not clearly evident". In this sense, a case study is an appropriate methodology for achieving this paper's purpose.

Two sources of information have informed this case study: Firstly, a review of the literature to explore relevant contributions to sustainability at Universities including organisational design, transitions theory and action research processes for sustainability. This material has provided the theoretical background for designing and guiding the overall experience of the case. Secondly, the researchers, as members of the Centre from its launch, have contributed information through an evolutionary and continuous process of internal action research.

The integration of thought and action has been a fundamental component of the itdUPM design process. This approach is founded on the belief that the conventional split between thinking and doing is not an appropriate way to deal with the kind of social problems faced by our society (Nelson and Stolterman 2012).

3 The Case of ItdUPM. *From an Institutional Network to a Networked Organisation*

This section studies the origin, approach, purpose and activity of a special centre devoted to sustainable development: the itdUPM. The Centre represents an organisational innovation within the context of a state university operating along traditional lines.

The process of change experienced by itdUPM is that of a transition from an institutional network to a networked organisation. In line with transitions theory (Geels 2011) and its particularisation within the university domain (Robinson et al. 2013), we see this process as the emergence of a "niche" that is trying to evolve, be accepted by and, at the same time, influence the mainstream "regime" of the university as a whole. This "niche" has evolved from a set of research groups with a common interest in international development to an organised network of UPM community members and external experts collaborating together on sustainability challenges.

3.1 itdUPM. *Origin and Evolution*

UPM is a public university that was officially established in 1971. However, some of its Faculties were established much earlier, in some cases more than 100 years prior to this date. Today, UPM is the largest technological university in Spain. More than 40,000 students follow bachelor, master and PhD programmes in 17 Faculties (known as "Engineering Schools") and nine Research Centres, which are distributed across four different campuses in the capital of Spain, Madrid.

itdUPM's origins are rooted in the early 1990s. Three stages can be seen in its organisational evolution: firstly, a spontaneous, bottom-up development (1990–2000); secondly, institutionalisation (2000–2010); thirdly, integration and the creation of a network (2010–present) (see Fig. 1).

In its first spontaneous, bottom-up stage in the 1990s, a common interest in areas like water, agro forestry, energy and Information and Communication Technologies (ICT), and their application in developing countries emerged among UPM researchers and students. In 1991, a group of these researchers established the NGO "Engineers without Borders Spain" and started to collaborate with other NGOs and international agencies.

Some years later, the UPM authorities decided to launch a specific organisational unit, the Directorate of International Cooperation for Development, under the Vice-Rectory of International Relations (institutionalisation, top-down stage).

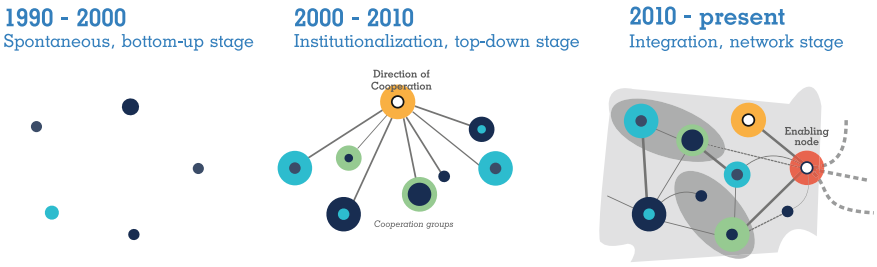

Fig. 1 The organisational evolution of International Development studies at UPM. *Source* the authors

At this time in Spain a large number of budget increases in Official Development Aid created something of a "golden age" of development grants and funding sources. As a result, the Directorate of International Cooperation for Development established Cooperation Groups. Over 20 Cooperation Groups were soon working in this field, most of which were research groups focused on challenges in developing countries. These groups operated in a very diverse and fragmented manner. Some became internationally recognised groups, e.g. the "Hispano American Health Link," while others conducted their activities like small NGOs.

Perhaps the most interesting effect of the flourishing of these groups was the consolidation of a strong, informal inter-disciplinary network of researchers and faculty members. These individuals worked together with a shared interest and common purpose. They had a common understanding of the importance of creating a cooperative environment for the co-creation of innovative technical and organisational solutions to address development challenges. This was the breeding ground for the birth of itdUPM.

3.2 The Launching of ItdUPM. *Vision and First Coordinated Lines of Action*

itdUPM was formally created in March 2012 as a new kind of organisational structure. In order to distinguish it from existing "Research Groups" and "Research Centres", itdUPM was defined as an "Innovation Centre". The aim was to create, within UPM, a new type of unit designed to promote inter-disciplinary and multi-actor collaboration in action-research. As the overarching intention was to be better prepared to offer appropriate solutions to the most common and recurring problems of poverty and sustainability, it was necessary for itdUPM to be:

- flexible enough to avoid blocking the ingenuity, spontaneity and identity of pre-existing organisational units and groups; while, at the same time,
- recognised as part of the formal structure of UPM so that it was not seen as a kind of "charity", particularly in the light of quite strong views that considered cooperation and sustainability as part of a "social action" add-on at the University rather than something embedded in its strategy.

The design of the new Centre was based on five basic features:

1. Affiliation of a university researcher or faculty member to itdUPM would not be incompatible with their belonging to a Department or Research Group.
2. The internal organisation of the Centre would take the form of a specific network.
3. A single "feeder" node would ensure the launching and development of the network and assume the functions of external representation, communication and administration.

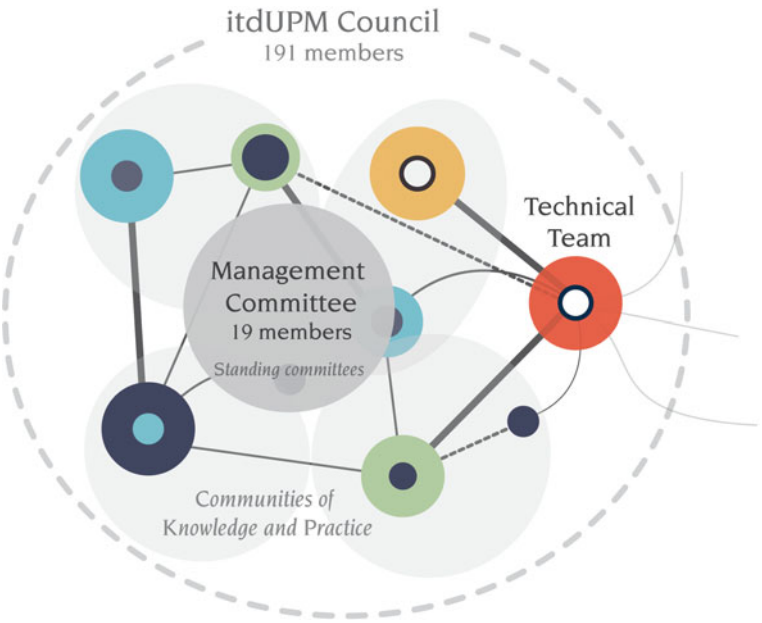

Fig. 2 itdUPM internal organisation (2016). *Source* the authors

4. itdUPM would have specific, articulated and regulated decision-making bodies that were appropriately connected with the UPM authorities.
5. Non-academic professionals and experts with a record of collaboration with itdUPM and its groups would be welcome as affiliates.

It should be noted that one of these basic features, multiple affiliation of a person to several organisational units, was facilitated by the previous existence of Research Groups, which allowed a person to belong simultaneously to a Department and a Research Group. With the new arrangement, a faculty member is supposed to undertake teaching duties for their Department, disciplinary research within their Research Group and action-research with members of itdUPM's network.

These features guided the design of itdUPM's organisational architecture (outlined in Fig. 2.).

Figure 2 shows the main itdUPM decision-making bodies, which are as follows:

itdUPM Council. Composed of 191 itdUPM members with diverse relationships to the UPM, includes professionals from organisations external to the University with whom a close connection exists due to work on joint projects.

Management Committee. Composed of 19 lecturers, including coordinators of Cooperation Groups and young PhD holders. The Committee also has a representative from the Vice-Rectory of International Relations (responsible for oversight of itdUPM). The Committee is elected by the itdUPM Council.
Standing Committees. Working under the Management Committee to speed up processes and programmes, they include the Quality Commission for the Master's Programme, the Management Commission for Experimental Spaces and the newly formed Management Committee Steering Group.
Technical Team (fulfils the enabler node function). A group of individuals dedicated exclusively to itdUPM under the auspices of the Management Committee.
Communities of Knowledge and Practice. Inter-disciplinary groups of teachers and researchers who apply knowledge from different disciplines to proposals and projects. Includes "communities" focused on energy, the use and application of big data, and resilience.

Inter-disciplinary and integrated projects were required to demonstrate the network's potential from the start. Emphasis was placed on projects with a scope and ambition that could not have been undertaken by a single research group. With this in mind, ten different Departments came together to work on a common project: the development of a Master's Degree in "Technology for Human Development". Although this was quite a challenge to UPM's traditional culture, the Master's Degree is now enrolling students for its sixth edition. With the involvement of the Complutense University of Madrid (UCM) in 2015, the degree has also evolved into an inter-university and inter-disciplinary programme that draws upon UCM's expertise in the field of social sciences.

itdUPM has also obtained various international contracts thanks to the experience of its researchers and the unique combination of competencies that it is able to offer. Inter-disciplinary projects in areas such as innovative and inclusive models of access to basic services (energy, health, water and sanitation) in Latin America and improvements to energy supply in refugee camps through partnerships involving the private sector, have been undertaken with multilateral institutions such as the Inter American Development Bank (IADB), the Office of the United Nations High Commissioner for Refugees (UNHCR), the Spanish Agency for International Development Cooperation (AECID), private technological companies such as Iberdrola and Philips, and corporate foundations such as the ACCIONA Microenergy Foundation.

Some findings and results (2016):

Inter-disciplinary orientation

- Affiliation of 15 Cooperation and Research Groups from 14 different UPM Schools.
- Broad age range among the 191 itdUPM Council members (from 25 to 70 years).
- 30 pupils on the Master's Programme equally divided between those with a technical background/experience and those with a social background/experience.
- Transversal research themes such as big data, social impact and resilience.

Multi-actor collaboration orientation

- 25 Master's classes open to the public involving professionals from partner organisations over the last three courses.
- Establishment of 12 strategic agreements with technological companies, international institutions and NGOs.
- International Conference held in June 2015 with support from ten organisations (businesses, corporate foundations, NGOs, communication agencies, professional associations of engineers, among others) and 452 participants.

4 Five Organisational Design Issues. *Critical Factors are Human Factors*

During the four years since its creation, the organisational design of itdUPM has undergone an evolutionary learning process in which special attention has been given to five issues that appeared as critical organisational design factors for building an effective collaborative environment. These are: (i) a horizontal networked structure; (ii) a leadership style able to pilot the process; (iii) incentives that align participants; (iv) a cultural environment able to deal with several simultaneous identities; and (v) a virtual and physical interactive space that enables and fosters a sense of purpose and community as well as an open culture of trust.

4.1 Network Structure: *Don't Talk About Decentralisation, Practice It!*

To achieve its vision, itdUPM's promoters understood from the start that some kind of networked organisation was necessary. They thus defined a horizontal networked structure with clear and regulated decision-making bodies connected to the UPM authorities. The network's nodes were created on the basis of the pre-existing Cooperation Groups that had their own history and dynamics but whose activities would be enhanced by linking to the network. In addition, individual researchers, faculty members and non-academic experts were invited to join the initiative. This latter group sees the Centre as a vibrant community within which they find a creative atmosphere for working. Among other positive effects, the openness of the network has also fostered interest within the business community.

Once the Centre had been designed, a Technical Team was recruited. This team acts as a "feeder" node that nurtures the development of the network. The team also assumes the functions of external representation, communications and administration for the Centre.

A network is very likely to become a "foreign body" in an academic environment. The use of the word "network" may even be interpreted by many as synonymous with "messiness" and at risk of losing control. For this reason, a "sense-making" process was needed through which people could understand and experience the advantages of collaboration processes. itdUPM's sense-making process focused on how relationships evolve in an open network environment. It was promoted through workshops that were designed to make people "live" the dynamic interactions between departments and research groups, and external organisations. This process has included awareness-raising, training and targeted communication activities (Fig. 3).

In order to launch and promote itdUPM activities, specific personal and financial resources were necessary. To become a "feeder", the Technical Team has been essential for ensuring the internal and external cohesion of the network. A fee from contracts signed with public and private institutions covers team costs.

itdUPM's business model was defined on the basis of long-term collaboration. As well as working closely with public and private institutions able to offer financial support, this has also meant the inclusion of people who share common strategic interests with itdUPM and who are willing to interact with itdUPM members in co-working processes (Molas-Gallart and Tang 2011). As a result an external network has also been shaped. In parallel, a strong client focus has been developed that promotes reciprocity rather than simply looking for grants. itdUPM thus has strategic agreements with a number of selected public and private organisations with which they collaborate in research (particularly applied research) and training (through collaboration on the Master's degree).

Figure 4 shows the itdUPM organisation as a network connecting people and complementary groups with different roles: individual researchers, faculty members, universities and research centres from other countries, as well as non-academic experts.

Fig. 3 Open sessions, conferences and workshops for itdUPM members and other professionals. *Source* the authors

This structure presents strong similarities with the "Star Model" proposed by Bursztyn and Drummond (2014). They define three different levels of connection within the University: some connections are located in disciplinary departments (Research and Cooperation groups in the itdUPM model); others play a bridging role (such as that of the itdUPM Technical Team); and a third group is formed by those with interests and skills in inter-disciplinary methods and practices (similar to the role played by itdUPM affiliated researchers).

4.2 Leadership and Governance: *From Ego-Systems to Eco-Systems*

As explained above, itdUPM depends organically on the UPM authorities. However, with regard to its plans and activities it functions as a horizontal network and does not have a vertical central node that exerts power over the rest of the nodes. In line with organisational theory it could thus be considered as a sort of holacracy (Robertson 2015). This kind of structure requires a type of distributed leadership and the development of sound self-management capabilities (Laloux 2014). In this respect, and depending on the type of decisions, itdUPM has different leadership styles (as shown in Fig. 2):

Fig. 4 The itdUPM network environment. *Source* the authors

- Decisions are taken by consultation in committees such as the Management Committee, the itdUPM Council or the Quality Commission for the Master's Programme.
- Decisions are taken by consensus in "Communities of Practice", which include faculty, students, representatives from business and public bodies, as well as Technical Team personnel.
- Decision processes concerning proposals; team composition and supervision of specific projects are designed and undertaken in an ad hoc manner.

None of the cases outlined above involve an "ego-system" leadership style. Moreover, given that "super egos" do not fit within its culture, itdUPM's is moving "from ego-systems to eco-systems" (Scharmer and Kaufer 2013). Such a culture requires: the silent promotion of increased personal autonomy and decentralised leadership; emphasis on creating a sense of community and purpose; far reaching transparency and accountability, and the promotion of self-criticism, rather than sanctions, as the most appropriate way to ensure continuous improvement.

The governance of itdUPM is based on transparency and participation. All the decision-making bodies mentioned above carry out their work in an agile and transparent manner and receive strong support from the Technical Team. The Centre also has a Director who was appointed by the Rector after a Council Hearing. The Director is, with the support of the Management Committee, responsible for external relations and communication, new project promotion and contracts, as well as supervision of the technical node of the network.

It is also important to highlight the intermediary role played by a range of individuals in the development of itdUPM. The Director of the Centre and members of the Management Committee have engaged in an ongoing process of dialogue and engagement with University authorities in order to position the Centre as an integral and valuable part of the University system. Not only have these efforts guaranteed institutional support for the Centre, they have also created a positive enabling environment for its work.

4.3 Incentives: *When Only Intrinsic Motivators are Available*

Motivation is what moves us to action. In the case of itdUPM, traditional coercive incentives (money and employment) do not exist because the contracts of professors and lecturers do not depend in any way on itdUPM. The motivation for belonging to the Centre thus relies on its appeal and interest. Its central attraction derives from its purpose (contributing to sustainability), its vision and its collaborative atmosphere. For this reason, open affiliation was a critical element in itdUPM's design.

From the beginning, membership for any UPM faculty member has been based on an individual, personal basis with affiliation made fully compatible with other School, Department, Research Group or Cooperation Group linkages. A number of early candidates were members of existing Cooperation Groups. To enable this possibility, the new Centre was granted a special status by the UPM authorities.

Members of the itdUPM Council, which meets twice a year, agree upon the acceptance of new candidates. As affiliation is voluntary, if the activities are not attractive enough for a given member, she or he can leave by presenting their formal resignation or simply ceasing to participate in itdUPM's activities.

Membership includes a certain personal risk. Inter-disciplinary research papers, for example, still face publication difficulties (Rafols et al. 2012). At the same time, the development success of the new venture has at times been quite insecure due to the budget restrictions affecting the Spanish public sector as a result of the financial crisis. Drastic spending reductions for research and very limited financial support from the UPM for the new Centre have meant that it has been a real challenge to make it grow, reach critical mass and become acknowledged by the rest of the UPM. In some ways, however, this challenge has also been an incentive for membership. Fortunately, many of these difficulties have now been overcome: membership currently exceeds 190 people in total and a more solid financial income enables the Centre to function well.

Many of the Centre's members have stated that the chance to interact and collaborate with members of different disciplines and external professionals in action research projects has been a great incentive for joining itdUPM. In this respect, the early launch of several multi-disciplinary and multi-actor activities and projects has provided itdUPM with credibility and important backing. As an example, during the last Council meeting, a diverse group of eight members, from young researchers to professors, enthusiastically shared their experience of working with itdUPM, some of their testimonies are reproduced in the following chart.

> Previously I felt that I worked in an excessively hierarchical manner; a teacher working more or less on my own. This new phase of working with the itdUPM is extraordinarily interesting and revitalising for me and I am learning a great deal about how inter-disciplinary groups can change the way we do things in the University. (Miguel Ángel Egido, Senior Lecturer, Institute of Solar Energy, School of Telecommunications Engineering)

> I love working with itdUPM because it's a space in which we encourage one another not to be afraid of failing…In the coming years, after completing my PhD, I would like to develop my academic career in this fresh, flexible and different space…and include our students in this… (Inma Borrella. PhD Assistant Teacher, School of Industrial Engineering)

> In the Centre I have met friendly people with a great capacity for change… (Jaime Cervera, Chair of the School of Architecture)

Other motivations for joining the Centre are more emotional in character and include trust, a shared passion for a theme of interest and a warm atmosphere. In preliminary surveys among the itdUPM community, belonging to a voluntary, challenging and vibrant learning community appears to be one of the main reasons for wanting to participate in the network.

We are aware, however, that the motivations cited above may not be enough to ensure long-term participation. As it expands, and with greater recognition for the Centre, other incentives directly related to the professional careers of researchers are increasingly important. The growing number of scientific papers published in relation to itdUPM projects demonstrates this trend.

4.4 Identities: *How to Wear Two or Three Hats Simultaneously?*

Collective identity stems from the interpersonal interactions that make up an organisational culture. The main pre-condition for enabling the development of itdUPM as a horizontal network with its own culture within the UPM was its official acknowledgement by the UPM authorities as an "innovation centre" endowed with a specific status.

UPM faculty members are used to belonging to a diversity of organisational units: Schools are the most traditional, permanent homes; Departments, for teaching purposes; and, Research Groups, for disciplinary research activities. In this context, the key was to specify that itdUPM had a different aim, namely, to develop

innovations by adopting a multi-disciplinary, multi-actor action-research approach. In this way a faculty member can engage in disciplinary research in his/her Research Group and collaborate with members of other disciplines and external professionals for innovation purposes in itdUPM.

The development of both an itdUPM culture and a new membership identity was carefully managed by its Director and enabled by the Technical Team via network communications and workshops. Through this process, a shared itdUPM culture has taken form and the Centre's identity has become interiorised by its members.

The culture of the Centre and the new membership identity were reinforced by the design of a logo linked to that of UPM. This "corporate identity" is used in the Centre's network messages and web diffusion spaces, including its website www.itd.upm.es, as well as in the social networks—Twitter, YouTube, SlideShare and LinkedIn.

4.5 Common Spaces: *Where There Is a Will There Is a Way*

Since its inception, the activities undertaken by itdUPM have encouraged members to act as a community of researchers and practitioners that focus on understanding contemporary society through a trans-disciplinary approach to solving key social problems. This, in turn, promotes the co-generation of innovative courses of action that can, as far as possible, be implemented and spread more widely.

The Centre began without an appropriate physical space and has, to date, relied simply on will to pursue its activities. The small office from which it operates has clearly been insufficient, even with the additional use of rooms that have been kindly lent by other Schools at the University. As a result, the idea of designing a project that could be an expression of "regenerative sustainability" (Robinson 2013) emerged: a working space to encompass the kind of organisational model that we wish to pursue.

Inter-disciplinary conversations among researchers and experts were held to explore this idea further. One of the suggestions was the use of the campus as a place for experimentation in sustainable technologies and behaviours. These conversations suggested that a sustainable future for itdUPM might more easily be achieved if it was reinforced by the construction of a bioclimatic building located at the heart of the main university campus (International Excellence Campus Moncloa). Architects (experts in bio-climate buildings), agronomists (experts in urban agriculture), engineers (experts in solar energy and water), and students were then brought together to develop a project that was finally approved in July 2015.

The itdUPM building has now been constructed. It will not only serve as the headquarters of the itdUPM but also as an open demonstration space devoted to spreading technologies and innovations for sustainability. Concepts and prototypes for urban agriculture, decentralised energy systems and the circular economy, among others, will be tested there. In parallel to the construction of the physical infrastructure, scientific and dissemination activities that will take place in this new facility are also being designed.

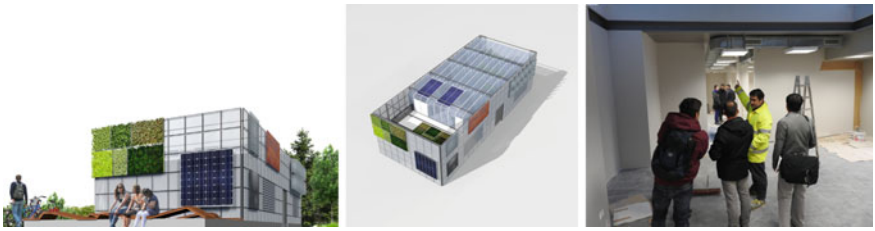

Fig. 5 The itdUPM building: plans and construction. *Source* the authors

This new physical facility is already attracting the interest of several actors, for example, the network of urban orchards. Several firms have also expressed a wish to use the space to test technological prototypes. Once the facility is available, it will ease multi-actor relationships and the interchange of experiences with the large number of social innovation spaces promoting citizen's involvement that are currently emerging in Spain and elsewhere (Fig. 5).

4.6 (Non-definitive) Conclusions. *Co-evolutionary Design Process*

The Innovation and Technology for Development Centre that is in place today is the result of an evolutionary organisational design process based on the previous experience of a network of researchers focused on sustainability. An ongoing process of permanent learning and adaptation has been put into practice.

In consequence, any conclusion to this study must be considered as preliminary and in need of fine-tuning. Indeed, conclusions may also need to be abandoned altogether as itdUPM, and other similar initiatives, accumulate, share and analyse their different trajectories and experiences. Bearing this in mind, we nonetheless believe that the following observations are worth sharing.

The creation of collaborative inter-disciplinary and multi-actor spaces has not been a simple task. It has involved a complex design process requiring careful decisions with regard to organisational and human factors such as leadership style, culture and values. In this sense, three lessons can be underlined:

- Solving the potential problem of multiple identities for affiliates from the start was a precondition for success.
- The promotion of self-management capacities and a distributed leadership style have been critical for the attractiveness of the Centre, its growth and the extension of its activities.
- The Centre's collaborative atmosphere and its sustainability focus have proved to be the most appealing incentives for potential members.

Relevant and specific capacities were needed to pilot the launch, not only in terms of financial resources but, above all, in terms of human resources and

institutional support. A dedicated team has been crucial to the development of the internal and external network and to nurturing its fragile ecosystem. The process has also required a long time to mature before being able to count on a genuine change management process in which behaviors, relationships and practices moved from those typical of a conventional university environment to those that are appropriate in a more collaborative and diverse environment.

The institutional anchoring of the Centre in the UPM has been crucial to its success. The formal status of the Centre is dependent upon the highest representative of the University: the Rector. At the same time, beyond this formal relationship, the promotion of itdUPM rests upon its personal relationship with the University authorities. This latter connection involves informing and, where possible, involving them, in the strategic decisions of the Centre.

itdUPM's integrative role has been mirrored in the way that external relationships have been built with companies, international organisations and NGOs. Beyond the traditional "extractive perspective" (institutions should support a university that works for sustainability), the Centre has developed a "mutual reciprocity perspective" (universities and other institutions need each other in order to address problems that affect all of them). In this sense, an advanced "client perspective" has been very important for adapting itdUPM training and research services to the real needs of its partners. As a result, a network of long- term relationships has established the basis of a sustainable business model for itdUPM.

Having completed its institutional infancy, itdUPM now faces new challenges. The organisational model based on a lean and horizontal structure needs to be expanded in order to demonstrate that it can scale-up without a centralised control structure. Moreover, its very success may jeopardise the itdUPM initiative, especially if the growing expectations it has created cannot be satisfied, or if the increasing visibility of the Centre is perceived as a threat to dominant unidisciplinary interests.

As Sennett (2012) points out, after decades of obsessive competition we have harmed our capacity for cooperation. At a time when transformation for sustainability is both urgent and desirable, universities have the opportunity to unleash some of the social creativity and clarity needed to find new and better development pathways.

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University of North Carolina at Chapel Hill Sustainability Plan—EmbeddingSustainability into the DNA of the Campus

Cynthia Shea, Carol Hee, Amelia Aboff and Steve Baumgartner

Abstract

UNC is a recognized leader in sustainability (AASHE STARS—Gold campus), leading in the tangible aspects of water and energy conservation with a mature recycling and composting program, sustainable buildings, enlightened food services, and cutting edge research and teaching. The University wanted to take sustainability to the next level and make it part of the campus culture; to change individual behaviors, business practices, and institutional priorities. Widespread engagement up and down the chain and across the campus resulted in a multi-pronged sustainability plan full of actionable ideas for what could be done differently and better at a wide range of scales, from the individual to the class, to the campus, and beyond. The intent is for campus activities to be measured against the "triple bottom line" of environmental, social and economic impact.

Keywords

Sustainability · Plan · Campus · Higher education · Triple bottom line

1 Background

The University of North Carolina at Chapel Hill (UNC-CH) is the oldest public university in the United States and is rated the "best value" in higher education for 15 years running by Kiplinger. The work of institutionalizing sustainability efforts began in 1999 with the formation of the Sustainability Coalition. Then-Governor Jim

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Hunt had called for all state agencies to adopt more sustainable practices through Executive Order 156, and student advocates simultaneously encouraged the university to proactively engage environmental issues. In 2001, UNC-CH hired Cynthia Shea as its full-time sustainability coordinator, the first such hire within the University of North Carolina's 17 campus system. By 2003, the sustainability office included an energy conservation manager and an administrative assistant. In 2005, the University formed the vice chancellor's sustainability advisory committee (SAC) and adopted a Campus Sustainability Policy that promoted life-cycle costing, reducing adverse impacts on natural systems, and promoting human well-being.[1]

UNC-CH has risen to national prominence for its sustainability achievements, receiving consistent ranking by the Princeton Review as one of the nation's greenest colleges, recognition as one of the Sierra Club's "Cool Schools," and obtainment of a "Gold" rating by the Association for the Advancement of Sustainability in Higher Education's (AASHE's) rigorous Sustainability Tracking, Assessment, and Rating System (STARS) program. These accolades reflect significant progress in the greening of UNC-CH operations including:

- Reducing energy use 29 % per gross square foot since 2003
- Reducing greenhouse gas emissions 19 % since the 2008 peak
- Reducing potable water use 60 % per GSF since 2000
- Diverting 45 % of waste from the landfill in FY 2015
- Managing an award-winning 32 MW cogeneration plant, five central chilled water plants, and a 5 million gallon thermal energy storage tank
- Constructing 635,671 square feet of LEED buildings—Certified, Gold, and Platinum.

Sustainability at UNC-CH has always encompassed more than efforts to reduce our environmental footprint. The Carolina Environmental Program (CEP) was formed in 1998 as a campus-wide, interdisciplinary initiative focusing on environmental learning, research, and public service. Environmental Studies and Environmental Sciences are now two of the most popular undergraduate majors in the College of Arts and Sciences. UNC's Kenan-Flagler Business School was among the first to include a sustainability concentration in its MBA program and created the Center for Sustainable Enterprise (CSE) in 2001. CSE has received numerous awards including a third place ranking for Corporate Social Responsibility by the *Financial Times* in 2013. UNC-CH currently offers 667 sustainability-related undergraduate and graduate courses in departments and professional schools as diverse as the university itself. $793 million in research funding provides more opportunities for students and faculty to address the greatest sustainability challenges of our times.[2]

[1]About Us http://sustainability.unc.edu/about/ accessed 15-Jan-2016.

[2]Research funding http://research.unc.edu/about/facts-rankings/research-funding/ accessed 19-Jan-2016.

In fall 2014, Cynthia Shea, Interim Chief Sustainability Officer, with the support of the pan-campus sustainability advisory committee (SAC), proposed to the Executive Vice Chancellor and Provost and the Vice Chancellor for Finance and Administration that the university undertake a comprehensive strategic planning process focused on sustainability. The objective was to develop guiding principles, high level goals, and priority actions for academic and administrative units across campus. These goals would help guide future initiatives in teaching, research, operations, and engagement—both internal and external—and position the university to continue on a pathway of excellence in sustainability.

If crafted collaboratively, the process of developing a pan-campus strategy would consolidate support and constitute an important step towards more completely engaging all university stakeholders (faculty, current and prospective students, staff, alumni, community members, governing bodies, donors, and prospective employers) and towards more comprehensively integrating sustainability policy and practice across all aspects of university life. It was further believed that crafting the Plan would better position UNC-CH to (1) address the most challenging issues of our time that by their complex nature require innovative, multi-disciplinary solutions that are grounded in the integrated, systems approach of sustainability and (2) to prepare our students to assume leadership roles in the pursuit of solutions.

Consensus formed early that the engagement of an expert consultant team with sustainability, higher education, and organizational change management experience would be critical to the success of the planning process. The timing was fortuitous as the sustainability plan would precede the development of a new campus master plan and thus help clarify the future vision of the campus. Recommendations for new initiatives could also be incorporated into the upcoming capital campaign.

Crafting the Plan The development of the plan was led by a six-person executive working group formed from the SAC and consultants from BuroHappold Engineering (technical experts in sustainability and strategic planning) and Brightspot (facilitation and engagement specialists). This team met weekly, most often virtually, between March and October 2015. The project included four phases:

1. Initiation
2. Campus Engagement
3. Focus Area Definition
4. Plan Development

2 Phase 1: Initiation

From the outset, the team placed importance on appreciating and understanding existing sustainability initiatives and successes so that these could be built upon. Equally important was acknowledging and exploring short-falls and challenges so

that root causes could be identified, adjustments suggested, and obstacles navigated. The sustainability plan was also considered in relation to other plans—existing and anticipated—including the campus master plan, the capital campaign, and the quality enhancement plan, to ensure alignment. External research was conducted to gain an understanding of the strategic approaches taken by leading and peer institutions to advance their sustainability goals.

3 Phase 2: Campus Engagement

Input from the campus community was solicited through a diversity of methods intended to reach and engage as wide an audience as possible through a variety of formats. Almost 20 interviews were conducted with high-level decision makers and administrators including the Chancellor, Provost, several vice chancellors and associate vice chancellors; deans and senior associate deans; the chair of Faculty Council; directors; and department chairs. Through these interviews, the team inquired about the administrators' current perception of sustainability at UNC, their vision for sustainability at UNC in the future, their top sustainability objectives, examples of sustainability success, and their perspective on what potential challenges might exist to implementation.

To obtain contributions from students, faculty, and staff, eight town hall workshops were held over several months to garner input about participants' understanding of ongoing sustainability efforts and to learn what their aspirations were for sustainability at UNC in the future. These eight highly dynamic and interactive town halls involved 130 individuals representing a broad cross-section of the campus community. To reach those who did not attend the town hall meetings, random intercept interviews were conducted at highly trafficked locations across campus in order to better understand the current state of sustainability awareness and involvement as well as receptivity to potential future initiatives. Additionally, a short (approximately 10 min) on-line survey was distributed to all members of the campus community to explore the current and desired state of sustainability at UNC. The surveys reached individuals with a wide range of interest in and knowledge about sustainability at UNC. The 300 survey responses (48 % staff, 29 % students; 10 % faculty) were particularly valuable because they produced easily quantifiable data. The sustainability office website was updated throughout the process to keep stakeholders informed and provide opportunities for input.

The interviews with high-level campus administrators made it clear there was support for sustainability from the top of the organization. One Vice Chancellor stated "Sustainability is so important to the public good that a public university can't afford to not be great at it. Part of UNC's mission is to be superb in this area." One Vice Provost declared that we need to "Embed sustainability in the DNA of the university; build sustainability into everything we do."

Input received during town hall meetings indicated that people's awareness and prioritization of sustainability initiatives skewed towards individual actions and initiatives that were easily observable. Discussions about the future desired state of sustainability at UNC-CH focused on the expectation that UNC be a sustainability leader; a desire to embed sustainability in the culture of the university; a desire to align behind a common vision with measurable goals; and awareness that, in addition to efficiency, sustainability initiatives should include a focus on resiliency and connectivity and should incorporate triple-bottom-line thinking.

The on-line campus survey supported the outcomes of the town halls and similarly revealed that across stakeholders, awareness and participation were highest for sustainability initiatives that involved resources, individual action, and were readily visible on a recurring basis such as water bottle refill stations, food waste composting, stormwater management, recycling, and energy conservation. More than 50 % of survey respondents rated resource-related issues such as recycling, water use, and energy efficiency as top priorities. The availability of funding to support new sustainability initiatives and research also emerged as a top concern.

4 Phase 3: Focus Area Definition

Synthesis of the data collected through campus engagement activities revealed common themes that provided the foundation for further progress. Combining the themes of resiliency, efficiency, and connectivity with the focus areas of sustainability's triple bottom line (social, environmental, economic) produced a framework that helped define the focus areas for which goals would be developed (Fig. 1).

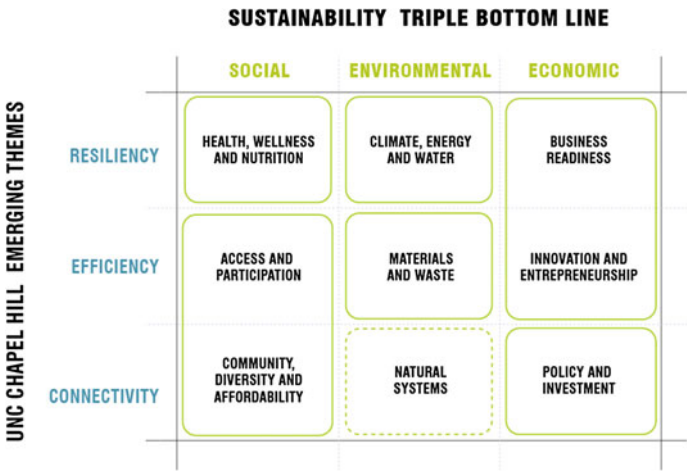

Fig. 1 Focus areas that emerged from campus engagement and that would form the foundation for the plan

The nine areas produced by the framework were grouped into seven categories, six of which would define the scope of six working groups. The area of natural systems, understood as the biome directly impacted by UNC's built environment, was judged to best be addressed through the new campus master plan that UNC started developing about halfway through the sustainability plan development process. Several individuals, including consultants from BuroHappold Engineering, are involved in both efforts which helps ensure the plans complement each other.

The campus engagement activities further refined the vision for what the sustainability plan would accomplish.

(1) Create a cohesive vision to embed sustainability into every aspect of campus life
(2) Enhance connections between teaching, research, operations, and engagement
(3) Establish organizational processes to connect stakeholder voices on an ongoing basis
(4) Build a model for holistic, institutional change in higher education

Incorporating a commitment for UNC-CH to make a positive impact at all scales —from the individual to the world—also emerged as important to the stakeholders involved.

5 Phase 4: Plan Development

Six working groups were assigned the task of defining specific goals for the focus areas that emerged from Phase 3. Working groups were led by administrative and academic co-chairs and were comprised of faculty, staff, administrators, students, alumni, industry experts, and community members who were identified through the town halls, through electronic requests to participate, by the steering committee, or by the sustainability advisory committee as having relevant expertise or interests (Fig. 2). The working groups contributed remotely through online surveys, web-hosted workshops, and collaborative document editing. A shared definition and "charge" was developed to align the planning efforts within each area (Table 1).

The "Innovations for Change" theme came to be viewed as overarching because achieving progress on all of the other themes would require innovation to develop the necessary tools, approaches, and new ways of thinking. The "Policy and Investment" theme came to be viewed as foundational because changes in organizational strategies, funding mechanisms, policies, and procedures have the potential to embed lasting change in the other focus areas.

In addition to the focus areas, the workgroups were challenged to consider how UNC-CH could make an impact at multiple scales. Thus the following eight distinct scales were defined: person, class, team, campus, town, state, region, and world (Fig. 3).

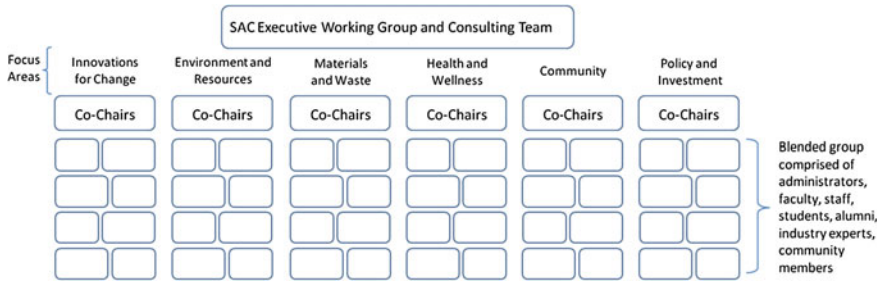

Fig. 2 Workgroup structure

Table 1 Each working group aligned development of three goals under a "charge" that defined the aspiration for each focus area

Focus area	Charge
Innovations for change	Aligning UNC for a changing world and educational landscape through innovations in sustainability
Environment and resources	Creating a UNC that contributes to the resilience, restoration, and sustainability of natural resources
Materials and waste	Moving towards a zero waste campus
Health and wellness	Creating a happier, healthier campus for students, faculty, staff, and visitors
Community	Enhancing the UNC community, town-gown relations, and communities across North Carolina
Policy and investment	Using policy and investment to guide sustainability achievements across scales and focus areas

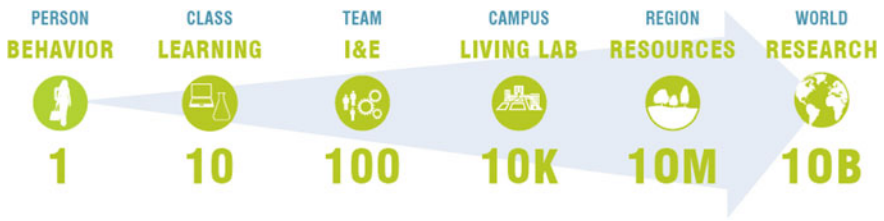

Fig. 3 The desire to make an impact across multiple scales guided development of the goals

Building on an understanding of current initiatives, successes, and challenges in each focus area, each working group developed multiple goals for achieving the charge and for having an impact across multiple scales. Members of the executive working group and the consultant team provided facilitation during virtual meetings, held face-to-face meetings with workgroup co-chairs, maintained open lines of communication with campus administrators to keep them up-to-date with project progress, and consolidated meeting notes to support continued progress and ensure discussion outcomes were accurately represented.

The time frame for the activity of the working groups was constrained to a period of approximately ten weeks during the summer, at the end of which output from the groups was distilled into three final goals per working group with supporting actions and strategies (Table 2). Language was also developed to detail UNC-CH's aspirations for making a positive impact across scales (Table 3). Finally, a vision statement and unifying graphical image were developed to capture the essence of the plan (Fig. 4).

Success Metrics The success of the university's efforts both within the six focus areas and across each scale of the sustainability plan will be evaluated. Many of the most useful metrics are already tracked as part of UNC-CH's participation in the Association for the Advancement of Sustainability in Higher Education's Sustainability Tracking Assessment and Rating System (AASHE STARS). Beyond the metrics in STARS, progress at UNC will be aided by the development of new metrics and monitoring systems to gauge progress towards achieving the plan's goals. Mechanisms are already in place to measure energy use, potable water consumption, and locally sourced food. More comprehensive, pan-campus initiatives are required to track the degree to which sustainability concepts are incorporated into courses, research, and learning outcomes.

Pilot Projects To maintain the momentum and enthusiasm that fostered the crafting of the plan, ideas for pilot projects that would quickly put the plan into action were solicited via the UNC Sustainability website and at town hall workshops and working group meetings. Proposed projects were subsequently vetted by the using the following 12 criteria that were developed by the consultant team and executive working group with additional input from the Chancellor's Office (Table 4).

Using these criteria, the complete list of pilot projects was refined to the top 17, which were then ranked according to how well they achieve the objectives described above. By overcoming obstacles and uncovering effective engagement tactics, these pilots will create initial wins, clear the way for expanded implementation, and set the stage for future successes.

Plan Roll Out and Implementation At the time of this paper's writing, the proposed sustainability plan is under review by the Chancellor's office. The scope of the pilot projects is under discussion and implementation plans are forming. A communications strategy is under development both to educate stakeholders about UNC-CH's sustainability achievements to date and to share and generate enthusiasm for the future vision described in the plan. UNC-CH's Development Office will be engaged to help garner financial resources to support fulfillment of the Plan's goals, and the Office of the Vice Chancellor for Finance and Administration will determine additional staffing and budget allocations. A presentation of Chancellor Folt's vision for a climate neutral, water neutral, zero waste campus was made to the UNC Board of Trustees in January 2016.

Lessons Learned and Future Needs While it is too early to judge the success of the plan in helping UNC-CH make groundbreaking strides in sustainability, we feel confident in the strength of the planning process we employed. By engaging a wide range of stakeholders from across the entire university and including graduate and

Table 2 Goals, actions and strategies for each focus area

Innovations for Change: Aligning UNC for a changing world and educational landscape through innovations in sustainability
Goal 1. *Leverage UNC's entrepreneurial culture to advance sustainability efforts on campus and beyond* **a.** Engage all campus audiences in sustainability-related entrepreneurship activities **b.** Facilitate and support the development of new ideas and technologies by the campus community **c.** Build upon existing innovation hubs and resources, including human capital **d.** Use UNC's expertise to support sustainability-related entrepreneurship beyond the university
Goal 2. *Utilize UNC as a test bed to apply new technologies and practices designed to meet sustainability-related challenges* **a.** Make UNC a model for connecting classroom learning about new technologies and tools to real-world practice **b.** Champion innovation in support of the other focus area working groups and scales
Goal 3. *Ensure UNC is resilient to future changes, from changes in higher education to an altered climate* **a.** Identify future risks and complete resilience planning for key scenarios **b.** Integrate sustainability into online education and related non-traditional education initiatives
Environment and Resources: Creating a UNC that contributes to the resilience, restoration, and sustainability of natural resources
Goal 1. *Integrate research, teaching, and practice about environmental and resource issues* **a.** Make sustainability integral to operations **b.** Locate facilities, resources, and test projects on campus to increase visibility and promote integration **c.** Strengthen the role of a central academic unit charged with coordination of interdisciplinary environmental education, research, and engagement across departments and schools
Goal 2. *Improve education and awareness about sustainability issues at all levels, for all parts of campus* **a.** Support staff, faculty, and leadership in making informed decisions about building operations **b.** Emphasize opportunities to utilize UNC as a living laboratory that researches, teaches, and models best practices **c.** Expand academic offerings related to environment and resources
Goal 3. *Develop and implement new resourcing strategies, financing structures, and policies to strengthen and expand sustainable operations, staffing, and business practices* **a.** Identify or establish funding streams for key improvement areas **b.** Develop strategic staffing plans for academic and operational sustainability efforts **c.** Optimize use of existing resources through partnerships and business practices

(continued)

Table 2 (continued)

d. Pursue improvements to policy and financing mechanisms **e.** Structure incentives and promotions to support staff and faculty efforts **f.** Ensure design standards for new construction and all renovations include/exceed best practices in all resource areas
Materials and Waste: Moving towards a zero waste campus
Goal 1. *Refine and expand existing successes by pairing infrastructure enhancement and behavior change* **a.** Implement additional benchmarking and analysis programs in addition to waste audits **b.** Expand presence of recycling and composting infrastructure **c.** Improve the efficiency of campus waste management **d.** Emphasize recycling and management of specialized waste streams such as e-waste, lab waste, medical waste, and hazardous materials
Goal 2. *Advance campus-wide education and awareness of materials and waste issues and best practices* **a.** Develop strong, consistent messaging around efforts and best practices, within UNC and with local communities and partners **b.** Utilize zero-waste events (including athletics) as opportunities to educate and engage new campus and community audiences **c.** Facilitate waste reduction behaviors through incentives, competitions, and infrastructure **d.** Provide more learning opportunities (formal classes or otherwise) on materials and waste issues, for students and staff
Goal 3. *Emphasize lifecycle thinking, beyond "reduce, reuse, recycle"* **a.** Institutionalize materials reduction efforts, starting with procurement **b.** Prioritize "back of house" materials and waste reduction efforts **c.** Encourage reductions in consumption in campus daily life **d.** Facilitate materials swaps and recycling within campus community **e.** Provide mechanisms for materials reuse by the broader community **f.** Strengthen standards for building and public realm materials selection
Health and Wellness: Creating a happier, healthier campus for students, faculty, staff, and visitors
Goal 1. *Provide workplace and student wellness resources and activities* **a.** Strengthen and expand existing programs and initiatives **b.** Improve communications strategies to raise awareness of existing health and wellness resources and support **c.** Establish new programs to supplement existing efforts and integrate healthy decisions into campus life **d.** Offer on-campus and virtual resources to promote physical and mental wellness, including preventive care **e.** Establish programs, incentives and discounts to facilitate healthy decision-making and promote lifestyle change

(continued)

Table 2 (continued)

f. Put new structures in place to create a true culture of health and wellness **g.** Ensure UNC policies are aligned with national best practices in key areas **h.** Enhance occupational health and safety resources
Goal 2. *Enhance and expand educational offerings related to health and wellness* **a.** Supplement and expand academic program offerings for undergraduate and graduate students **b.** Expand non-academic educational opportunities, promote existing resources for all members of the UNC community **c.** Actively educate the campus community through everyday interactions (marketing, events, signage, etc.)
Goal 3. *Foster health and wellness improvements in university-community collaborations and collaborations within the university* **a.** Formalize responsibilities for engagement around health and wellness **b.** Identify strategies for interdepartmental collaboration in efforts to win funding for health and wellness initiatives **c.** Renew focus on local/North Carolina health issues, in addition to devoting resources to global health efforts
Community: Enhancing the UNC community, town-gown relations, and communities across North Carolina
Goal 1. *Empower students, staff, and faculty to engage in community service efforts* **a.** Improve communications and publicize clear paths for community service and engagement **b.** Expand and replicate successful policies and programs linking UNC to its larger community
Goal 2. *Enhance inclusivity and dialogue across the campus community and ensure UNC remains an affordable, accessible institution* **a.** Establish communications and dialogue around the issues faced on campus daily **b.** Identify and provide services for underserved on-campus communities, including those aligned by need rather than demographics **c.** Provide resources for UNC students, staff, and faculty to drive professional development
Goal 3. *Formalize engagement with underserved communities to provide service and support* **a.** Improve funding and administrative mechanisms to support community-engaged research **b.** Utilize UNC student and faculty projects to provide technical support for local communities and the state **c.** Approach engagements with goal of building long-term, in-depth relationships **d.** Shift focus to state and local community issues, to supplement existing work on national and international levels
Policy and Investment: Using policy and investment to guide sustainability achievements across scales and focus areas

(continued)

Table 2 (continued)

Goal 1. *Develop innovative short- and long-term financing mechanisms to support sustainability initiatives* **a.** Formalize process of evaluating and prioritizing proposed sustainability investments and policy efforts **b.** Identify and attract investors and partners for funding vehicles and other strategies, including: 1. Assess and establish new funding strategies 2. Align capital investments with campus sustainability goals 3. Align endowment management, fundraising efforts, and investments with campus sustainability goals
Goal 2. *Establish policies to reinforce sustainability as a core value within UNC culture* **a.** Evaluate and expand sustainability course offerings and research opportunities **b.** Integrate sustainability lifestyle education into campus life **c.** Engage all audiences in sustainability initiatives **d.** Incorporate sustainability goals into standard operations and procurement procedures
Goal 3. *Identify conversation-changing, big picture strategies for implementation* **a.** Put organizational structures in place to ensure long-term support and execution of triple bottom line sustainability initiatives **b.** Develop realistic strategies for achieving zero waste, water, and carbon goals

undergraduate students, administrators, staff, and faculty, we reached out early to give voice to those whose involvement will be critical to the successful implementation of the plan. Using multiple methods of engagement, that varied in the level of time commitments required, enabled a wide range of stakeholders to engage as much or as little fit their preference. Additionally, including individuals from the academic and administrative arms of campus ensured that these two very different perspectives were included throughout.

The complementary expertise of these two groups created outcomes that would not have been achievable by one group working in isolation. In addition to expertise, key individuals also contributed knowledge of initiatives simultaneously underway across the university, such as the development of a new campus master plan and the Provost's Taskforce on the Environment. Staying informed about the broader internal context ensured that the sustainability plan is as relevant as possible. Equally important was consideration of external factors such as the policies and perspectives of state and local politicians and university governing boards. Finally, the engagement process made it clear that many people share an understanding of what the university needs to do even though people's awareness of past accomplishments and current initiatives may be incomplete.

Ongoing support from the Chancellor and the Office of the Vice Chancellor for Finance and Administration has been critical at all stages of the planning process—from its inception to roll out. The Chancellor's continuous engagement infused the

Table 3 Vision statements were developed to guide impact across scales

Scale	Impact
Person/Behavior: Drive behavior change	We will empower our campus community to understand the impact of our actions here at UNC and beyond
Class/Learning: Integrate sustainability into curricula	We will prepare our students for the challenges of today and tomorrow by integrating sustainability into our courses and curricula, thus enabling students to use sustainability as a lens throughout their education and careers
Team: Embrace cross-disciplinary collaboration	We will form new partnerships, both internally and externally, to support interdisciplinary efforts and advance innovative, entrepreneurial technologies and solutions
Campus: Transform campus into a living lab	We will make our campus a living lab where sustainability is part of daily life for our community, both inside and outside the classroom, and new ideas are integrated into our buildings, infrastructure, and business practices
Town: Connect with communities	We will work hand-in-hand with our closest community partners, and leverage our learning and experience to support triple-bottom-line sustainability efforts in Chapel Hill and Carrboro
State: Support economic development and service across the state	We will support our students, staff, and faculty in outreach and service efforts across North Carolina and will apply our skills and knowledge to assist economic development and social entrepreneurship in our communities
Region: Demonstrate responsible stewardship	We will reduce our environmental footprint, aiming for long-term waste, water, and carbon neutrality
World: Accelerate path from idea to impact	We will support cutting-edge student and faculty research, examine the impacts of our supply chains, and collaborate with industry and other partners to accelerate the transfer of ideas to practice

effort with energy and her support communicated that progress towards the plan's ambitious goals are an integral part of her vision for the university. The Chancellor's support also helped cultivate the support of other high-level administrators, such as deans, whose time and attention is always in demand. Students engaged in the plan's development saw their priorities acknowledged as important.

The engagement process demonstrated the importance of highly skilled facilitators and of high quality graphic images and visual aids. These contributions made by the consultant team conveyed professionalism and established credibility at the same time they helped forge a common understanding and shape the plan's vision and objectives. Equally important, the consultant team provided an external perspective that could see beyond current organizational boundaries and contributed additional capacity to thinly stretched staff. Weekly online meetings with the executive working group and the consultant team kept the momentum strong. Close

Fig. 4 The Plan's unifying graphic and mission statement

collaboration between the consultants and the executive working group facilitated ongoing assessment of engagement strategies and ensured that continuous improvements and minor course corrections could be made as issues arose, thus averting any major problems.

Looking ahead, additional effort is required to develop the implementation plans needed to advance progress towards the sustainability plan's ambitious goals. Further achievements will require the dedication of teams comprised of diverse

Table 4 Criteria for evaluating proposed pilot projects

Feasibility	Short-term	Able to be implemented within one calendar year
	Implementable	Feasible with respect to political and resourcing challenges
Impact	Representative	Reaches multiple interest groups and campus communities (cross-cutting)
	Scalable	Able to be replicated for greater impact in the future
	Measurable	Able to be quantified or qualitatively reported upon
	Reach	Number of students, employees, visitors touched by the project
	Path-breaking	Overcomes administrative obstacles and clears the way for future efforts
Engagement	Relatable	Clearly understood by all audiences
	Visible	Easily accessible or visible to students, employees, and visitors
	Community-building	Unites viewers/participants around the project
	Inspiring	Engages viewers/participants to pursue further learning or involvement
	Fun	Excites viewers and evokes genuine interest and enthusiasm

stakeholders and supported with adequate resources. In addition to funding, fulfillment of the plan's vision will require ongoing communication about the university's sustainability ambitions, progress made, efforts underway, and ongoing challenges. A strong and dynamic web and social media presence will be critical as will be continuous communication of support from the Chancellor and leaders at all levels of the university.

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The Contribution of Brazilian Post-graduate Scholarships Abroad to the Environmental Sustainability of Higher Education Institutions

João Filipe Torres Soares, Laise Frizon, Ulisses Miranda Azeiteiro and Luciana Londero Brandli

Abstract

This paper systematizes the information on post-graduation scholarships financed by Science without Borders (SwB) fostered by CAPES and CNPq. Results were evaluated for the environmental and sustainability areas increment of science indicators. The focus is the postgraduate scholarships on environmental sciences and related in a three years period (2011 to 2014). As indicators were used the number of scholarship per year and study area with an environmental interface. At this point, it is analyzed for each researcher contemplated by SwB the number of articles and publications, mentorship, number of participations in transnational projects and if there was an increase in the number of foreign visiting researchers. It is expected that the results may guide the discussion and serve as a tool for policy makers and academic stakeholders giving a contribution for the effective and efficient distribution of financial resources.

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Brazil · CAPES · Science without borders · CNPq

1 Introduction/Theoretical Referential

In a world which is fast changing and facing new and complex problems like a global economic crisis, climate change adaptation problems and increasing social disruption phenomenon's, higher education has a key role regarding science, knowledge transfer and sustainable development (Stephens et al. 2008).

A play role that must be antagonist of the one that has been played until now where political and management leaderships formed all around the world in the best Universities took us to this poor reality (Cortese 2003; Stephens et al. 2008). Efforts to launch the discussion and help the decision makers and researchers to establish common platforms to implement Sustainability in Higher Education (SHE) (Rusinko 2010) should be continued.

SHE has a lot of ways to be fulfiled through a sustainable management, mobility plans, bioarchiteture among many others (Wennen 2000), but more important are the concepts transversality which revealed the capacity of being included in all degree curricula (Lozano et al. 2011) in order to give the future professionals the exact interpretation of the WCED concept of Sustainable Development applying it to their expertise area their personal and professional life. From the Cardiff University example we see that more important than including a roll of subjects in the course curricula it is necessary a holistic perspective in order to truly innovate and achieve the main goal of a true change toward SD (Lozano 2010).

As seen until now internationalization and globalization are important chapters in the life of scholars and students all around the world (Lien 2007) and in order to fulfil their expectations, governments created programmes to promote and finance the expected exchange of expertises and rapidly try to diminish regional development cleavages (Mehmet and Hoong 1985). In these movements of students and researchers, post-doc scholars assume one of the most important roles. With solid careers and strong scientific production they face different difficulties when they return to their Universities (Melin 2005). So it is important to start measuring not only the quantitative metrics but above all the quality of the scientific production and also the transfer of good practices consequence of the period abroad (Melin 2005).

Concluding Rio+20 in Brazil, Capes published a discussion of the Brazilian graduate contribution to sustainable development (2012). The document emphasizes the importance of economic and technological policies in the training focused on issues that combine economic viability, social justice and environmental conservation. Therefore Brazilian Post-graduates has a large field for expansion in order to fulfil the new development rules on a sustainable basis.

In order to achieve those goals the Program Science Without Borders is providing 101,000 scholarships in the categories doctorate degrees, full doctorate, post-doctorate, sandwich graduation, technological development and innovation abroad, attracting young talent and special visiting researcher, students and researchers in the country and abroad. Actions such as this seek to strength the image and integration of the country abroad through its students and researchers.

According to Capes (2012) the presence of Brazilian science on an international stage is reflected both in qualitative and quantitative terms, the performance of Brazilian scientists in the major international institutions of science, often on high importance positions, on international scientific cooperation actions promoted by development agencies, federal and state through internships and graduate programs as well as international publications.

The commitment of the federal and state governments in Brazilian education is taken for granted in Brazil, as well as its commitment to the training and qualification of the scientific community (Mueller 2002). The time has come to measure the results of these efforts. On the other hand increases the certainty that regional disparities are growing in the country, between a North/Northeast less prolific and a South/Southeast strongly committed in a sustainable development model in higher education, bringing for the national scenario cleavages experienced in previous decades between developed countries and those in development or emerging ones (Corbucci 2003; Cavalcante 2011). Then it is also important to know, if that phenomenon is accentuating or dissipating under penalty of the inequalities growth and uneven the regional competitiveness. The authors also seek if this is also happening within the South UF and if so if it is relevant.

This study is an excerpt of a larger project that aims to explore and evaluate the inclusion of Brazilian postgraduate scholars whom study abroad in the area of environmental sustainability. The results show a trend and they are important since they can show if Science without Borders (SwB) investments has a return to the country, in practical terms, for its sustainable development, as “Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.” (WCED 1987). If possible, establish a connection between their work and their department environmental performance.

2 Methodology

First the authors downloaded all the data about scholarships granted in the years 2011 and 2012, those available at the moment at CNPq platform. After the authors divided them in graduate and pos-graduate and focus their attention on those who went abroad with a financed post-doc program. The study continued by crossing this information with their Lattes CV in order to find from what university they came from, and finally their research area.

The study focuses on the post-doc scholars who set their studies abroad, between the years 2011 and 2014, which came from the Federal Universities of the South of Brazil, more precisely Rio Grande do Sul (RS), Santa Catarina (SC) and Paraná (PR), and developed their research in environmental related areas.

These three states represent 6 % of the Brazilian's territory and concentrate 13 % of the country's population, according to the 2010 census. But the more relevant data is that it concentrates 17 % of the total of Brazilian's higher education institutions, and 15.6 % of the total volume of students in Brazil (SEMESP 2015). It constitutes one of the five macro regions in which Brazil is divided.

So, the following areas were selected according to their definition and SwB program insertion:

(i). Sustainable agricultural production, "one that respects the environment, fair from a social point of view and economically viable. Agriculture to be considered sustainable should ensure the future of the following generations, the ability to meet the needs of production and quality life on the planet" (Ehlers 2010);
(ii). Biodiversity and bioprospecting, to the fullest extent of Article 2 of the Convention on Biological Diversity, held at the Conference on Environment and Development, Rio-92;
(iii). Renewable energy "that originates from natural sources that have the capacity for regeneration (restoration), or does not exhaust." (Tolmasquim 2003);
(iv). Marine sciences (insofar as it is the area of knowledge dedicated to the production and dissemination of knowledge about the components, processes and resources of the marine environment and transition zones) and is framed goal in Sea Resources National Policy " guide the development of activities aimed at utilization, exploration and exploitation of living resources, minerals and energy of the Territorial Sea, Exclusive Economic Zone and the Continental Shelf, in accordance with national interests in a rational and sustainable way to develop socioeconomic Brazil, generating jobs and income, and contributing to social inclusion (Krug 2013);
(v). Disaster prevention and mitigation technologies (the latter chosen mainly by the component associated with extreme weather events, a consequence of global warming).

The data obtained so far is from secondary sources. It was obtained from publications identified in the bibliography (CAPES 2013) and from the officials Internet websites (CAPES and CNPq—Science without Borders). Besides those sources the authors also cross information, nominally, with the CV's Lattes platform. More than six hundred CV were consulted in order to separate those who fulfil the study profile at this point. Those researchers were identified and in a posterior part of the studied through an inquiry are expected to establish a connection between their work and their department environmental performance.

The analysis was based on the researcher's individual production in the years before SwB's scholarship and in the years after their return (Heitor et al. 2013). Four parameters were compared before and after the stay abroad:

i. Papers Published;
ii. Nº Publications (books/magazines);
iii. Mentorships;
iv. Transnational Projects Participation.

One of the limitations of the study at this point, is the impossibility of direct comparison of absolute numbers, because in one hand we have all and previous production referring to the entire academic career of the researcher and on the other, his work in only 1 or 2 years, depending of each case.

Production indicators considered were: published articles, books and magazines published number of mentorships and transnational projects participation.

3 Results and Discussion

Table 1 shows the total post-graduate, only from the Brazilian southern universities and in the areas of the study. A significant growth in the last four years is observed. The growth between 2011 and 2014 stands at more than five times, the highest absolute growth occurred between 2011 and 2012, with a duplication and after stabilized totalizing a total of 2012 supported researchers.

Considering the 2014's data for each study area, or thematic area, Table 2 shows the total number of Brazilian supported researchers and the total of Southern scholarships.

Data shows that from the study target areas, understandably that which most arouses the attention of scholars in the south is the sustainable agriculture production (SAP), which has an impact on the primary sector of the economy of the southern states, transposed to the volume of scholarships in that geographic area, which reaches about a quarter of the national total. Here the correlation between University and Society is fully reached.

Another aspect that stands out is the percentage of scholarships concentrated in the southern states in relation to the total, reaching around 20 %, which is average in a country divided in 5 larger regions.

When the study goes for the confrontation with Lattes CV and the cross information for the studied areas in the years with available information from CAPES, the authors built the following Tables 3 and 4. From a total of 584 scholars

Table 1 Southern postgraduation scholarships granted

Southern postgraduation scholarships on SwB	2011	2012	2013	2014
Year's total	165	390	617	840

Source CNPq

Table 2 Comparison of the number of scholarships in 2014

Study area with Environmental interface	Total of Brazilian scholarships at studied areas	Total of Southern scholarships	Total of Brazilian post graduation
Sustainable agriculture production (SAP)	2893	654 (22.6 %)	1475
Biodiversity and bioprospecting (BB)	1159	131 (11,3 %)	672
Renewable energy (RE)	925	173 (18.7 %)	130
Marine sciences (MC)	731	149 (20.3 %)	183
Disaster prevention and mitigation technologies (DPMT)	246	55 (22.3 %)	59

Source CNPq

Table 3 Scholarships Researchers in the studied areas, abroad since 2011

					Before scholarship				After scholarship			
ID	Univ	UF	Graduation Course	Postdoctoral Research	Pappers published	Nº Publications (books/magazines)	Mentorships	Transnational projects participation	Pappers published	Nº Publications (books/magazines)	Mentorships	Transnational projects participatona
R1	EUSC	RS	Agronomics	Vegetable Genetics Improvement	7		0	0	17		7	0
R2	UTFPR	PR	Agronomics	Vegetables Molecular Physiology	32	3	0	0	13	1	6	1
R3	UFSM	RS	Agronomics	Genetics Improvement	13		0	0	1			2
R4	UFRGS	RS	Agronomics	Soils Microbiology	30		24	0	18		11	0
R5	UFSC	SC	Enviromental Sciencies	Solid Waste Management and Treatment	18	5	34	0	17	1	29	2
R6	UFRGS	RS	Ecology	Population Ecology	11		1	0	5	1	2	0
R7	UFRGS	RS	Ecology	Water Resources and Environmental Sanitation	22		4	0	10		8	1
R8	FURGS	RS	Oceanography	na	na	na	na	na	na	na	na	na

Source Lattes platform

Table 4 Scholarships Researchers in the studied areas, abroad since 2012

Scholarships researchersin the studied areas, abroad since 2012												
					Before scholarship				After scholarship			
ID	Univ	UF	Graduation course	Postdoctoral research	Pappers published	Nº Publications (books/magazines)	Mentorships	Transnational projects participation	Pappers published	Nº Publications (books/magazines)	Mentorships	Transnational projects participation
R1	UEM	PR	Agronomics	Plants Biology	41	0	85	0	9	0	7	0
R2	UEL	PR	Biological Sciences	Fisiology	2	1	1	0	0	0	1	0
R3	UFPR	PR	Biological Sciences	Molecular and Celular Biology	6	1	7	0	2	0	2	0
R5	UFPEL	RS	Biology	Biotechnology	42	15	37	0	28	2	24	0
R6	UFPEL	RS	Biological Sciences	Biotechnology	26	26	69	0	30	3	34	0
R7	FURG	RS	Oceanography	Oceanography Chemistry	28	6	40	0	10	1	9	0
R8	UFRGS	RS	Biological Sciences	Biology	7	0	2	0	4	0	1	0
R9	PUC-RS	RS	Biological Sciences	Molecular and Celular Biology	13	0	0	0	2	0	3	0
R10	PUC-RS	RS	Biological Sciences	Molecular and Celular Biology	13	0	0	0	2	0	3	0
R11	UNISINOS	RS	Sciences	Entomology	3	3	0	0	0	0	0	0
R12	UFSM	RS	Biological Sciences	Ecology	8	3	0	0	5	1	0	0
R13	FURG	RS	Oceanography	Marine Ecology	28	6	39	0	14	1	19	0
R14	UFRGS	RS	Biological Sciences	Molecular and Genetics Biology	28	1	46	0	8	0	29	0
R15	FURG	RS	Oceanography	Enviromental Geology	21	3	31	0	3	1	13	0
R16	FURG	RS	Oceanography	Biological Oceanography	18	0	28	0	4	0	3	0
R17	PUC-RS	RS	Biological Sciences	Zoology	2	0	1	0	1	0	0	0
R18	na	RS	Biological Sciences	Zoology	26	0	0	0	10	2	0	0
R19	na	SC	Biological Sciences	Biotechnology	2	0	0	0	0	0	0	0
R20	UFSC	SC	Biological Sciences	Molecular Biology and Genetics	12	0	6	0	6	1	4	0

Source Lattes platform

identified by name, institution, UF and graduation course, 28 researchers were found fulfilling the studies' scope and for this reason target of a deeper researched according to the their study area.

Is remarkable the growth in the participation of the scholars in transnational projects and the average of papers published in only three and four years after departure. Highlighted too is the high participation of scholars from Rio Grande do Sul (RS) in comparison with Santa Catarina (SC) and Paraná (PR) at both years studied.

When we compare the number of papers published before and after, in 2011 we have an average increase of 61 % and in 2012 a growth of 41 % although in some cases the researcher career is longer than the 3 years after scholarships.

According the results the rate of participation on international research projects grew six times what means that the majority of the scholars found science partners abroad and implicitly established networks (Figs. 1 and 2).

The information collected either from 528 researchers, as of the 28 target of further investigation, pointed to a strengthening of the national regional and local scientific community by the internationalization process made possible by Sw. Also can be concluded in a preliminarily moment that there is a connection between the produced science and the predominant economic activities in the South of Brazil.

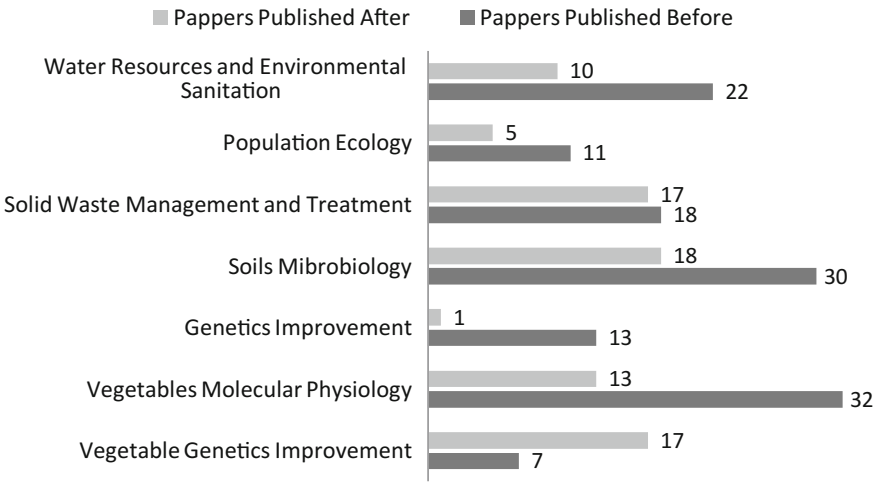

Fig. 1 Postdoctoral SwB's scholarships of 2011. *Source* Lattes platform

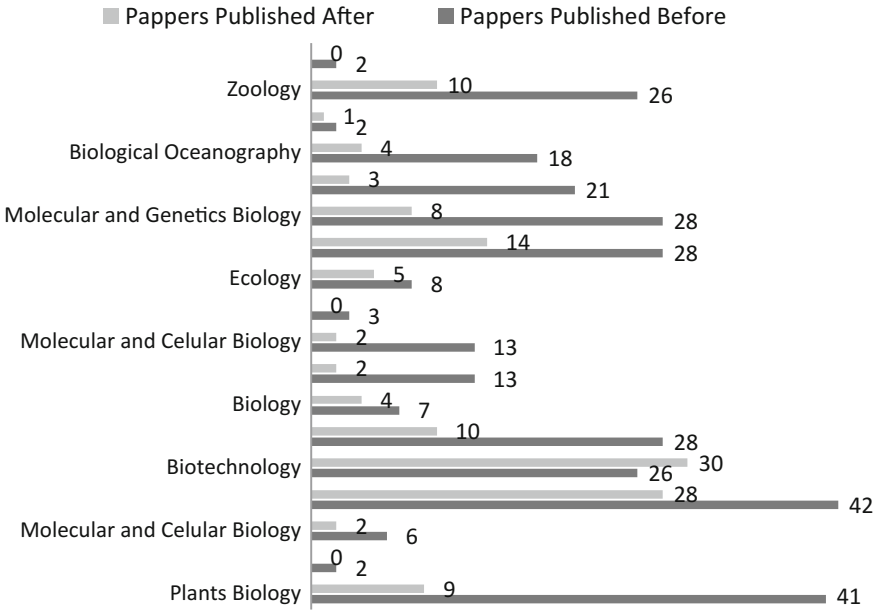

Fig. 2 Postdoctoral SwB's scholarships of 2012. *Source* Lattes platform

4 Conclusions

Two points are raised in this paper: the importance of this topic focused on sustainable development and the importance of researchers and students who have left Brazil to study abroad and deepen this topic. Government investments in terms of science without borders have been quite relevant and its impact on society, upon the return of these researchers to Brazil in the short or long term tends to be positive.

The data collected so far identified four themes that permeate environmental issues of sustainable development and show an increase in demand in these areas. The South Region has around 20 % of the investments in each of the areas, the total in Brazil. There is a growth of at least 600 % of participation of Brazilian scholars in active research projects around the world. The increase of papers published and in some cases books and magazines shows clearly that the science production is growing and is being broadcast.

As a continuation of this research is intended to raise quality indicators that can qualify the scientific production in the period and areas analyzed in order to qualitatively and quantitatively check their impact at the southern Brazilian scientific sphere and the sustainable development from the local (their own University department) to the national and international layer.

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Sustainable Management for a Contaminated Area on Campus

Fernanda Bertaco Bueno, Wanda Maria Risso Günther and Arlindo Philippi Jr

Abstract

Although remediation technologies solve environmental and public health issues caused by contaminated areas, they can also generate negative environmental externalities such as energy and natural resources consumption; imbalance of water cycle within hydrological regimes; soil erosion; nutrient depletion; and greenhouse gas emissions. Due to recent occurrence with contaminated areas at the University of São Paulo—USP the paper aims to present a theoretical framework about elements and challenges for developing a sustainable management plan for a contaminated area located on the USP Capital campus that promotes the use of sustainable practices in university campus, contributing to Program of Environmental Policies, coordinated by the Superintendence of Environmental Management of USP. The research methodology is based on literature review about sustainable remediation and LEED certification (Leadership in Energy and Environmental Design) for green building; characterization of four contaminated areas located on USP Capital campus; and a qualitative

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analysis of actions, sustainable practices and lessons learned applied on national and international case studies of contaminated sites. An area will be selected for elaboration of the plan based on the integration of remediation and construction stages in order to promote the use of sustainable practices on *campus*, through an approach that protects human health and minimize adverse environmental impacts.

Keywords
Sustainable campus · Contaminated areas · Sustainable management · Sustainable remediation · LEED

1 Introduction

Throughout history, the role of Higher Education Institutions has been directed to knowledge dissemination to social, economic, political and environmental transformations of society. In this context, the issue of sustainability has also motivated the creation of an institutional culture that uses the university campuses and their management practices as *locus* of experiment, researches and innovation for shifting paradigms regards institutional relationship with environment.

Based on new parameters of sustainable development, rethinking public management models is crucial to promote improvement of the quality of people's life. (Philippi et al. 2012).

Thus, this paper hopes to share the experience of Capital Campus of University of São Paulo—USP in the design, development and implementation of a Sustainable Campus Program, aiming to become USP an important center of excellence in knowledge production, and also a national reference in Sustainability, promoting its recognition in international rankings, and starting this process by planning and developing sustainable projects, consolidated in a sustainability agenda of Campuses USP. These projects were planned using guided participatory methodologies as instrumental techniques, including action research, perception surveys, diagnostics and participatory rapid diagnosis, affective map and talking map, technical meetings, logical framework, among others, enabling the creation of tools and instruments for management based on sustainability principles and seeking to improve quality and consolidation of life of its members on the campus and surroundings. The Program activities are divided into three conceptual frameworks and will last for 20 years until 2034 to celebrate the University centennial.

In this way, the University of São Paulo—USP has been active since the 1990s in the creation of several initiatives related to the prospect of a sustainability model such as USP Recycling Program in 1994; Permanent Program for the efficient use of energy in USP in 1997; Rational Use of Water Program in 1998; the creation of

Superintendence of Environmental Management in 2012 and the implementation of USP Sustainable Campus Program in 2014.

Designed and implemented in 2014 by Prefecture of University of Sao Paulo Capital Campus—PUSP-C, the Sustainable Campus USP Program is scheduled for completion in 2034, the University's centennial year, and it has the following objectives:

- Contribute to make USP national and international reference in sustainability;
- Plan and develop sustainable projects on USP;
- Consolidate sustainability agenda of Campuses USP;
- Articulate research, education, culture and extension to sustainability;
- Integrate projects and sustainability initiatives at USP;
- Expand and strengthen campus relation with the city;
- Create management tools based on sustainability principles to seek improvement and consolidation of quality of user's life on campus and surrounding areas.

The articulation of research, education, culture and extension is shared in nine thematic projects that comprise the program, including: (i) Territorial Water Management; (ii) Energy Management; (iii) Integrated Waste Management; (iv) Green Area Management; (v) Functional Urban Management; (vi) Environmental Health Management; (vii) Education, Research and Sustainability; (viii) Sustainability Culture; and (ix) Campus Governance.

In 2015, the Sustainable Campus Program became part of Environmental Policies Program, under the coordination of the Superintendence of Environmental Management of University.

As part of the projects of Sustainable Campus Program, the Integrated Waste Management includes actions such as mechanized collection; implementation of integrated matrix of management and waste management; and assessment, monitoring and control of contaminated areas of capital campus (Lima et al. 2015).

The presence of contaminated areas represents a major challenge for sustainable urban development. The recent occurrence of contaminated areas at universities such as USP which has in the Capital campus disabled gas stations and waste disposal lands is an opportunity to rehabilitate these sites with environmental risks securely for the use by local frequenters.

The paper aims to present a theoretical framework about elements and challenges for developing a sustainable management plan for a contaminated area located on the USP Capital campus that promotes the use of sustainable practices in university campus, contributing to Program of Environmental Policies, coordinated by the Superintendence of Environmental Management of USP.

2 Methodology for Development of a Sustainable Management Plan

The research methodology for the elaboration of the sustainable management plan is based on exploratory qualitative research developed as case study. The methods adopted for the research is literature review, documental research and case study.

First, towards a better comprehension of the theme it will be carried out a literature review of existing tools at international level for implementation of sustainable remediation and LEED (Leadership in Energy and Environmental Design) certification for green building that covers aspects such as conservation and efficiency practices for water and energy use; materials reuse; local generation of renewable energy; among others. As basis of this study it will also be considered the sustainable practices applied in national and international cases of contaminated sites.

For selection of a contaminated area for case study it was considered areas located in USP Capital campus whose contamination is already delimited through environmental assessments. At the moment, four areas of Capital campus are contaminated: two gas stations, a former industrial area considered unclaimed inheritances and the land occupied by the School of Arts, Sciences and Humanities of University of Sao Paulo where there was waste disposal in the past.

The procedure for secondary data collection of contaminated areas will be based on documental research and it will include: (i) consultation with the environmental studies and technical reports elaborated by Environmental Company of State of São Paulo (Cetesb), the regulatory agency for contaminated areas of the State of São Paulo; (ii) consultation with the administrative and technical documents in PUSP-C and Superintendence of Physical Space, both located at USP; and (iii) research at local agencies of Cetesb.

From characterization of four contaminated areas (two gas stations, a former industrial area and a waste disposal area occupied by the School of Arts, Sciences and Humanities of USP Capital campus, data will be collected such as type of contaminant; physical environment properties; current management stage; future use of the area; intervention measures; remediation technologies; and recommendations and restrictions of regulatory environmental agency.

The criteria for selecting a contaminated area of USP Capital campus will be based on the complexity of contamination; associated risks; and the possibility of future sustainable buildings construction on site. Therefore, an area will be appropriate to elaborate a sustainable management plan when there will be need of remediation to manage risks and the possibility of building construction with sustainable elements in redevelopment project.

Based on the literature review of sustainable practices applied on national and international case studies of contaminated sites, a qualitative analysis of actions, sustainable practices and lessons learned will be carried out to support the elaboration of the sustainable management plan for the contaminated area of USP Capital campus.

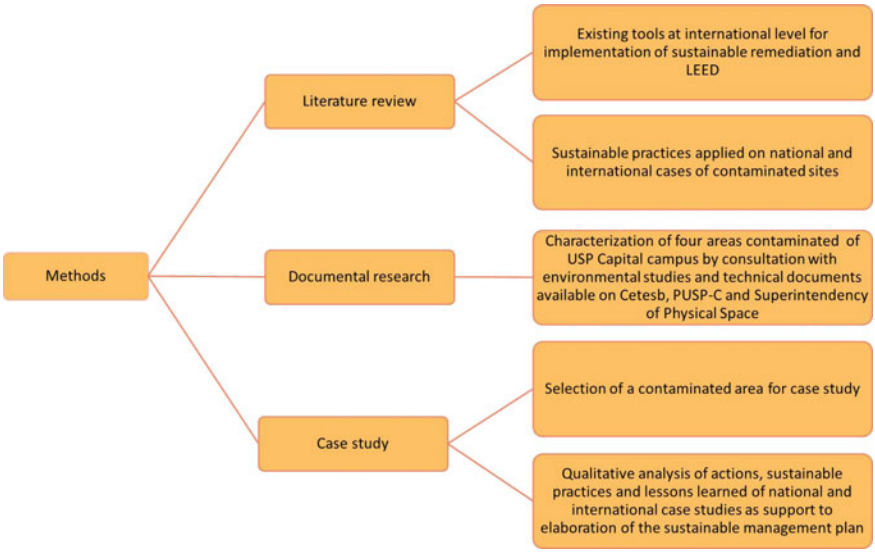

Fig. 1 Framework of adopted methods for the research. *Source* The authors

For the development of the plan, alternatives of remediation technologies, construction elements and sustainable practices will be considered to incorporate into the management of contaminated area.

The methods adopted for research are structured in the framework shown in Fig. 1.

3 Limitations of the Research

The constraints and limitations of the research include:

- Availability of scientific papers on sustainable remediation and effectiveness of sustainable practices, since there are not many published books and articles related to this topic.
- Lack of sustainability metrics to conduct an analysis of contaminated areas cases.
- Lack of quality and/or information on environmental assessment studies of the contaminated areas of USP, as the studies may not have been performed in accordance with existing procedures.
- Restriction on availability of successful case studies of contaminated areas rehabilitation because cases may be confidential.

4 Contaminated Areas Management

The presence of contamination by toxic and/or carcinogenic substances in soil and groundwater released by industries, landfills and gas stations can entail risks to environment and human health from infiltration of hazardous substances; water impairment as drinking water; restrictions on area reuse; and reduction on economic value and social function of the land.

Only after the occurrence of health problems in people exposed to these areas, specific legislation for soil protection and management of contaminated areas were adopted in order to prevent environmental damage and reduce toxicity and/or carcinogenic risk to acceptable levels (Sanchez 2004).

The management process of contaminated areas involves identification, assessment and risk assessment on the site. Figure 2 illustrates an example of release mechanism of chemicals and its pathways to environment and potential receptors. In cases where there are risks to human health and environment, it is necessary implementation of emergency measures, engineering or institutional controls remediation technologies and/or monitoring for closure (CETESB 2007).

The conceptual risk-based approach in a contaminated area requires the combination of three factors: contamination source, pathways and receptors. The risk management consists in interrupting one of these connections by controlling the source such as an installation of a remediation system to reduce or eliminate the mass of contaminants; or managing pathways like the adoption of restriction of groundwater use; or protecting receptor such as the prohibition of occupation of certain areas (Bardos et al. 2012).

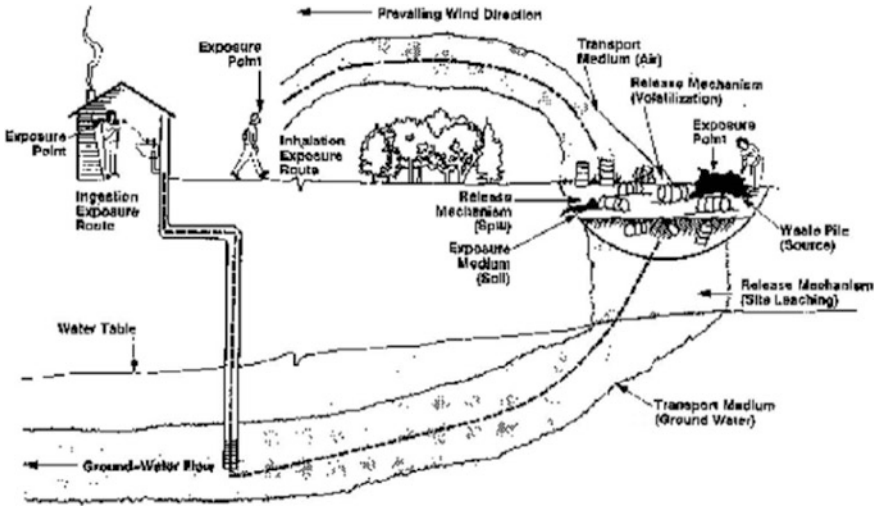

Fig. 2 Illustration of exposure pathways (USEPA 1989)

When the risk management requires intervention on hotspot by means of installing remediation technologies for containing or treating contamination, these are applied with the purpose of achieving remediation goals set for the area, so human health risk is reduced to acceptable levels (CETESB 2007).

Although remediation technologies solve environmental and public health issues, they can also generate negative environmental externalities such as energy and natural resources consumption; imbalance of water cycle within hydrological regimes; soil erosion; nutrient depletion; and greenhouse gas emissions such as carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), as illustrated in Fig. 3. Besides that, remediation technologies can generate risks to site workers and surrounding population, and compromise economic viability of the project for future reuse of the site (SURF 2009).

Given this situation, the question arises about which it is the alternative with lower environmental impact for a tonne of contaminated soil with hydrocarbons: install a remediation system and consume tens of liters of fossil fuel to recover hydrocarbons or excavate contaminated soil for disposal in a landfill to cause impacts elsewhere? (Bardos et al. 2012).

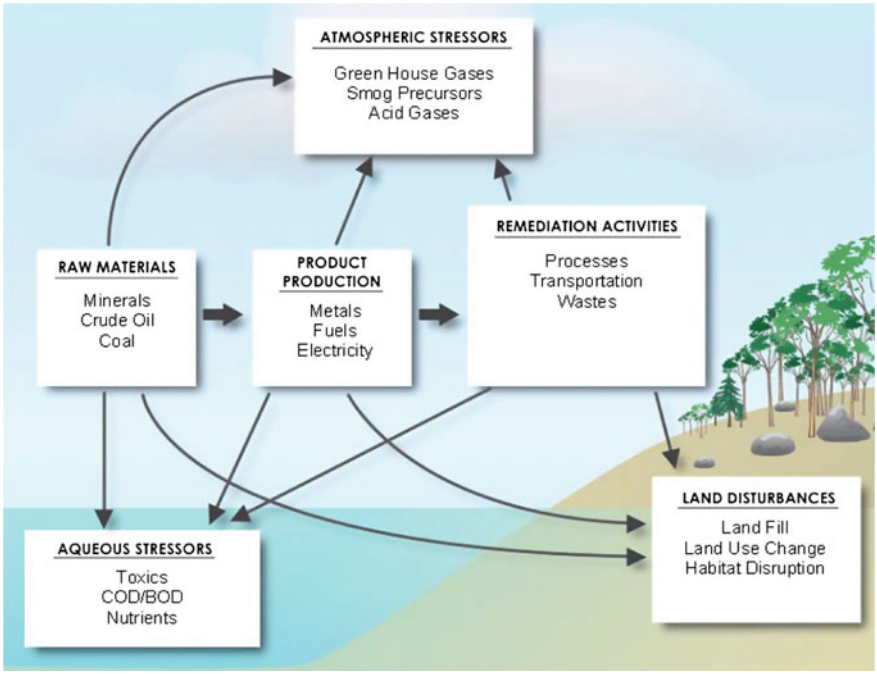

Fig. 3 Illustration of effects of remediation activities on atmosphere, soil and water. *Source* DTSC (2009)

In face of these impacts originated from remediation process, the inclusion of sustainability in land remediation becomes an alternative to reduce adversities and a challenge to find new solutions for the future use of contaminated site.

5 Sustainability in Remediation Processes and Buildings

The concept of sustainable development was defined in the Brundtland Report, published in 1987 by the World Commission on Environment and Development—WCED: *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*. From that concept, several definitions have developed with a consensual idea that sustainability comprises environmental, economic and social aspects (Polaz and Teixeira 2015).

In this context, sustainable remediation and construction include the holistic consideration of environmental, social, and economic impacts of an activity and evaluation of these impacts on future generations (ITRC 2011).

By means of an approach that protects human health and minimizes adverse environmental impacts, the implementation of sustainable remediation associated with sustainable construction becomes an alternative for safe rehabilitation of contaminated areas, considering sustainability as part of the decision-making process when selecting a remedial process (SURF 2009).

The concept of sustainable remediation emerged in the United States in 2006, after the creation of an organization formed by remediation professionals known as the Sustainable Remediation Forum—SURF, in order to establish a framework that incorporates sustainable concepts throughout the remedial action process while assuring protection of human health and safety and achieving standards regulatory. According SURF, sustainable remediation comprises soil and groundwater risk-management actions that are selected, designed, and operated to maximize net environmental, social, and economic benefits.

When remediation process actions are adopted to minimize environmental impacts focusing mainly on preservation and conservation of natural resources is called green remediation (Smith and Kerrison 2013). According to *Green Remediation—Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites* (2008), a publication of *The United States Environmental Agency (USEPA)* green remediation has defined as follows: *"The practice of considering all environmental effects of remedy implementation and incorporating options to maximize net environmental benefits of cleanup actions."*

In addition to protecting human health and environment from hazards of contaminated areas, the adoption of sustainable practices on cleaning up process results in environmental, social and/or economic benefits, such as reduction of pollutants emissions, creation of employment opportunities and reduction of costs. A listing of these benefits examples is provided in Fig. 4 (USEPA 2008; SURF 2009).

Examples of environmental, economic and social benefits of sustainable remediation	
Environmental	• Minimize degradation or enhance ecology of the site and other affected areas, • Reduce emissions of greenhouse gas, • Reduce total pollutant and waste burdens on the environment.
Economic	• Reduce costs associated with improvements on remediation technologies, • Increase economic productivity of local communities, • Achieve greater long-term financial return from investments such as renewable energy.
Social	• Provide employment opportunities related to development of new remediation technologies and renewable energy, • Minimize the risk of accidents on roads with trucks and other vehicles by reduction of contaminated material transport, • Decrease export of waste from communities with little or no landfill capacity to other facilities.

Fig. 4 Examples of environmental, economic and social benefits of sustainable remediation. *Source* USEPA (2008), SURF (2009)

In recent years, the development of qualitative and quantitative tools based on methods of multi-criteria analysis, life-cycle assessment and feasibility study enabled the evaluation and the estimative of environmental impacts associated with remediation technologies (Texeira et al. 2012).

The combination of remediation and construction design on planning stages can be considered an alternative on site rehabilitation to incorporate sustainability in contaminated areas redevelopment, avoiding unnecessary use of energy, material and financial resources, such as the installation of a renewable energy plant on site for remediation system operation, and subsequently for future energy supply of the site.

One of the certification tools for sustainable construction widely used internationally is the Leadership in Energy and Environmental Design—LEED developed by the U.S. Green Building Council—USGBC (Hernandes 2006). The design of Green Building incorporates elements to use less materials, energy and water in building's life cycle with environmental, economic and social effects broader than a regular construction (NORTE ARQUITETURA E URBANISMO 2015).

Internationally recognized in over 100 countries, this certification has four rating levels (Certified, Silver, Gold and Platinum), which are obtained according to points earned in the project. Based on the incorporation of practices such as conservation and efficiency of water and energy use; reuse of buildings materials; local generation of renewable energy and innovative design in buildings, projects can elect to pursue to gain points toward LEED Certification. Points are earned by prerequisites (required elements) and credits (optional elements). The LEED Certification categories and objectives are described in Table 1.

Table 1 LEED Certification categories and objectives. *Source* GBC BRASIL (2015)

Categories	Objectives
SS—Sustainable sites	Encourage strategies that minimize the impact on ecosystems and water resources
WE—Water efficiency	Promote smarter use of water, inside and out, to reduce potable water consumption
EA—Energy and atmosphere	Promote better building energy performance through innovative strategies, such as energy simulations, measurement and use of efficient equipment and systems
MR—Materials and resources	Encourage using sustainable building materials (recycled, regional and reused) and reducing waste
EQ—Indoor environmental quality	Promote better indoor air quality and access to daylight and views, focused on the selection of materials with low emission of volatile organic compounds, thermal comfort and prioritization of areas with outside view and natural light
IN—Innovation	Address sustainable building expertise as well as design measures not covered under the other LEED credit categories
CR—Regional priority credits	Address regional environmental priorities for buildings in different geographic regions, according to environmental, social and economic differences in each location

6 Sustainable Management Challenges

The lack of guidance documents and specific legislation that considers sustainability as part of the decision-making process when selecting a remedial process is one of the barriers to the implementation of sustainable remediation, since the acceptance for sustainable practices by all stakeholders becomes harder without these guidelines.

Other factor considered as an obstacle to sustainable remediation techniques is the lack of sustainability metrics and decision methodologies for remedy selection. While most quantitative tools include assessment of energy consumption and greenhouse gas emissions, a more complex analysis is required to consider other parameters such as air quality, the value of land and water, worker injury and loss of life. From identification of key metrics that could be based on principles of sustainability, an effort is necessary to provide consensus on how sustainability metrics would be measured, estimated or evaluated in decision making.

Besides the lack of guidance documents, specific legislation, sustainability metrics, decision methodologies, the lack of reported sustainable remedy examples is a significant barrier for implementing sustainable remediation as an alternative to

conventional remediation. Sharing experience and lessons learned from cleaning up case studies is essential to demonstrate effectiveness, feasibility, benefits, costs and barriers for incorporating sustainable practices in each project and encouraging stakeholders (consultants, owners, investors and government) for adopting technologies and management tools that consider sustainability into site cleanup decisions, as well cases will be important examples for future projects of sites rehabilitation.

At last, economic barriers also hinder implementation of sustainable remediation. Despite an estimated high initial investment, sustainable techniques as renewable energy sources at remediation sites can result in economic gains and long-term benefits, which include significant reduction in the carbon footprint of an energy-intensive remediation project; and creation of opportunities for new energy markets and jobs. As example, renewable energy systems could be reused for future energy supply of the site, through integration of remediation and construction design phases on site rehabilitation in order to avoid unnecessary use of energy, material and financial resources.

In this way, to overcome economic barriers, financial or certification incentives are needed to encourage innovation and adaptation of sustainable remediation practices. Economic instruments such as financing programs, loan fund programs, tax credits, public private partnerships and government subsidies is fundamental in reducing resistance from investors and contaminated areas owners applying sustainable practices as part of the property redevelopment process (SURF 2009).

7 Expected Results and Future Prospects

The literature review of existing tools for implementation of sustainable remediation and LEED certification along with the systemic analysis of sustainable practices applied in national and international cases of contaminated sites described in this paper will drive the decision-making process when selecting sustainable techniques and practices that could be applied in a contaminated area of USP Capital campus.

From the characterization of four contaminated areas of USP Capital campus, a contaminated area will be selected for case study in order to develop a sustainable management plan that includes the integration of remediation and construction design in planning stage.

Based on selection criteria, an area will be appropriate to elaborate a sustainable management plan when there will be need of remediation to manage risks and the possibility of building construction with sustainable elements in redevelopment project.

In order to seek an alternative to conventional remediation technologies and reduce unnecessary use of energy, material, and financial resources; a sustainable management plan will be prepared for a contaminated area of campus in such a way

that includes integration of remediation and construction design phases on site rehabilitation.

Thus, examples of that integration could be elucidated by installation of a power generation system for future energy supply of the site from extraction and flaring of gas derived from organic waste disposal areas; or also by reuse of treated soil after decontamination as backfill on the site for constructing green areas or living spaces.

8 Conclusions

The sustainable management plan for a contaminated area of USP Capital campus could encourage USP to adopt sustainable practices into remediation and construction design phases on site rehabilitation, through an approach that protects human health and minimize adverse environmental impacts.

The incorporation of sustainability principles in contaminated areas may motivate use of tools and management instruments in search of improving and strengthening the quality of life of the regulars of USP Capital campus. Planning for the sustainable management of a contaminated area on campus can contribute to the Program of Environmental Policies, as well assist USP to be an important center of excellence in knowledge production and national reference in sustainability from planning and development of sustainable projects.

Although there is no single and standardized solution for all contaminated areas, the evaluation of strategies to be adopted in the case study can be used as an example for other contaminated areas of campus which aims sustainable management, considering challenges and characteristics of each site.

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Education for Sustainable Development Through Policies and Strategies in the Public Portuguese Higher Education Institutions

C. Farinha, U.M. Azeiteiro and S. Caeiro

Abstract

Many European countries, particularly in Northern Europe, have conducted integrated studies on Sustainable Development in Higher Education. In Portugal, no attempt has been made to evaluate how Public Higher Education Institutions (HEI) are incorporating Education for Sustainable Development (ESD) at policy and strategy level and how it was implemented within Ministry of Education and Science. The aim of this paper is to discuss the integration of sustainability in the 14 public HEI in Portugal through policies and strategies within the framework and goals of the United Nations Decade of Education for Sustainable Development (DESD) 2005–2014. The methodological approach is based on a documental content analysis where pre-selected key terms were used after a review of the literature in a deductive approach theory. Documentary research on polices, plans and programs from the Governmental Great Planning Options as Governmental Constitutional Plans and the Portuguese Ministry of Education and Science was performed through the analysis of the possible forms of implementation of DESD, and their consequent impacts on strategies of the public Institutions taking part of the Portuguese Council of Rectors. Given that 2014 was the final year of DESD 2005–2014 and 2005 was the Millennium Development Goals (MDG) assessment year, the integration of sustainability

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through policies and strategies in the Public Portuguese HEI is on schedule. More detailed studies must be undertaken at a later stage, namely interviewing the key stakeholders in the Government, Ministry of Education and Science or Portuguese University Rectors Council (PURC). Notwithstanding some international drivers and a few practical examples at University level, preliminary results showed that ESD is still in its early stages of development and that there is a lack of national integrated strategies or policies. We do believe that there is an absolute need for a change in the paradigm of Portuguese HEI and several barriers to overcome, as from learning as from the application of best practices from other European and worldwide countries. This paper will be useful to academics and researchers interested in further develop the topic of integration of sustainability through policies and strategies in Public HEI in Portugal.

Keywords
Education for sustainable development · Decade of education for sustainable development · Governmental constitutional plans · Governmental great planning options · Portuguese higher education institutions · Sustainability

1 Introduction

In the last decade many research have been developed to evaluate how Sustainable Development has been applied and implemented in Higher Education Institutions (HEI) (Lozano et al. 2015). In Portugal, no attempt has been made to evaluate in detail how Public HEI are incorporating Education for Sustainable Development (ESD) at policy and strategy level and how it was implemented within Ministry of Education and Science. Taking into account that the Decade finished in 2014 (the last year of this UNESCO program) this is an opportunity to verify if the aforementioned principles have been applied in the Portuguese context by the implementation of policies and/or strategies of the multiple HEI. To accomplish this two main goals were defined for this study:

(1) How and the extent to which the Portuguese Government integrated the sustainability in their plans, programmes and policies;

(2) The extent to which the Ministry of Education and Science had done so with some of the documentation produced in the period 2005–2014.

2 Theoretical Framework

The level of achievement and accomplishment of integrated studies on SD and sustainability in Public Portuguese HEI it is not yet comparable to those in many European countries, particularly in Northern Europe. As example we mentioned the

transformation of HE towards sustainability in Sweden. "The time required fostering transformation in HE towards sustainability is a slow process, but possible! (…) The research reviews progress made by a number of Swedish universities following a 1996 requirement that all Swedish public authorities (including universities) were made responsible for contributing to the sustainable development of the society" (Lotz-Sisitka 2004). Other good examples can be seen in German and Czech Republic, although more specific in certain Universities due to important research groups working at the level of curricula and educational and pedagogical tools [see for example (Dhouhá and Burandt 2015)]. In fact European countries are more familiar with or are more interested in ESD in HES discourses than educators from other regions of the world (Lozano et al. 2015).

Portugal has 14 Public HEI geographically spread and the studies and discussion about the integration of sustainability through policies and strategies within the framework and goals of the International Decade for Education for Sustainable Development concerning 2005–2014 (DESD 2005–2014) proclaimed by the General Assembly of the United Nations is far beyond what it should be. Nevertheless, Aleixo et al. (2016) refer few good examples like: (1) "(…) Portuguese Public HEIs are predominantly at an early stage of SD and, based on their policies and strategies, SD seems to be incremental", and (2) "Portuguese Public HEIs show, in the first place, awareness in the way they communicate, whether through institutional documents or websites".

Hopkins (2012) refers that despite all "(…) it is almost impossible to identify the exact origin of education for sustainable development (ESD). Each of us in the field has a story of our initial reaction when and where we first became aware of it".

The final document about Sustainable Development from United Nations Conference, which is globally known as Rio+20 Conference (2012) was approved in 22th June 2012 and adopted by far more than 190 countries. About Sustainable development (SD) one can read:

> We encourage Member States to promote [its] awareness among youth, inter alia by promoting programmes for non-formal education in accordance with the goals of the United Nations Decade of Education for Sustainable Development, 2005–2014.

According to DESD (2005–2014): International Implementation Scheme (2005), the aims were quite clear namely those related to (1) helping countries to make progress towards and attaining the Millennium Development Goals (MDG) through ESD efforts and (2) providing countries with new opportunities to incorporate ESD into education reform efforts). At the time there was a broad approach: DESD implementation efforts were linked to multiple processes: (a) MDG as there were 8 goals and 18 measurable targets where education was a major asset and an important input as to "ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling", (b) the movement "Education for All" (EFA) (whose focus is to provide education of quality for all) and (c) "United Nations Literacy Decade" (UNLD) (concentrating on promoting the key-tools for all forms of structured learning). The milestones for DESD were listed in the implementation scheme as well as the strategies for integrating

ESD as there was "(…) a commitment that will be implemented by Member States according to their priorities and approaches" (DESD 2005).

It was reported by Tilbury and Mulà (2009) that the path to SD required new mental framework and action which enables us to transform the way we create choices and view the future. Education and learning are therefore key activities in order to facilitate the critical process and change mentalities, according to DESD (2005) and HEI was a critical "actor" of this whole process because it prepares the policy-makers and leaders of today and tomorrow. On the one hand, the HEI leaders' signature and commitment made them as SD catalysts and gave a promotional sustainable "signal" as reported by Karatzoglou (2013), which can be verified from multiple Declarations, Letters or Initiatives concerning ESD in Higher Education in a previous DESD period. The Talloires Declaration was determinant in the definition of sustainability in terms of HEI as it had been signed in 1990 by more than 265 presidents in 40 countries on five continents as admitted by Clugston and Calder (1999). On the other hand and taking into account ESD applicability, the Copernicus Charter (CO-operation Programme in Europe for Research on Nature and Industry through Coordinated University Studies) resulted from the Conference of European Rectors (CRE 2003), which was signed in 1988 by far most than 2 hundred universities, mentions that:

> Universities and equivalent institutions of higher education train the coming generations of citizens and have expertise in all fields of research, both in technology as well as in the natural, human and social sciences. It is consequently their duty to propagate environmental literacy and to promote the practice of environmental ethics in society.

Given the very rapid political changes after 1989, taking the word of AdomBent et al. (2014): "the many claims on scarce resources and the at times bewildering need for creative thinking in order to adjust quickly to a rapidly changing environment, it is understandable that CEE governments and ministries of education have given relatively low priority to what they perceive (or better, misperceive) as a 'fashionable trend'". Even though Council of the European Union (2010) emphasizes the need for greater recognition of ESD:

> Education is a prerequisite for promoting the behavioral changes and providing all citizens with the key competences needed to achieve sustainable development.

Higher Education leaders have to be committed to sustainability by integrating it into policies and strategies; showing the commitment by signing a declaration, charter, or initiative; establishing short-, medium-, and long-term plans for its institutionalization; and ensure that sustainable development is implemented throughout the HE system (Lozano et al. 2015).

As stressed earlier Northern Europe had conducted integrated studies on SD in HE, and despite Tilbury (2004) criticism about the lack of investment in ESD area, it is recognized that for example the drive for HE in Wales to be at the forefront as reaffirming its role in contributing to a sustainable future coming from the top, what is required to support possible success. The Welsh model is considered to be a Capability Maturity Model and there was adherence to Government priorities in

strategic plans aligned with strong leadership according to Glover and Peters (2013). Even in Spain, where there is a lack of sufficient studies that investigate sustainable development in higher education, there were increasing attraction levels of attention from both the public and policy makers in recent decades, namely a number of previous studies that have called for a more comprehensive integration of sustainable development into university operations and curricula according to Lárran et al. (2014). In 2002, Alba and Blanco (2008) mentioned that the Committee of Rectors of the Spanish Universities (CRE) approved the creation of a Work Group about the environmental quality and the SD in the Spanish Universities. A top-down action or a cascade process took place as to initiate the commitment process and the subsequent actions in HEI:

> One of their main goals is to encourage the participation of Spanish HEI's by means of the exchange of experiences and through the development of joint projects. This group is made up of thirty universities, and its most important actions are the thematic seminars organised within different conferences and workshops twice a year.

As a step forward the Universidade Autonoma de Madrid (UAM) did a survey as to assess the Universities situation concerning sustainability up to date (2006) using the *Sustainability Assessment Questionnaire* (SAQ) of *United Leaders for a Sustainable Future* (ULSF), that allowed the analysis of the commitment and the planning for sustainability through technical questions and inclusion of the thematic in the Strategical Plans. From the survey results it was concluded that the sustainability in Spain was implemented by the great involvement of the CRUE (Alba and Blanco (2008)).

Portugal hasn't yet done any evaluation in detail how Public Higher Education Institutions (HEI) are incorporating ESD at policy and strategy level and how it was implemented through the Government and/or the Ministry of Education and Science. This study aimed to discuss the integration of sustainability in the 14 public HEI in Portugal through policies and strategies within the framework and goals of the United Nations Decade of Education for Sustainable Development (DESD) 2005-2014.

3 Methods

3.1 Sample, Data Collection, Analysis and Treatment

In order to measure and analyze how and the extent to which the Portuguese Government had integrated the sustainability in their plans, programmes and policies, a content analysis of all the Great Planning Options (GPO) (2005–2009, 2007, 2008, 2009, 2010–2013, 2012–2015, 2013, 2014 and 2015) as well as the three Constitutional Governmental Programmes (CGP) [XVII (2005 to 2009), XVIII (2009 to 2011), and XIX (2011 to 2015)] was carried out. Those documents

Table 1 Selected key words after a content analysis of systematic review

1. DESD—Decade for education for sustainable development	8. Development
2. Environmental education	9. Transdisciplinary
3. Sustainable development	10. Holistic
4. Science for sustainability	11. Integration
5. Environmental management	12. Higher education/universities
6. Sustainability/sustainable	13. Curricula/curricular plan/curricular programme
7. Environment/environmental	14. Campus

were available at the Portuguese Parliament website (Portuguese Parliament Assembly (2015).

The qualitative approach using content analysis, based on Bardin (1977) methodology, consisted of classifying the information disclosed in different categories that represented different dimensions of integrating sustainability in the plans, programmes and policies under analysis.

The data collection was carried out in October 2015. In order to analyze and treat the data we developed a coding system bearing in mind the selection of terms or mix terms (see Table 1) that were gathered after a content analysis of systematic review.

In order to evaluate the integration of sustainability in plans, programmes and policies at the Ministry of Education and Science we did also a content analysis as we intended to study "if and how Portugal in its Education Reform implemented Sustainability through strategies and policies during DESD 2004-2015 in the public Universities?" Nevertheless the documentary sources were not so easy to gather as it seemed there was a lack of national integrated strategies or policies, plans or programs concerning integration of DESD 2005-2014 into Portuguese HEI. The documents were collected through internet, library search and personal contacts to employees of the Ministry.

The documents were gathered and organized chronologically:

(1) *Law n.62/2007, 10th September - Legal status of higher education institutions* [Lei n.º 62/2007 de 10 de Setembro - *Regime jurídico das instituições de ensino superior*,
(2) *National Strategy for Development Education (2010–2015)*,
(3) *Decade of United Nations for Education for Sustainable Development (2005–2014): Contributions for its dinamization in Portugal* [Década das Nações Unidas da Educação para o Desenvolvimento Sustentável (2005–2014): Contributos para a sua dinamização em Portugal],
(4) *State of Education 2012: Autonomy and Decentralization* [Estado da Educação 2012: Autonomia e Descentralização],
(5) *A trust agreement in higher education for the future of Portugal: Investing in the future* [Um contrato de Confiança no Ensino Superior para o futuro de Portugal: Investir no futuro (2010–2013)].

The "National Strategy for Development Education" 5 year participatory strategical document engaged by PIDS (2009) (IPAD—Instituto Português de Apoio ao Desenvolvimento) and other governmental and non-governmental actors as UNESCO is the responsible organization for the DESD implementation because it is their responsibility the invitation of the Governments to be involved on the inclusion of ESD in their Educational as ED should be assumed as an important instrument for the universal and quality access in the long run and so contribute to the solid commitment of all the people.

NVIVO version 10 software was used for the quantitative content analysis of the selected documents, and it was "searched" for word(s), text (see Table 1) and build some codification matrixes in order to look for:

a. the most frequent words (top 20 with length less or equal to 10 characters) (see Figs. 1, 2, 3 and 4);
b. the text after analysed the data in order to have a cluster analysis; then we organized in nodes or categories (see Fig. 5);
c. the document coverage and the number of codified references taking into account the key words and the systematic review (5 documentary sources) in order to obtain a codified matrix and understand if, and how was the implementation of DESD in HE (see Fig. 6).

Due to the relatively small number and quality of the documentary sources we were able to gather, despite our efforts, this outlines the limitations of our work and some constraints of this paper. Adding this we also consider these sources as a sample and so they cannot be regarded as representative, but this can show the lack of commitment from the governmental institutions towards ESD (we analyze this in the next section).

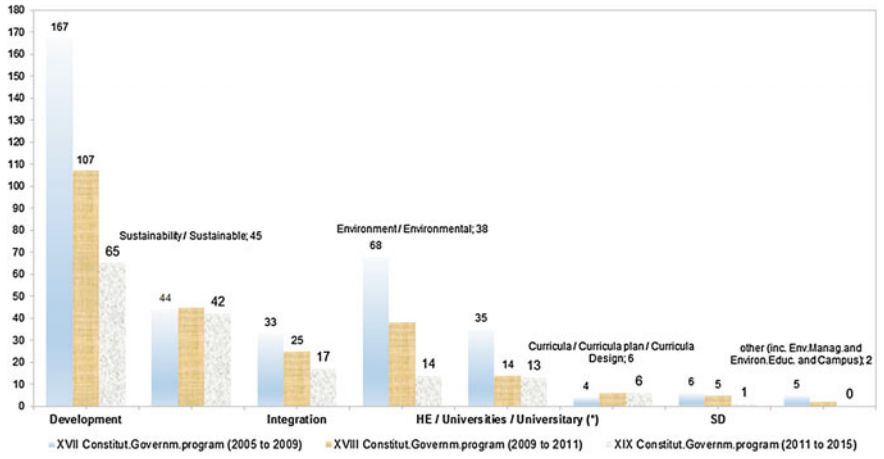

Fig. 1 Number of key words (words or text) references through the Portuguese Governmental programmes (from 2005 to 2015)

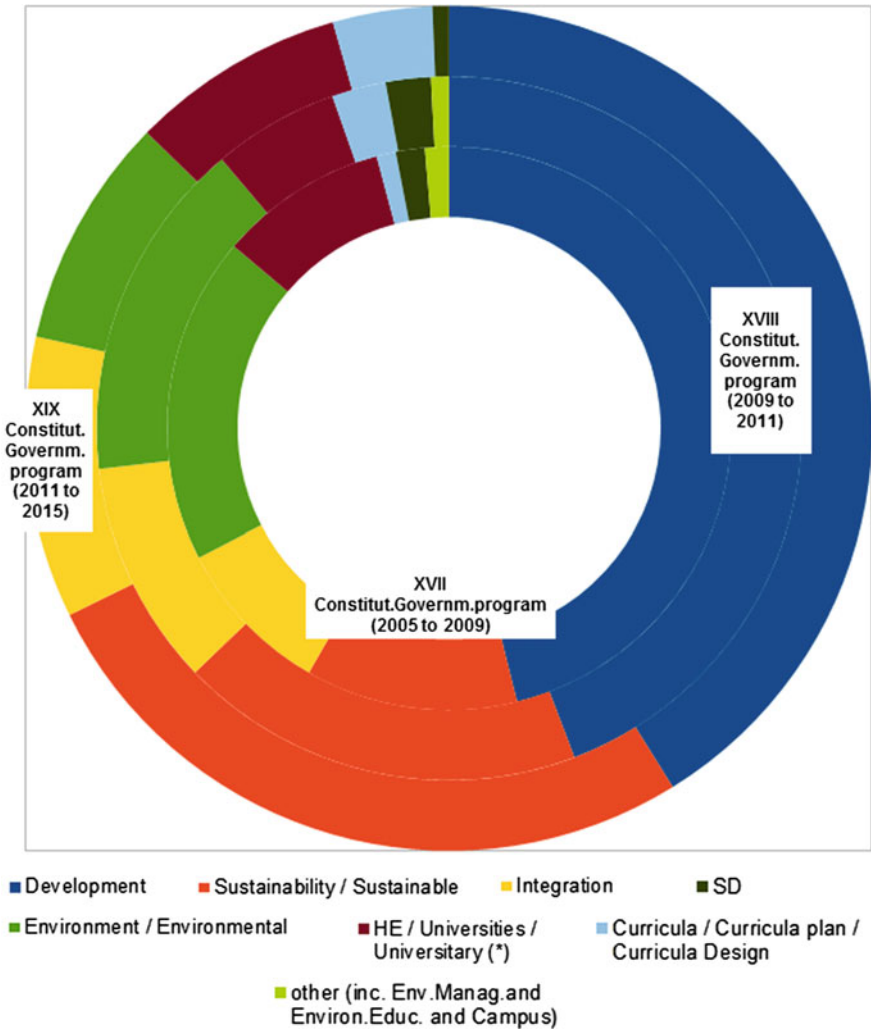

Fig. 2 Number of key words (words or text) references in the three Constitutional Governmental programmes (2005–2009); 2010–2013 (This is a quadrennial GPO so it is not totally comparable to the use of annual GPO); 2012–2015

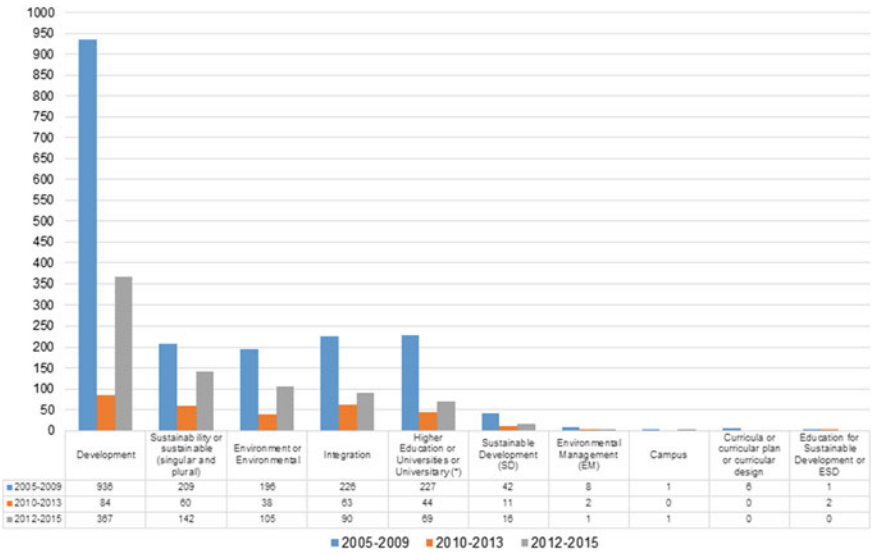

Fig. 3 Number of key words (words or text) references in the great planning options (GPO) (*) from 2005 to 2014 in Portugal (**)

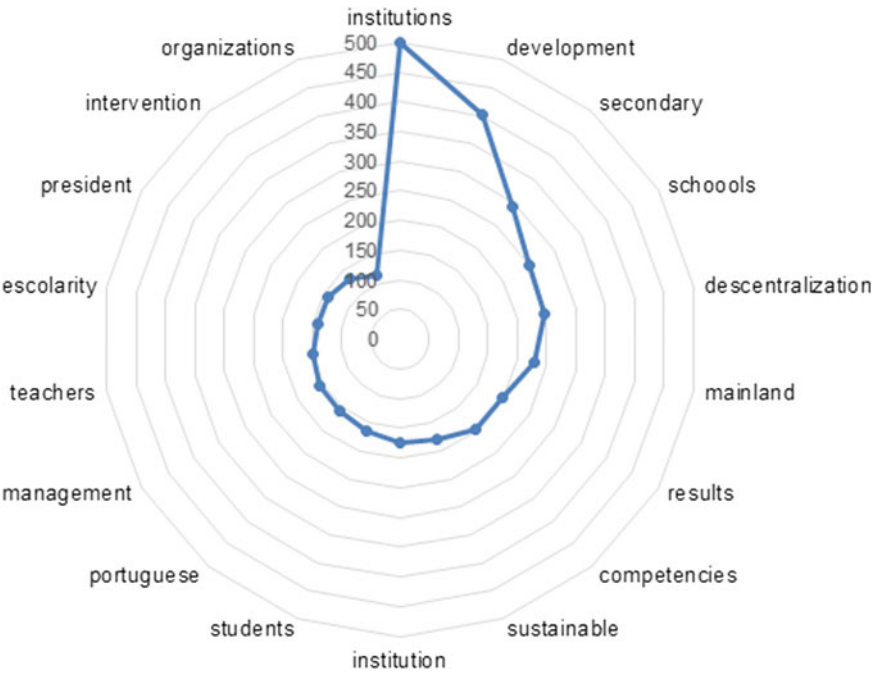

Fig. 4 The top 20 of words references in the national documents related to ESD and DESD 2005–2014 in Portugal

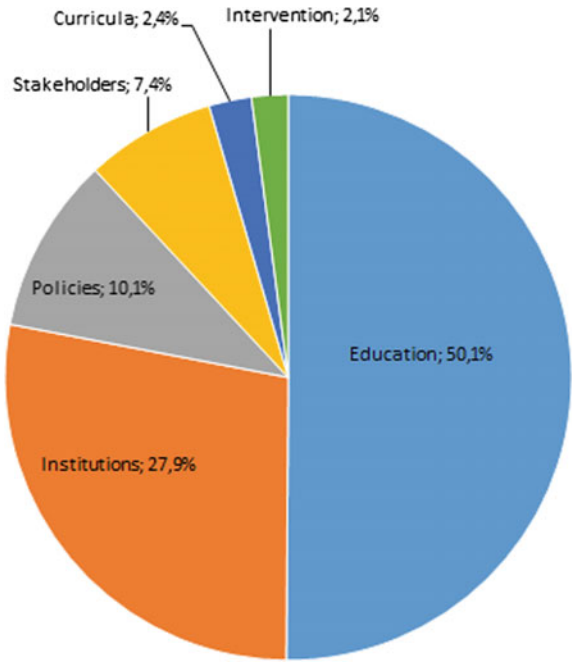

Fig. 5 The nodes percentual distribution for the most frequent words (top 20 ranking)

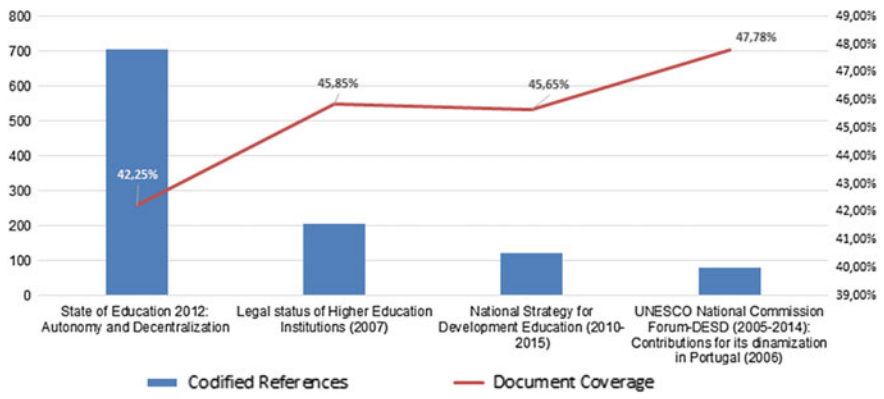

Fig. 6 Number of codified keywords references and document coverage

4 Results and Findings

4.1 Governmental Planning and Education for Sustainable Development

After computing the key words (see Table 1) in the defined coding system we obtained the following results (Figs. 1, 2 and 3). In 2005–2009 CGP when searching for the main keywords by descendent order, "Development" was the main reference found, followed by "sustainability" or "sustainable" which didn't seem to be as strange as in 2007 Portugal had had the approval of National Strategy for Sustainable Development, known as ENDS. Nevertheless what we would expect was a large number of "Sustainable Development" (SD) references in 2005-2009 Governmental Programme which seemed not to be so high (only 6 references). Concerning "universities" as well as "integration" altogether, both accounted for 20 % of all the references and decreased in 10 year period time by 63 and 50 %, respectively.

Even with a small number of references words related to "curricula", it seemed to have enlarged their implementation during DESD period (Fig. 1).

From Fig. 2 we observed that governmental results all over the DESD (2005 to 2014) period change: less "development" (decreased about 2/3 in 3 different Constitutional Government Programmes); less "environment" (−80 %), less "sustainable development" which didn't seem to have happened to "sustainable" or "sustainability" references (See Fig. 1) despite PIENDS (ENDS Implementation Programme) in the XVII the Constitutional Government; So it was questioned if there hadn't been other focus or if a change of paradigm had happen, from a narrow concept ("environment") to a holistic and transdisciplinary concept, like "sustainability" or "sustainable"?

"Sustainability" or "sustainable" trough the 3 different Governmental Programmes maintain the number of references in spite of the multiple scope they might have acquired. "Sustainability has entered the lexicon on the Growth Agenda (…) and innovation ((…) associated with serious delays in the process of qualification (…)" in 2005–2009 CGP; in 2009–2011 CGP one could read "the commitment to sustainability (…) refers to the policy of Development of scientific and technological capabilities, and scientific institutions, universities (…)" and these two contrasted with 2011–2015 CGP as "the sustainability is linked to budgetary commitments, Social Security (…), the National Health System (SNS)", amongst other matters. Nevertheless it didn't happen when analyzing the number of key terms references in GPO during the same period (see Fig. 3).

Remark (*): We are referring to Constitutional Governmental Programmes and Great Planning Options and these Plans and Programmes are those that are not the specified ones referred in CRUP or within Universities.

Remark (**): *GPO 2005 and 2006 are* included in GPO 2005–2009 analysis as 2010 to 2013 in GPO 2010–2013 and lastly, 2012 to 2015 includes 2013 to 2015.

Although we obtained the same descending order when analyzing the frequency of keywords references that we had in Fig. 1 but the results here are not so conclusive. Nevertheless we obtained references to ESD in Portugal, even in small number.

4.2 Ministry of Education and Science Policies and the (Un) Leverage Effect on HE

According to the Law n.62/2007, universities as other HEI are high level institutions oriented for the creation, transmission, and dissemination of culture, knowledge, science and technology through the linkage amongst studying, teaching, investigation and experimental development.

In Fig. 4 "institutions", "development" and "sustainable" appeared in the top 10 ranking (see Fig. 4) out of top 20 ranking when we analyzed the words not as text but as individual words though when studying them in detail they were not exactly in the context of ESD. And this findings resulted from the analysis of the 5 documents.

When we analyzed the data we decided to organize it in nodes or categories in order to have a cluster analysis. The nodes percentual distribution for the most frequent words (top 20 ranking) according to the documents can be seen in Fig. 5.

The node "Education" had had 50 % of the references and here was included the Education for Development, followed by "Institutions" (28 %) and then "policies" (10 %) but when we looked up in detail it had not much to do with Plans, programmes or strategies related to ESD. "Institutions" are related not to HEI but to secondary institutions (79 %), establishments or decentralization and "policies" related to public policies (44 %).

From what can be read in *UNESCO National Commission Forum – Portugal (2006)* it seemed that the civil society made by itself a kind of a implementation movement towards ESD, as so we could not yet found any clear evidence that the integration of sustainability was led by Ministry of Education and Science through plans, programmes and policies until this point.

When analyzing document coverage and the number of codified keywords references (text/wording related to 14 key words (see Table 1) to obtain a codified matrix in order to evaluate the integration of sustainability in plans, programmes and policies within the Ministry of Education and Science, we accomplished the following results (Fig. 6):

(a) A greater document coverage corresponds to the least codified references and there was a document that didn't show a single reference (the case of "*A trust agreement in higher education for the future of Portugal: Investing in the future")* and so we obtained data in 4/5 of the documentation analyzed;
(b) The document "UNESCO National Commission Forum-DESD (2005–2014): Contributions for its dinamization in Portugal (2006)" had a great coverage and not so many references as it was a 37 page document written by a Work

Group whose purpose was to identify areas of priority intervention, propose transversal actions to create dynamism in multiple society sectors, and identify concrete projects capable of changing processes; nevertheless this document was aiming an application at all levels of education and not only at HEI level.

(c) On the opposite side there was "State of Education 2012: Autonomy and Decentralization", a document that had the greatest references comparing to the others, but it was a report, and not a law, programme or a plan;

(d) With this analysis we couldn't have enough information to affirm categorically that there wasn't a top down or even a mixed implementation of how sustainability was implemented in Portugal within the Ministry of Education and Science.

5 Discussion

Lozano et al. (2015) mentioned as the result of an international survey to a large number of HEI many higher education institutions worldwide, in particular in Europe, have become involved in embedding sustainable development into their academic systems.

The results and findings of our work suggested however that in Portugal there hasn't been any incorporation of ESD at governmental policy and strategy level as through the Ministry of Education and Science in the Public Higher Education Institutions (HEI). Aleixo et al. (2016) highlighted the initial stage of SD Portuguese public HEI, based on their policies and strategies. Nevertheless in Portugal six universities (Universidade do Minho, Universidade do Porto, Universidade de Lisboa, Universidade Técnica, Universidade Nova de Lisboa and Universidade Católica Portuguesa) signed the University Charter for Sustainable Development (Copernicus 1993).

From Lozano et al. (2015) point of view there are strong linkages between the institution's commitment to sustainability, implementation, and signing a declaration, charter, or initiative and that the academic leadership's commitment was a leading cause for signing a declaration, charter, or initiative, and implementing sustainable development. For example in Wales, a "small nation" of around 3 million people, the Government and Higher Education Funding Council for Wales have had plans and strategies of ESD implementation in HEI and adding these the sense of cultural identity that contributed to the cohesion within the citizenship agenda. These facts altogether could be seen as a great commitment from HEI with ESD (Glover and Peters 2013). On the one hand, the Committee of Rectors of the Spanish Universities (CRE) was responsible for the approval of the creation of a Work Group for the environmental quality and the SD in the Spanish Universities that had issued a set of guidelines to incorporate sustainability into the curriculum which indicated a top-down action or a cascade process, in a 47 million inhabitant's

country. Both processes were top down approaches for the implementation of sustainability in HEI and showed commitment with it (Lárran et al. 2014).

At this point the findings as well as the non-institutional group that wrote the document "the *UNESCO National Commission Forum—Portugal* (2006)" created in 2006 proactively by the Ministry of Education and the Presidency of Ministry's Council had the responsibility to lead the process, discussed the Strategy of DESD 2005–2014 and facilitated its linkage with different areas of the educational sector aiming social transformation. But this document didn't show neither political or strategical, nor institutional implementation of sustainability in HEI. As far as universities are concerned, this group determined a follow up effect as to promote the interaction between multiple actors and institutions likewise the involvement of public administration institutions, investigation laboratories, non-governmental institutions, universities and mass media amongst others.

Notwithstanding some international drivers as mentioned, and a few practical examples at University level, preliminary results showed that ESD is still in its early stages of development and that there is a lack of national integrated strategies or policies. There haven't been any plans or programmes at least integrated to let us conclude safety that it was quite intentional.

Further research is needed to continue in order to better understand how sustainability was integrated in the Higher Education Institutions (HEI) through governmental policies and strategies and within the Ministry of Education and Science in Portugal, through surveys and interviews with key actors that can also lead to other widen or not accessible plans, policies and programs. Also it will be important to analysis the plans, policies and strategies at HEI level as real implementation practices at those institutions.

6 Conclusions

From this paper we can draw some important conclusions:

(a) Results between the Governmental Programmes and GPO content analysis for the same period of time didn't seem to have produced any dramatic change even though the meanings of "sustainability" or "sustainable" had varied through time. Nevertheless, it seemed clear that "sustainability" or "sustainable", although more recent, is a far more adopted and accepted concept than before, even with other meanings.

(b) When we studied the extent to which Ministry of Education and Science integrated "sustainability" in their plans, programmes and policies through the documentation that we had accessed to in the period 2005–2014, "institutions", "development "and "sustainable" appeared in the top 10 ranking of the most frequent words, not as part of a composite text but as individual words, and that suggested that even Education (and here we are talking about

"Education for Development") was a major issue but the implementation of ESD was not of a matter of major importance for the Ministry.

As more detailed studies must be undertaken, we ought to outline future prospects. Interviewing the key stakeholders in HE is what we considered absolutely mandatory to deepen our study. The methodology we used is described but we ought to move a step further through:

1. Interviewing key-actors concerning the implementation of sustainability in HEI through DESD 2005–2014 as from the Government side likewise Ministers, Secretaries of State, General Directors as from the non-governmental society;
2. Analyzing the plans, policies and strategies at HEI level, as well as interviewing the Rectors, and rest of the Rectoral Team, Responsible for Pedagogical and Scientific Councils of the HEI was another approach.

There is an absolute need for a change in the paradigm of Portuguese HEI and several barriers to overcome, both through learning and application of best practices from other European and worldwide countries. Due to the relatively small number and quality of the documentary sources we were able to gather, despite our efforts, this outlines the limitations of our work and some constraints of this paper. Adding this we also consider these sources as a sample and so they cannot be regarded as representative, but this can show the lack of commitment from the governmental institutions towards ESD. These are considered the main lessons of this paper.

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Three "Gs" for Campus Sustainability Development

Siarhei Zenchanka and Siarhei Malchenka

Abstract

"Agenda 2015" considers ensuring the inclusive and equitable quality education and promoting the lifelong learning opportunities for all as one of the goals of Sustainable Development. In accordance with this document "all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles". The goal of the article is to present the holistic 3Gs approach to campus sustainable development. This approach includes "Good Governance" based on implementation of ISO 9001 standard ("Quality Management Systems") and project financial management, "Greening of Campus" based on implementation of ISO 14001 ("Environmental Management Systems") and ISO 50001 "Energy Management Systems" standards and "Gain of responsibility" based on ISO 26000 standard and programs of education for sustainable development. Practical implementation of this approach is directed on sustainable development of the university campus based on international standards of management which permits move to 4th G approach—"Global Compact". Some examples of successful implementation of the 3Gs approach in Russian universities are presented.

Keywords

Sustainable development · University · ISO standards · Good governance · Greening of campus · Gain of responsibility

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1 Introduction

Sustainable development covers all areas of human activity, but one of the most important areas is education for sustainable development. The goals of sustainable development adopted at UN Summit in September of 2015 (Agenda 2015) consider education as an important factor of sustainable development: "By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university". New goals and objectives came into force on 1 January 2016, and for the next 15 years when making decisions will need to be guided by them.

In recent years, much attention is paid to the development of universities for sustainable development. Monographs "Contributions to the UN Decade of Education for Sustainable Development" (Gonçalves 2012), "Sustainable Development at Universities: New Horizons" (Leal Filho 2012), "Implementing Campus Greening Initiatives. Approaches, Methods and Perspectives" (Leal Filho 2015a), "Transformative Approaches to Sustainable Development at Universities. Working Across Disciplines" (Leal Filho 2015b), "Integrative Approaches to Sustainable Development at Universities. Making the links" (Leal Filho 2015c) consider different aspects of transformation of universities into a sustainable one: the development of university management, waste management at universities, energy safety, curricular on sustainable development.

Ciani (2015) suggested to consider five key factors of sustainable development, i.e. economics (income adjustment), social (adaptation of the quality of life), environment (productive conservation and sustainable use of natural resources), cultural environment (productive conservation and sustainable use of natural resources), cultural (management of cultural diversity) and management (sustainability management) and presented results of Summer School training activities on "The Sustainable Management and Promotion of the Territory". Callewaert, Marans and Shriberg (2015) describe Campus Sustainability Integrated Assessment (CSIA) in Michigan University. This assessment was held in four areas—Climate action, Waste prevention, Healthy environments and Community awareness. As a result of CSIA, more and more cross-disciplinary and cross-operational dialogue and collaborations are taking place on campus. At the same time, National University in California categorized sustainable green campus in such three key areas as administrative leadership, curriculum and research, and community and outreach (Radhakrishnan and Viswanathan 2015). Tikhonirova et al. 2012) considered an integrated approach for transforming the university into the University of Sustainable Development. Thilagam (2015) suggested "Campus Sustainability Plan" including organization, operation, teaching and research and outreach, as a first step to campus sustainability. Such plan and further actions help construct an ideal model for planning and design of new campuses on the principles of sustainable development.

The problem of food waste treatment is considered by Boruah, et al. (2015), Trivedy (2015) and Nandhivarman et al. (2015). Pondicherry University uses food waste for biogas generation that saves them approximately INR 7900 per month. Slurry manure is a by-product of biogas generation, which can improve top soil because it is very rich in NPK (Nandhivarman et al. 2015). Pretorius, et al. (2015) showed a benefit of distance education in reducing carbon footprint. The need for an integrated approach towards Smart Campus based on developing a cluster of interconnected eco-innovation actors was outlined by Némoz (2015): the campuses of the university (21 university institutions) are connected with by smart grid technologies integrating solar photovoltaic systems in the green buildings for the lighting of university territories and for electric car sharing between different areas of the university. Author pointed the importance not only technological innovation for campus greening, but sociologic innovation too, which can "provide insights into the barrier to socio-political and market acceptability". Eggieston (2015) described the implementation of renewable energy and available courses at the University of Wyoming. The new Birley campus of the Manchester Metropolitan University uses a number of key environmental technologies in zero carbon, zero waste, zero water and maximum biodiversity (MMU booklet, n.d.).

Disterheft et al. (2012) analyzed how universities involve students and faculty in their efforts to campus sustainability. The authors analyzed several tools for assessing the influence of the campus community on its sustainability and pointed that "the perception of the dimensions of participation is limited". Pallant et al. (2012) presented research project on transforming a school of good intentions to an institution of effective actions. The authors pointed that sustainability initiatives should be grounded in student-faculty research, on education and reinforcement for campus decision-makers, on a combination of bottom-up and top-down approaches.

Pedagogical aspects of education for sustainable development and development of environmental courses were considered by Holmberg et al. (2011), On November 19th, 2015, the White House launched "American Campuses Act on Climate" (ACAC) initiative to amplify the voice of the higher community in support of a strong international climate agreement in the United Nations COP21 climate negotiations in Paris (Release 2015).

Analyzing today state of the university campus greening Leal Filho (2015a) pointed that "its use is not as widespread as it can and should be" and shows the advantages of this process such as innovative approaches, decreasing of waste, new curricular, etc.

Most of the initiatives in campus greening are connected with technological ones such as using of renewable energy sources, waste treatment and management, CO_2 emission elimination, etc. Few articles considered the impact of the university management on its sustainability. Several authors only considered complex approaches directed on development of different areas of university sustainability.

2 Methodology

There are many different approaches to campus greening. Most of them introduces improvements in one or two areas of sustainability. During the last three decades the International Standards Organization developed standards for different areas of management. These standards are widely used in various fields of economy, but only some of them are used in the education. For example, in 2014 ISO 9001 standard is used in 2327 educational organizations in Germany, in 497 organizations in France and in 6949 organizations in Italy, but ISO 14001 standard is used in 11, 15 and 38 educational organizations respectively (ISO Survey 2014).

The methodology is based on comparison of ISO standards demands with sustainable development principles and integrating these demands in management system of the university. Great attention is paid to the implementation of the principles of the ISO 9001, ISO 14001, ISO 50001 and ISO 26000 standards in management practice. Each standard contains correspondences with some other standards that helps realize the holistic approach.

3 Development of Campus Sustainability

In accordance with Waas and Hugé (2014) "sustainable higher education refers to campus "greening" initiatives such as recycling, energy and water savings, sustainable infrastructure, sustainable procurement, carbon and ecological footprinting and so on". Holistic approach to the campus sustainability is related with the implementation of all aspects of sustainable development in the activities of the university.

This section considers sustainable development of the university and its sustainable management on basis of "3Gs" concept—"G1: Good Governance" based on implementation of ISO 9001 standard ("Quality Management Systems") and project financial management, "G2: Greening of Campus" based on implementation of ISO 14001 ("Environmental Management Systems") and ISO 50001 "Energy Management Systems" standards and "G3: Gain of responsibility" based on ISO 26000 standard and programs of education for sustainable development.

3.1 G1—Good Governance

University is a complex hierarchy structure. It combines different departments and/or institutions with different vertical and horizon links (Némoz 2015; Callewaert et al. 2015). UNEP (2013) considers the university during its transformation into green and sustainable campus as "a small town, with all the associated issues of spatial planning, management of physical growth and development, maintenance of buildings and open spaces, supply of electricity, water and other utilities, and often

Fig. 1 Quality management principles

provision of residential accommodation and ancillary services. In addition, there are the typically corporate functions of finance, procurement, human resources, etc."

Implementation of quality management system (QMS) in accordance with international standard ISO 9001:2015 permits to define a processes and their interaction, i.e. to create a university process model (ISO 2015a). The combination of quality management principles and traditional approach to guarantee an education quality will provide a new quality of education of specialists.

QMS developed in accordance with ISO 9001 is a management subsystem which is based on a structured set of documents that regulates key aspects of organizational activity. New version of this standard has differences from the previous version (ISO 2008) and should be developed in accordance with the high level structure (Annex SL 2015). There are seven quality management principles now (ISO Quality 2015). Look at the main aspects of implementation of standard in relation to the processes of university in accordance with this principle (Fig. 1).

Principle 1. Customer focus. The primary focus of quality management is to meet customer requirements and to strive to exceed customer expectations.

In accordance with this principle the university team must look into the future and develop new curricula in accordance with their mission and vision and needs of society and give new competences to graduates.

Principle 2. Leadership. Leaders at all levels establish unity of purpose and direction and create conditions in which people are engaged in achieving the quality objectives of the organization.

This and the next principle demand strong interaction between university top managers and university staff in achieving quality of education.

Principle 3. Engagement of people. It is essential for the organization that all people are competent, empowered and engaged in delivering value.

Competent, empowered and engaged people enhance its capability to create value throughout the organization.

Principle 4. Process approach. Consistent and predictable results are achieved more effectively and efficiently when activities are understood and managed as interrelated processes that function as a coherent system.

Typically, universities use the process approach in the learning process only. Today, in order to understand the effective functioning of such complex system, as a university, it is important to develop and include in the process model of the university all management and support processes.

Principle 5. Improvement. Successful organizations have an ongoing focus on improvement.

As for a Principle 1, university must look at a future, develop new curricula and research activity and include in university's processes last scientific and pedagogical innovations.

Principle 6. Evidence-based decision making. Decisions based on the analysis and evaluation of data and information are more likely to produce desired results.

Decision-making is a complex process and can involve some uncertainty. To avoid such uncertainty a management review must include confirmed information.

Principle 7. Relationship management. For sustained success, organizations manage their relationships with interested parties, such as suppliers.

Universities are not working in a vacuum today, but in businesses and the organization's environment. Identifying the important relationships with interested parties and its management will drive sustained success.

Implementation of these principles permits to create at the university a flexible management system corresponding sustainability demand.

For effective management of the university the financial management should be incorporated in the common management system, which helps manage the university more effectively. One of approaches of such combination of the systems of quality management and finance management is a Balance Scorecard System (Kaplan and Norton 1996), which uses elements of project management (Guide PMBoK 2004) additionally. Financial management (FM) of the organization is based on International Financial Reporting Standards (IFRS 2011) taking into account a regional perspective. The functions of Financial Management are:

- Planning, which covers the whole range of activities;
- Forecasting;
- Regulation, especially, of current activities;
- Coordination—harmonization of all parts of management system.

Balanced Scorecard should be responsible for coordination and management of financial flows.

3.2 G2—Greening of Campus

There is a growth of understanding over the world that it is necessary to support and improve environmental quality, to protect peoples' health. There is a growth of attention to the potential impacts on the environment of the results of activity of different organizations and institutions, their products and services (Agenda 2015; UNEP 2013; Report 2012).

Educational institutions negatively impact on the environment too. Various types of waste, emission and discharge occur during the working of different type of research and learning laboratories, computer and copy devices. Universities play a remarkable role in the education system of any State and in investigation, policy forming and information exchange. University campus must be first who answer to environmental pollution (Leal Filho 2012; 2015d). The dissemination of knowledge in ecology and environment uses the principles and systems of environmental management in universities.

In 1996 an instrument of system approach to solving of environmental problems was developed as international standards ISO 14000 series. Now environmental management system (EMS) should be developed in accordance with ISO 14001:2015 standard (ISO 2015b). As a result (ISO 2015c):

- Environmental management to be more prominent within the organization's strategic direction;
- A greater commitment from leadership;
- The implementation of proactive initiatives to protect the environment from harm and degradation, such as sustainable resource use and climate change mitigation;
- A focus on life-cycle thinking to ensure consideration of environmental aspects from development to end-of-life;
- The addition of a stakeholder-focused communication strategy.

The activity of the university in environmental management should be concentrated around environmental aspects and their impact on the environment. Realization of such EMS demands the using of others ISO series 14000 standards (see www.iso.org). Environmental aspects are identified in accordance with the next groups (ISO 2013):

- Emissions;
- Water pollutions;
- Waste;
- Energy;
- Resource;
- Soil pollutions;
- Noise;
- Vibrations;
- Accidents;
- Workplace environmental conditions.

Well identified environmental aspects should help to find a reasonable approach to environmental issues of the campus and to develop the programs for reducing its impact on the environment in the future (Zenchanka and Ahafonenka 2010).

Decreasing of energy consumption is essential demands for campus sustainability and its greening. Besides the economic costs of energy to an organization, energy can impose environmental and social costs by depleting resources, pollutant emissions, thermal pollutions and contributing to environmental problems such as climate change. ISO 50001 standard (ISO 2011) specifies requirements of an energy management system (EnMS) for an organization to develop and implement an energy policy, establish objectives, targets, and action plans, which take into account legal requirements and information related to significant energy use.

Worldwide application of this standard contributes to more efficient use of available energy sources, enhanced competitiveness, and to reduce greenhouse gases emissions and other related environmental impacts.

3.3 G3—Gain of Responsibility

New ISO 26000 standard was adopted in 2010. This standard establishes principles of social responsibility of the organization (ISO 2010):

- Accountability—the organization should be accountable for its impact on society, the economy and the environment;
- Transparency—an organization should be transparent in its decisions and activities that impact on society and the environment;
- Ethical behavior—an organization should behave ethically;
- Respect for stakeholder interests—an organization should respect, consider and respond to the interests of its stakeholders;
- Respect for the role of law—an organization should accept that respect for the rule of law is mandatory;
- Respect for international norms of behavior—an organization should respect international norms of behavior, while adhering to the principle of respect for the rule of law;
- Respect for the human rights—an organization should respect human rights and recognize both their importance and their universality.

Implementation of these principles in the university practice will enhance its responsibility towards society, stakeholders, staff and students.

The realization of all Gs (G1, G2, G3) helps convert university campus in green campus with the flexible management system. The combination of these principles corresponds to the principles of the UN Global Compact Program (UN 2010) in Human Rights, Labor, Environment and Anti-Corruption. On Fig. 2 the interaction between G1, G2 and G3, which form G4, is shown.

Fig. 2 Interaction between different Gs

4 Implementation of 3Gs Concept in Russian Universities

Quality management system (QMS) in accordance with standards ISO 9001was successfully implemented in Russian universities starting from the beginning of 2000th. The special methodical recommendation was developed to help universities in developing, implementing and control QMS (Guide 2005). The introduction of a new version of the standard ISO 9001:2015 requires re-certification of these systems.

At the same time the certification of environmental management systems (EMS) of different organizations in Russia lags behind the world level and it affects on the implementation of the ISO 14001 standard in universities—only individual universities implements the EMS. Development of the training of specialists in the field of ecology requires the implementation of EMS at the universities, which will allow students to better understand the principles and structure of such systems.

The Social responsibility of the educational institution in Russia is connected with the development of the Code of Corporate Management, implementing standard ISO 26000:2010 and participation in the UN Global Compact Program. 10 principles of the Global Compact (UN 2010) include principles in Human Rights, Labor, Environment and Anti-Corruption. Only 12 academician institution, including research institutions, entered in the UN Global Compact in Russia (UN 2015).

The realization of all G (G1, G2, G3) helps to convert the university campus in green campus with a flexible management system. The combination of these principles corresponds to the principles of the UN Global Compact Program (UN 2010). On Fig. 2 the interaction between G1, G2 and G3 is shown, which form G4—Global Compact Program.

5 Conclusion

Sustainable development of the university's campus is usually considered in terms of campus "greening" which means the implementation of different "green technologies" such as solar panel, PV-panel, waste management etc. Many universities introduce "green" programs and curricula. At the same time, management and social responsibility play an important role in the development of campus sustainability. In this article the concept of 3Gs, based on ISO standards, is suggested. Implementation of international standards of management help to transform the university campus in sustainable campus, in which combination G1—Good Governance, G2—Greening Campus and G3—Gain Responsibility forms G4—Global Compact.

Poor implementation of elements of 3Gs concept in Russian universities is due mainly to lack of financial resources which in accordance with Dahle and Neumayer (2001) is the most significant barrier to greening.

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Is There a Place for Resilience Within Sustainable University Transition Management?

Giulia Sonetti, Patrizia Lombardi and Lorenzo Chelleri

Abstract

The implementation of sustainability standards in university campuses is a global trend. Yet, very few institutions are leading the way after systemic perspectives for campus sustainability, being often stuck in technocratic targets set around the regnant energy efficiency paradigms. This paper builds on a broader definition of what being a "Sustainable University" should mean, integrating four propeller blades for a sustainable transition: (i) the built-environment quality improvement, (ii) the civil society engagement (iii) the industry partners' involvement and (iv) the public institutions support and collaboration in policies implementation. The paper aims at highlighting how resilience thinking could boost such holistic definition and its operationalisation. After un-packing the resilience metaphor through different management approaches in universities, sustainability strategies implemented in different case studies (in Italy, Mexico, the UK and Japan) are collected via focus groups and stakeholders interviews, and then framed along an integrated sustainability-resilience approach from literature reviews and innovative proposals.

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Resilience assessment · Resilience thinking · Resilience principles · Sustainability assessment · University campus · Sustainability transition · Mexico · Japan · United Kingdom

1 Introduction

In a world increasingly dominated by cities and urban systems (United Nations 2014), the role of university campuses in contributing to a fair and more sustainable and low carbon society transition is becoming more and more urgent (Hordijk 2014). However, there is a serious gap between the aspiration related to sustainability by higher education institutions and their actual performances (Zsóka et al. 2013). Whilst formally moving towards sustainability within their curricula and resources management, universities' leading green-washing strategies are mainly related to enhance their scores within international rankings (Green 2013). Current campuses sustainability assessment frameworks (CSAs), although quite recent and not so diffused (Alonso-Almeida et al. 2015; Lozano et al. 2015), play a crucial role in supporting the functionalist rhetoric and the eco-efficiency paradigm in the evaluation of a truly sustainable university campus (Caeiro et al. 2013). Arroyo (Arroyo 2015) synthesized indeed current CSAs limitations in: (i) not providing mechanisms for comparison (nationally and internationally), (ii) emphasising mainly Eco-Efficiency (EE) bornegree indicators, over a range of long-term social and built-environment sustainability measures, and finally (iii) being too narrow and qualitative, without providing normative targets (Shriberg 2002). A critical perspective on sustainability university frameworks is introduced by Sonetti et al. (2016), proposing a new approach that encompasses clusters of homogeneous campus typologies to allow meaningful comparisons among similar cases.

In line with these critiques and emerging solutions, this paper takes a wider look to frame leading urban concepts (i.e. sustainability and resilience) into a university campus effective sustainability performance evaluation, that should take into account both short and longer term university/urban challenges (Alshuwaikhat and Abubakar 2008).

This research proposes an integrated definition (and therefore criteria for the evaluation) of a Sustainable University, based on the interaction among four spheres of actions: (i) built-environment improvement, (ii) civil society engagement, (iii) industry partners involvement and (iv) public institutions support and collaboration.

Within such a framework, the emphasis is put on long term policies and short term actions integration, linking physical elements (structures and built environment) and social practices (users' attitude toward resources consumption,

collaborations with different urban stakeholders, identity building, activities, and so on) (Brandon and Lombardi 2010; Lombardi 2011).

An integrated university management should indeed look not only at long term goal setting toward sustainability, but also at short-medium term enhancement of operational skill for business continuity and behavioural change (Herbane et al. 2004).

Unfortunately, the short term priorities dealing with the everyday management challenges are often framed apart from the sustainability goals, tackled just to fill out final year reports and to comply with international ranking audits. Being these the intrinsic limits when one tries to operationalize theoretical concepts in urban design (Tyler and Moench 2012), focusing on the university campus dimension could be a first, yet simplified step, to understand scalable and transferable practices toward a sustainable goal.

To this extend, this paper put ahead the thesis that finding campus resilience determinants could twist universities challenges management toward a behavioural, long-term and community empowerment transition goal (Adger et al. 2009).

In fact, recent resilience paradigms applied in urban studies by environmental scientists (Elmqvist 2014), planners (Eraydin and Tasan-Kok 2012, Coaffee 2013), and policy makers (Satterthwaite and Dodman 2013; Wagenaar and Wilkinson 2013) explore the links with sustainability strategies (Redman 2014). As proposed by the United Nations' urban sustainable development goals (USDG 11, 2015), resilience is going to become an attribute of sustainability. Responding to this challenge, the paper presents some reflections on how to integrate these two concepts, presenting the results from resilience determinants scouting in different university campuses, taken as smaller sample of wider (and far more complex) urban districts.

The structure of the paper presents three main sections. The first one addresses a review of current CSA tools and their failures in translating theoretical concept into trackable practices. The second section explores how resilience is un-packed in different approaches and how these relate to new criteria for integrated resilience-sustainability CSA. The last section addresses examples of how some universities actions enhancing sustainability are indirectly contributing to some facets of resilience, and which could be the integrated criteria for a more meaningful evaluation of a sustainable university.

2 Method

In a first part, current failures of CSAs are reviewed through similar papers in literatures and compared with fieldwork results of a number of universities' key stakeholder interviews. The selected study cases for these data collection were the Politecnico di Torino (POLITO) and the University of Turin (UNITO), in Italy, the Hokkaido University (HOKUDAI), in Japan, the University of Cambridge (UNICAM), in the United Kingdom, and finally the Universidad Autonoma de

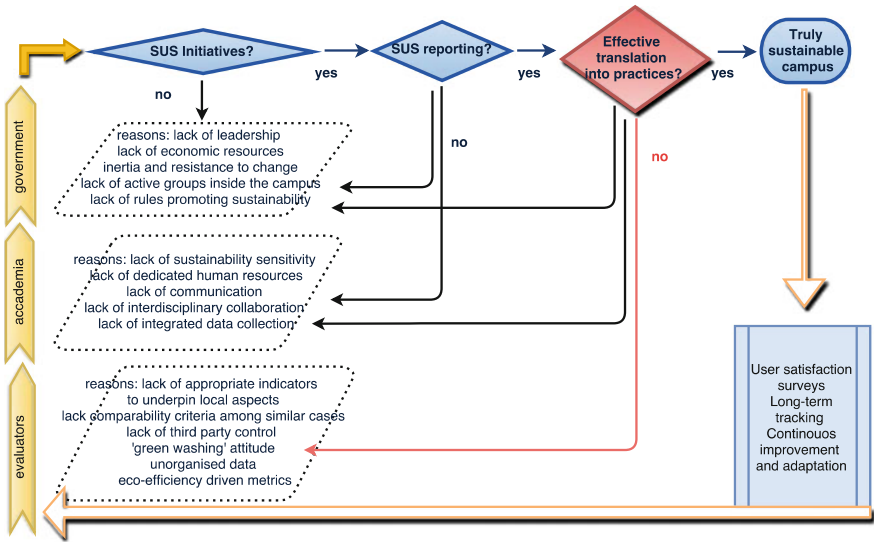

Fig. 1 Different classes of problems related to current sustainability framework development and adoption. *Source* Sonetti et al. (2016)

Tamaulipas (UAT), in Mexico. These cases were selected because of their involvement in a Marie Curie Project (namely "UNI-Metrics"[1]) and its follow up funded by a private bank (the project is called "Politoward"[2]), both coordinated by the Politecnico di Torino. Their shared aim was to find the gaps among current sustainability assessment practices, recognised as a key point to underpin the failed translation of policies into practices (red arrow in Fig. 1) and to foster universities' single sustainability initiatives and related researches.

A first round of individual interviews were held during five full days of workshopping in Turin (September 2015) where representative from POLITO, UNITO, UNICAM, UAT and HOKUDAI attended among others. Interviewees were selected mainly based on their level of involvement with sustainability initiatives and their organizational position in the university. Four main themes were: sustainable campus initiatives (according to the area of expertise and knowledge of the interviewed); *in fieri* activities; governance of the decision-making process; management control systems (and more particularly about data collection and use).

In the second part of the paper, collected data, both qualitative and quantitative, were analysed according to their visibility in the international ranking and their translatability into sustainability criteria for universities. Results have been compared among similar cases and then grouped second resilience criteria. In this way,

[1]EU FP7 Marie Curie IRSES Grant Agreement Number: PIRSES-GA-2010-269161. UNI-Metrics: Value Metrics and Policies for Sustainable University Campus.

[2]Politoward is a project for the internationalization of research funded by Compagnia di San Paolo: www.politoward.org.

three main barriers for the transition toward a new resilience-sustainability model for universities were highlighted: one relies on the way data are collected; another in the way data are displayed, and analysed and communicated for report purposes; the last in the not clear agreement on priorities and concept translation to be pursued.

3 Gaps and Opportunities for Universities Sustainability Management Practices: The Four Spheres of Actions

3.1 Exploring the Gaps from Study Cases' Sustainability Management

Notwithstanding last thirty years of policies and discourses around the pivotal role played by education in driving sustainability transitions, few universities' initiatives have produced effective reductions in resource use or energy consumption. One of the main gaps lies in the mismatch between sustainability indicators and long term effective actions and policies, as well as the invisible consumption practices unable to be underpinned by current evaluation methods (Amin 2008).

Current actions and practices are often collected and tracked via living labs and smart infrastructures and services put in place by many universities. From the study-cases emerged that data monitoring does produce energy and money saving, both in the short and in the long term.

POLITO (IT), UNITO (IT), UNICAM (UK) and HOKUDAI (JP) have all a strong IT based data collection infrastructure and a dedicated office that analyses those data.

However, when data access is not easy or open via a web site or a living lab facility, the learning and comparison potential is just a missed out opportunity. On the contrary, human (i.e. non-automatized) supervision of data trends, targets achievements and failures in energy trends appears crucial for learning and mutual sharing of experiences among universities. To this extend, POLITO represents a gold practice among the different case studies. Differently from HOKUDAI, POLITO's living lab has an open data source where every user can access data and charts, and with the help of the living lab manager, several types of data set can be crossed with each other along selected time spans, departments and energy sources. This transparency and easiness in data accessibility made flourish several research projects and management procedures having the POLITO buildings as test beds. This, in turn, produced cost saving results and a considerable lower energy consumption trend per square meter and per capita compared to similar universities (Sonetti et al. 2016). Strangely enough, the POLITO's virtuous energy consumption and resources management does not match with its low position in most of the current world green university ranking, also compared to the other Italian universities (see Table 2 in Appendix).

An opposite example is represented from the study case of UAT (MEX), which does not collect any quantitative information regarding energy/water consumption, but it scouts all best practices related to sustainability via on-site surveys, interviews and focus groups.

The strong community building and good practice screening carried on by a dedicated sustainability office, in charge of complying with the Green Metrics tables and requirements, made all the single sustainable initiative emerge and shared. Relying just on a qualitative data domain, UAT's sustainability performance have been carried on without any emphasis on quantitative data collection, resulting in good positioning in the university ranking, confirming that even low GDP countries can enter the top positions thanks to good performances along other criteria than just Energy or Climate Change (see Figs. 4 and 5). Both UNITO (IT) and HOKUDAI (JP) perform better than POLITO in international ranking, even if their energy consumption per square meter did not register any reduction in the last three years. Finally, UNICAM (UK) having no office providing monitored resource consumption trends, is member of "The International Alliance of Research Universities (IARU)", which promotes institutional joint working on various levels of the member universities, such inter-university networking, institutional learning and staff development. Projects cover a broad range of topics, ranging from equal opportunities, technology transfer, technology-enhanced learning, research administration, libraries and open access. Free from the yearly quantitative data collection and reporting, the UNICAM sustainability management welcome the analyses of several single buildings, jointly with voluntary initiatives born from individual colleges, private grants and student works.

Being part of a network or an international ranking system or none of the two, a common weakness in all the observed cases is the absence of a long-term follow-up of the screened activities. All the projects underpinned by specific sustainability indicators tend to be carried out over the short term (six months to a year) just to fulfil a mandate or a number to communicate to the sustainability office or a network website. At the present state, no indicator seems able to measure the long term efficacy of building envelope renovation initiatives, or users' environmental education activities on consumption trends. A lack of a holistic strategy for sustainability management and performance tracking is responsible of the difficulty systemic transformation by means of shared and contagious policies and practices. To complicate the assessment, the persistence of energy savings and related economic benefits has also fuzzy correlation with their further social impact or environmental knowledge transmission. If the resilience-sustainability goal is to assure long-term changes in users' behaviour and practices, the lack of appropriate metrics makes difficult to assess the current size of the direct rebound effect with a high level of confidence (Hobson 2003).

This is why a set of sustainability metrics should be developed as first step to improve universities long-term strategic planning (Disterheft et al. 2016). This could encompass the emerging resilience paradigm merged with the sustainability long term goals, and be covering the full range of the university's operations, and not be limited to greening or resources consumption patterns (Sterling 2010;

Trencher et al. 2013; Yarime et al. 2012). In the scientific literature this is regarded as "holistic sustainability" management practices in higher education institutions (Lizarralde et al. 2015; Lozano 2010; Shriberg 2002).

3.2 A Framework for Operationalizing University Sustainability Practices

The most relevant individual stakeholder interviews made in the UK, Mexican, Japanese and Italian case studies confirmed that the current trend when discussing sustainability targets is focusing mainly on environmental issues over social and economic ones. The focus on campus-based physical impacts (rather than socio-economic and behavioural profiles) is not surprising, since the facilities managers, the ones in charge of sustainability data management in universities, largely deal with the physical aspects of the campuses, and have the control over their organization, improvement and visualization. However, none of those interviewed facility managers knew how to address socio-economic issues in data requirement or policy recommendation, nor to track related performances when coming to proof the benefits of urban outreach strategies or community building activities. Drawing from the qualitative outcomes of these interviews and from the resilience literature approach (linked in Sect. 4), the paper proposes that universities' sustainability transitions could be effective only when the management focuses on the three policy-blades boosting sustainability transition (see Fig. 2), all built on a resilient community management. This representation put the sphere of university campuses physical and human structure at the centre of a systems that synergistically run with industry partners, public institutions and civil society engaged within sustainability policies. The propeller relies on:

1. University Campus management practices: in the campus sphere (represented in green), the built environment elements (consisting of infrastructure, facilities, open spaces, services, etc.) coexist with the university's social capital (user behaviour, education targets, research plans, etc.). Each of these elements falling in the university sphere plays an interacting role within the community and influences both the physical and cultural metabolism of university campuses.
2. Civil Society engagement: the influence of universities on civil society (and *viceversa*) can significantly contribute to social innovation, boosting interactions among generations, different urban stakeholders, NGOs and associations driving societal transitions. In this light, any university policy regarding sustainability is mutually reinforced through the society outside the university, engaging associations and people in the dissemination activities and research projects led by the campuses and *viceversa*, supporting different societal needs through research and innovation.
3. Public Institutions support: the relationship between universities and public institutions is definitely a jeopardizing issue which depends on the socio-cultural and economic context. However, the dependence of universities on public

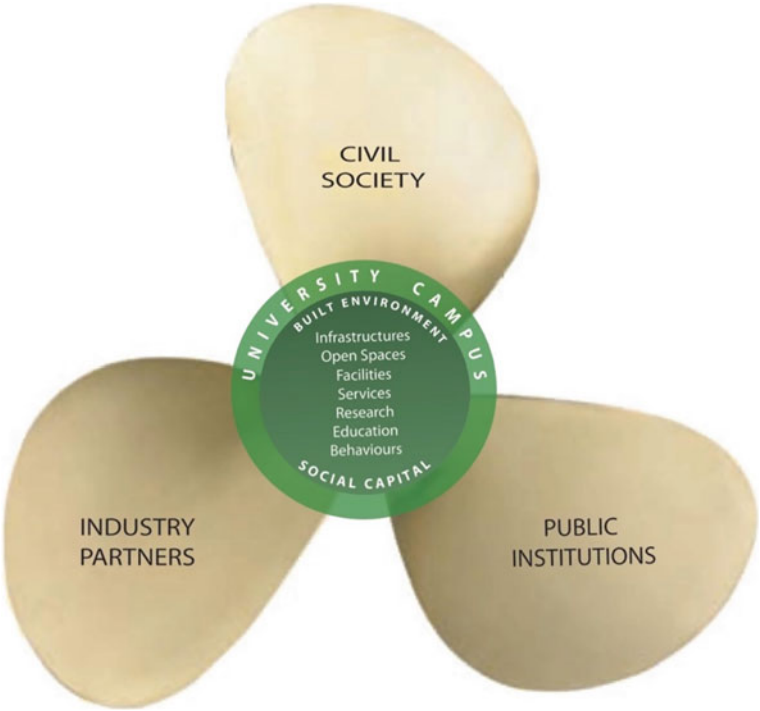

Fig. 2 The three policy-propeller blades enabling urban sustainability transitions for universities campuses

funding does not always reflect effective bilateral and supportive collaborations between the two players. Results of joint research projects are often forgotten after their completion, or never applied to real-world practices. Connections between public, research and education activities should be fostered by letting academics be more influential on the policy level, and in turn by calling academics into urban impacts actions out of their *turris eburnea* (the ivory tower that host specialists who are so deeply drawn into their fields of study that they often cannot actively search for solutions).

4. Industry Partners collaboration: public-private partnerships have been the engines of most relevant urban transformations in recent times. Whether research should not pursue only private interests is a long lasting discussion in different academic fields. However, university have the power to twist this partnership with the other blades toward a sustainability transition, to protect and ensure democratic, participative and integrated approaches.

Such an integrated framework, involving three different set of possible sustainability policies, maximize the operational path to follow for addressing the holistic university sustainability target. In the following section, the paper addresses

the introduction of resilience in this framework as a concept supporting this synergistic integration within sustainability policies.

4 Un-packing Metaphors into Urban Management Approaches

This section builds on the policy trends which globally have adopted resilience as a paradigm challenging or supporting the sustainability's one. In the light of the above mentioned holistic framework for operationalizing campuses' sustainability, the paper proposes resilience as a specific co-player enabling certain facets of sustainability and reinforcing skills and practise. In a first sub-section, the paper introduces the concept of resilience and how it relates with sustainability. In a second part, the possible management approaches for resilience operationalization toward sustainability goals are presented using university campuses as test beds.

4.1 Resilience or Sustainability?

Resilience thinking entered the global policies discourses framed as a conceptual response to climate change and risks reduction challenges (GSP 2012).

The metaphor of resilience has been stretched and adapted to almost any field and political discourse in last decade, until the point to which it is at risk of becoming meaningless (Christopherson et al. 2010). "To be capable to adapt to changes" is the metaphor that has slowly conquered the global development policy agenda (GSP 2012). Multidisciplinary literature recently highly criticized the links from the metaphorical meaning of resilience and "business as usual practices" (Beilin et al. 2013, Schuetze and Chelleri 2015), dealing with policy making (MacKinnon and Derickson 2012), planning (Davoudi et al. 2012), disaster recovery (Creech and Steele 2005), climate change (Pelling et al. 2014) and in general questioning the sustainability of resilience-related practices (Chelleri and Olazabal 2012). Recent calls for integrating transformative capacities within the spectrum of resilience features (Folke, Carpenter et al. 2010, Elmqvist 2014) have launched the challenge of operationalizing and managing different (sometime potentially conflicting) facets of resilience (Chelleri, Waters et al. 2015). Indeed, resilience could be related to both long-term goals (supporting learning, transformative changes, transition in technology, etc.) and short term ones (building robustness for critical infrastructures, enhancing monitoring and on-time management of services, etc.). From this point of view, addressing long or short term challenges is related to the correct forecast shocks and stresses recovery. Since most of the stresses deal with systems' durability, a longer term perspective of being resilient conceptually overlaps with sustainability challenges (Redman 2014). In particular, such overlapping enables resilience to become a policy catchword replacing the broadness (and vagueness of) the sustainability concept, thanks to its

active message rooted in the action (in responding to threats, in adapting risks) (Fiksel 2006, Anderies, Folke et al. 2013). However, there's still a huge gap between theory and practices, since if from the conceptual side resilience could be replacing sustainability, in the practices resilience per se is not always linked to sustainability (or social justice) outcomes, as addressed from recent critical literature on this issue (Beilin, Reichelt et al. 2013, Friend and Moench 2013, Vale 2013, Anguelovski 2014). Because of this, resilience should be carefully oriented through sustainability paths; its framing in order to avoid lock-ins or unsustainable pattern traps (Wilson 2014) is discussed in the next section.

4.2 From Resilience Building to Resilience Management

When trying to enhance the resilience of a system, for instance an energy network, a typical choice is between (a) increase lines redundancy (and so build new lines and hubs), or (b) investing in diversity, (for instance by fostering renewable energy sources multiplying services providers). Both options do contribute in building a more resilient system, but the sustainability implications of those solutions are completely different. In the first case, the production (and the disposal scenarios) of excess materials if far more unsustainable than the second case, where energy self-sufficiency is assured by local energy sources. Apart from the complex co-services required by each solution (a middleware hub that should prioritises energy flows in case of decentralised productions, or a market system that should reduces uncertainties to maximise the sizing of main energy production sites), this example state quite clearly some of the resilience-sustainability trade-offs. The concept of trade-offs, emphasizing such synergistic or potentially conflicting aspects of resilience operationalization, has been recently introduced by Chelleri (Chelleri, Waters et al. 2015) to support and highlight the potential undesirable effects of resilience.

How to manage resilience trade-offs represents one of the most pressing challenges for both researchers and practitioners in this field (Elmqvist 2014, Chelleri, Waters et al. 2015). In order to contribute to this debate, the paper un-packs different and potentially conflicting approaches in operationalizing resilience within current university sustainability challenges, to test their efficacy in a smaller city portion.

Figure 3 represents three different approaches detected from the huge and multidisciplinary literature on resilience. These are:

(i) the capacity to withstand shocks and quickly recover to a pre-disaster state (Manyena 2006);
ii) the capacity of adapt changes by enhancing the system tolerance to disturbs and stresses (Adger, Agrawala et al. 2007);
iii) the transformation capacity, which consists in the ability to re-frame systems' structures and functions through a transition path (Alliance 2007).

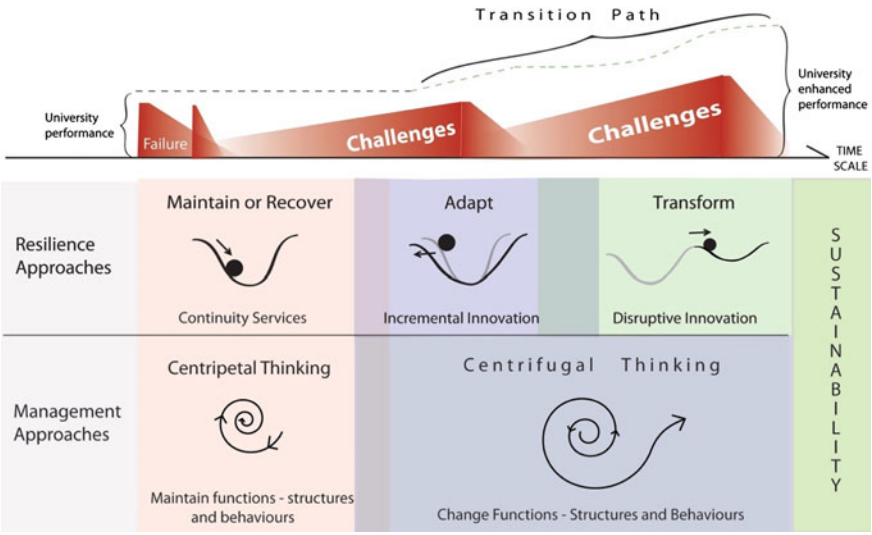

Fig. 3 Resilience and management approaches in a timeline toward a sustainable university

In Fig. 3, these different characteristics have been represented in relation with time (longitudinal axis) and different kind of threats (shocks-failures) and stresses.

In the context of university campuses, stakeholder's interviews revealed that shocks are seen as potential failures in the energy networks, workers strike, hackers attacks to IT system, and so forth. Longer term challenges are mainly connected to the economic and human sustaining base of the whole university function, and so to maintain a certain proportion of students/professors, assure projects funds, preserve the academy role within the societal context, etc.

The linkages among the different approaches shown in Fig. 3 have been addressed from a variety of disciplines, emphasizing the tensions between conservation/resistance to change (proper of recovery-adaptability views) versus transformation embracing change (Pelling 2011, Pearson and Pearson 2012, Chelleri, Waters et al. 2015, Matyas and Pelling 2015). Inspired by the work of Pearson and Pearson, these two approaches refer to centripetal and centrifugal thinking, illustrating the two different mental setting when enhancing the persistence of systems maintaining its functions and behaviours, or totally re-shaping systems' roles and structures (Pearson and Pearson 2012).

University campuses are believed to be a good case study to test how leaders from small community samples can respond to current challenges and prioritise among different solutions second a centripetal/centrifugal approach. One limitation of this study is certainly the lack of a legitimated comparison among university and bigger urban community's dynamics. The restricted sample of universities taken into account, and the precise typology of interviewers selected among just sustainability leaders in campus sustainability management is also limiting the number of actors that can play as drivers and changes activators. However, their opinion

counts when focusing on the gap from which this study starts (see the red arrow in Fig. 1 and literature reviews results in Sect. 3.1). The lack of leadership commitment toward sustainability transition and the lack of indicators able to underpin hidden resilient social practices is a node from which university leader can start to untangle an ineffective policy translation and lack of long term results. A shared strategy applied at campus level can be of sure inspiration for urban leaders and scholars when trying to operationalise the resilience paradigm into policy making. From the individual interviews, three main challenges emerged among across different countries, university systems and cultural context:

1. The first challenge is to be able to be a credible example of sustainability, asking others to act sustainably being engaged in first row in reducing its own environmental impact. Universities have the opportunity of introducing elements of sustainability as an application of their research (especially if they include engineering and architecture departments) and as a cultural message to the students, but a revolution is required to introduce a life cycle assessment studies in every course dealing with materials and processes, ensuring a proper use of energy, natural resources, waste management, and so forth.
2. A second challenge deals with openness. Many of the activities and processes that occur in contemporary universities are different from traditional ones, and require tearing down barriers between disciplines, between the students and the lecturer, between researchers and corporate R&D personnel, and between the usual place of knowledge transfer. One of the best-known formats currently in use is the MOOC (Massive Online Open Course), in which professors offer courses or talks for an unlimited number online students to follow. #webinar[s], now found on Twitter, are invitations to a "web seminar" open for anyone interested in whatever topic is at hand. As with any paradigm shift, people take extreme positions on all sides, providing profound critiques of the emerging ways to diffuse and infuse knowledge. Despite the success of some courses, the MOOC model, for instance, has been severely criticised; its detractors refer to the difficulty of maintaining academic standards. The most interesting developments in education may have yet to take place. From this perspective, it could therefore be the case of a critical evaluation of the radical innovation and the strategic rethinking needed by universities.
3. A third challenge for a sustainability university can be seen as an extension of the previous one, and it has to do with infrastructure flexibility in the medium-long term. We are using (or designing) campuses thinking about the university of today, but how will these same campuses support the knowledge production and dissemination processes that will occur in 2050 is still an open question.

Therefore, it appears necessary to move on the two fronts: to respond and be prepared to the short term features of these challenges and guarantee the service continuity (the real-time monitoring illustrated in Sect. 3.1 is an example of short term solution adopted my most universities), but also to plan a gradual change of

functions and structures on the long term (like the community building at UAT, shown in Sect. 3.1). Of course, there is still not a clear cut-line among different approaches: the main challenge in resilience managing consists indeed in simultaneously guarantee the continuity of the service (short time-related resilience approach) while planning for longer term transition. At the beginning of the international debate on resilience versus sustainability, the tensions emerging between conservation and change forces, or persistency and transition aims, have been conceptualized as the main difference between the resilience (recovery capacity) and the sustainability (long term change) theory. The examples explored in this paper suggest that resilience should instead be managed in synergy with long term sustainability goals, and that should not constitute a barrier for transitioning paths. In the next section, a set of indicators and actions is proposed to explain how such synergy could be operationalized in university campus management, with a focus on energy-related issues.

5 Beyond Metaphorical Meanings: Possible Campus Resilience Principles and Indicators

Up to this point, the resilience concept has been introduced by un-packing its metaphorical meanings into different approaches related to management perspectives as found in the literature review. Examples and indicators from university campus experiences can help in translating these different approaches into practices. This section proposes possible principles driving change toward a resilience management in university campuses, and examples show how those could be linked to the operative perspectives and finally to the sustainability framework proposed in Sect. 3.

5.1 Introducing Resilience Principles and the Evaluation Framework for Campuses' Resilience Actions

There is a very fragmented and multidisciplinary literature proposing resilience principles with a variety of examples, referring to ecosystems (Biggs, Schlater et al. 2012), social-ecological systems (Carpenter, Walker et al. 2001), urban systems (Leichenko 2011), economies (Lang 2012), social systems etc. However, while conferring resilience to the system, these principles do not guarantee sustainability oriented outcomes. Because of this, different policies-actions outcomes are considered from sustainable good practice found in a number of case studies from Japan (the Hokkaido University Campus), Mexico (the Universidad Autonoma de Tamaulipas), the UK (the University of Cambridge) and Italy (the Politecnico di Torino and the University of Turin). Their sustainability practices are linked with:

(i) Industry partners, public institutions and civil society propellers proposed as the university sustainability propeller in Sect. 3 (the propellers the collaboration is matched second their high (+++), medium (++) and low (+) grade of involved in University's actions);
(ii) the related resilience approach (the approaches, as illustrated in Fig. 3, have been schematically reported as Business Continuity, Adaptation, Transformation);
(iii) the related resilience principles as found in the literature review summed up at the beginning of this section (namely: Self-sufficiency (increase of), Diversity (increase of), Redundancy (increase of), adaptive capacities (increase of), Exposure to Disturbances (decrease of), Learning and Knowledge Transfer (increase of)).

Table 1 synthesizes results from surveys and sustainability actions scouting within the different universities taken as case studies.

The focus has been constrained to the energy-related issues, to provide easy traceable examples to subscribe in the highly conceptual frames found in the literature.

However, the same evaluation criteria linking actions to resilience approaches, principles and sustainability, could be replicated for any resource, of domain of campuses' sustainability plans.

As illustrated in Table 1, the Universidad Autonoma de Tamaulipas (UAT) made large investment plan for renewable energy plants, following the new rector's willingness of "green" branding this relatively young university in northern Mexico. This increased the energy self-sufficiency of the campus, avoiding risks of black-outs and systems failures in the short term. This kind of action reflects a perfect synergy between the short and long term perspectives of resilience, since at the same time it assures business continuity (for the capacity to withstand an electric breakdown) while contributing to a "urban" switch to a de-centralised energy power system.

A different way to opt for diversity is the solution adopted by Politecnico di Torino (POLITO) and University of Turin (UNITO): both Italian universities buy the 100 % of their electricity from a "green" (i.e. renewable) certified source. However, this solution does not prevent from black-outs (short terms) or political crises (long term) bringing failures of the energy system, since the site of energy production can be far away from the places of consumption and the stability of the grid is out of the direct control of the campus.

A different example of energy resilience enhancing is provided by the Hokkaido University (HOKUDAI), which after the Fukushima disaster invested in diversity to avoid dependency from nuclear energy. The energy mix as liquefied natural gas, oil and renewables needed to cover for approximately 30 % of the country's electricity that was formerly supplied by the 52 suspended nuclear power plants (Sunikka-Blank and Iwafune 2011).

Table 1 Universities' actions in relation with energy resilience principles, approaches and sustainability

Case studies' investments toward energy resilience	Resilience principle	Sustainability propellers with degree of involvement (+)	Resilience approaches
Universidad Autonoma de Tamaulipas (MEX): local plants of renewable energy sources (photovoltaic cells)	Self-sufficiency	Industry +++ Governmental institution +	Business continuity Transition
Hokkaido University (JP): energy system plan to include different energy sources (nuclear + hydropower + thermal). Politecnico di Torino and University of Turin (IT): green procurement on electric energy bought from renewable sources	Diversity	Industry + Governmental Institution +++	Business continuity Adaptation
Politecnico di Torino and University of Turin (IT): Uninterrupted Power Supply (UPS) systems; living labs to monitor and control energy data collection	Redundancy	Campus Infrastructure +++	Business continuity
University of Turin (IT): users' engagement strategies for energy saving measures	Adaptation	Civil Society + Education +++	Adaptation
Hokkaido University (JP): education for behavioural change, regarded as both incremental inclusion of sustainability in university curricula and as disruptive innovation in fostering more sustainable lifestyles	Learning Knowledge transfer	Education ++ Civil Society +++	Business continuity Transition
The University of Cambridge (UK): investment on disruptive innovations (patents coming from research grants on energy topics, test beds for several energy efficiency initiatives and products)	Knowledge transfer	Research +++ Campus Infrastructure +	Transition

The Uninterrupted Power Supply (UPS) solution, adopted by POLITO and UNITO (Italian cases), assures business continuity in the short term but no action has been taken to assure the long term resilience of the energy system.

Regarding a community engagement toward an aware use of energy sources in campuses, UNITO invested in research projects aiming at policy design drawn from users' comfort perceptions and discomfort tolerance thresholds. Energy resilience could indeed have a facet about users' behavioural change, in line with the adaptive capacity and long term sustainability requested in a resilient system.

The good practice to this extend is represented by the UAT Mexican case: to enhance self-sufficiency, learning and redundancy, the rector decided to brand the Tamaulipas University as "green" selling "proudly made in UAT" products from local farming cutting all the relative embodied-energy cost from imported food. Similarly, the Japanese HOKUDAI campus relies on local cropped wood for university users' domestic heating.

The gold practice for knowledge sharing is certainly the UK case. Cambridge University indeed counts with a millenary tradition self-learning innovations, a characteristic of both resilience and sustainability strategies. Potential disruptive innovations coming from endogenous universities' research products are important resilient features, corresponding conceptually to the adaptive capacities able to create local solutions to new challenges, and so minimizing external dependencies.

6 Conclusions and Further Research

This paper reviewed the concept of sustainability campuses in search for a holistic definition encompassing resilience features as drawn from recent urban literature. Whilst formally moving towards sustainability within their curricula and resources management, universities' leading green-washing strategies are mainly related to enhance their scores within international rankings, being often stuck in technocratic targets set around the regnant energy efficiency paradigms and the "tick-the-box" philosophy. If sustainability is assured by the cooperation toward low carbon performances of built environment elements (consisting of infrastructure, facilities, open spaces, services, etc.) with the university's social capital (user behaviour, education targets, research plans, etc.), each of these elements plays an interacting role within industry partners, public institutions and civil society.

To fuel these propellers, resilience thinking metaphor has been un-packed through different management approaches. The recovery (or business continuity), adaptability (capacity to adapt changes) and finally transformation capacities of universities are related to short-medium and long term time frames. In this view, resilience emerges to be one of the operational characters of sustainability. Indeed, business continuity in the short term is an essential component of long term survival of systems, but also self-learning capacities fed through community engagement and user awareness is essential to maintain a long term success of such initiatives. Trying to frame university campuses sustainable strategies into resilience capacities, the paper collect quantitative and qualitative data based on relevant stakeholders' interview. Because of the broadness of the factors to analyze, this research focused only on energy related examples. Management examples from Japan (the Hokkaido University Campus), Mexico (the Universidad Autonoma de Tamaulipas), the UK (the University of Cambridge) and Italy (the Politecnico di Torino and the University of Turin) gave different solution for energy resilient management not disregarding sustainability goals. If the trade-offs among more sustainable or more resilient practices is still unclear, this paper proposes a first stepping stone for

further studies on how to increasingly disentangle the relative impacts of organizational, relational, cultural, community and behavioral contexts on various energy performance measures in universities.

Moreover, a wider sample of urban cases can help in addressing critical reviews of which could be the resilience principles to include in sustainability goals. The first evidences suggest that although resilience per se is not always related to sustainability outcomes, when it is framed through a long term strategy it could enable capacities (like self-sufficiency, redundancy, diversity) helping in managing the transition toward truly sustainable universities campuses.

Appendix

See Table 2, Figs. 4 and 5.

Table 2 Green Metrics Chart ordered per Total Score in Italy, 2015. Highlighted in yellow, the average scores; in green, the highest score per column

Country	Average_Total Score	Average_Education	Average Energy and Climate Change	Average Setting and Infrastructure	Average_Transportation	Average_Waste	Average_Water
Italy	4'940	403	1'169	470	995	1'350	552

Ranking position	University	Total Score	Education	Energy and Climate Change	Setting and Infrastructure	Transportation	Waste	Water
97	University of Bologna	6094	351	1460	557	1325	1650	750
100	University of Turin	6057	521	1460	551	1000	1650	875
140	Universita degli Studi di Bari Aldo Moro	5628	491	1285	528	1000	1575	750
143	Universita degli Studi di Padova	5566	75	1285	431	1400	1500	875
154	Universita Ca Foscari Venezia	5488	574	1560	248	856	1500	750
164	Politecnico di Milano	5452	672	1220	486	800	1650	625
178	Universita degli Studi di Perugia	5262	587	1235	640	850	1200	750
197	University del Salento	5031	516	1195	395	1150	1650	125
206	Scuola Normale Superiore di Pisa	4986	225	800	536	1350	1575	500
242	Universita degli Studi di Ferrara	4679	375	945	384	625	1725	625
277	Universita degli Studi di Milano Bicocca	4143	355	1235	403	1025	975	150
280	Polytechnic University of Turin	4103	480	1245	379	725	525	750
296	Universita degli Studi Mediterranea Reggio Calabria	3948	200	1155	569	1050	975	0
299	Universita degli Studi di Trieste	3926	197	510	418	850	1200	750
309	Universita degli Studi di Trento	3731	433	950	524	925	900	0

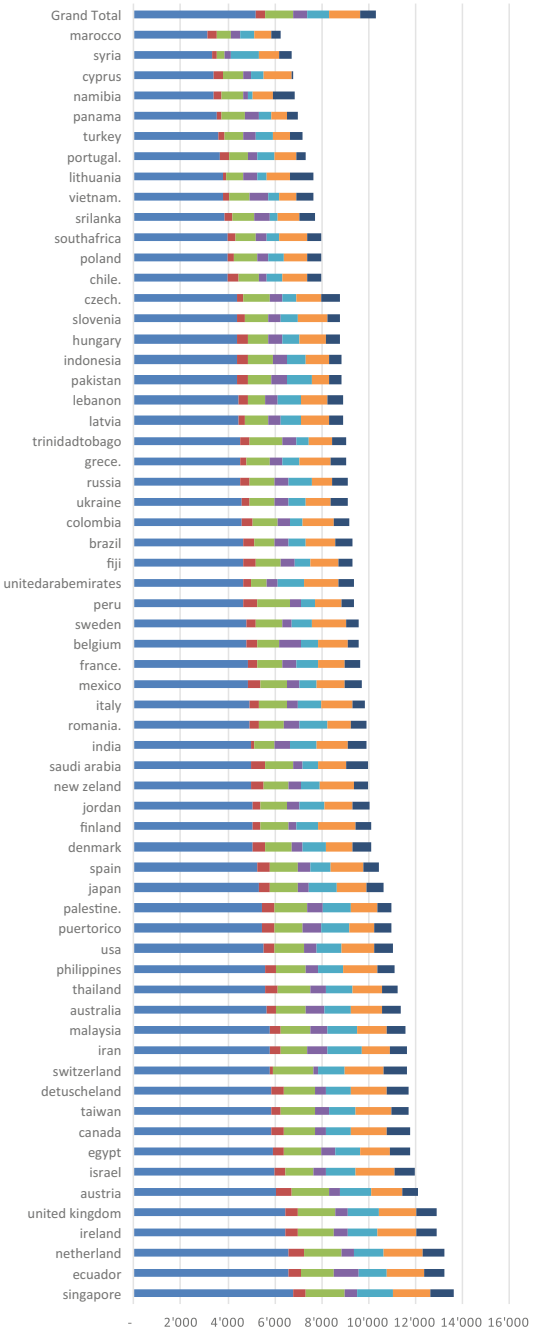

Fig. 4 Green Metric Ranking for 2015 ordered per ascendant Total Average Score (*blue stack*) per Country

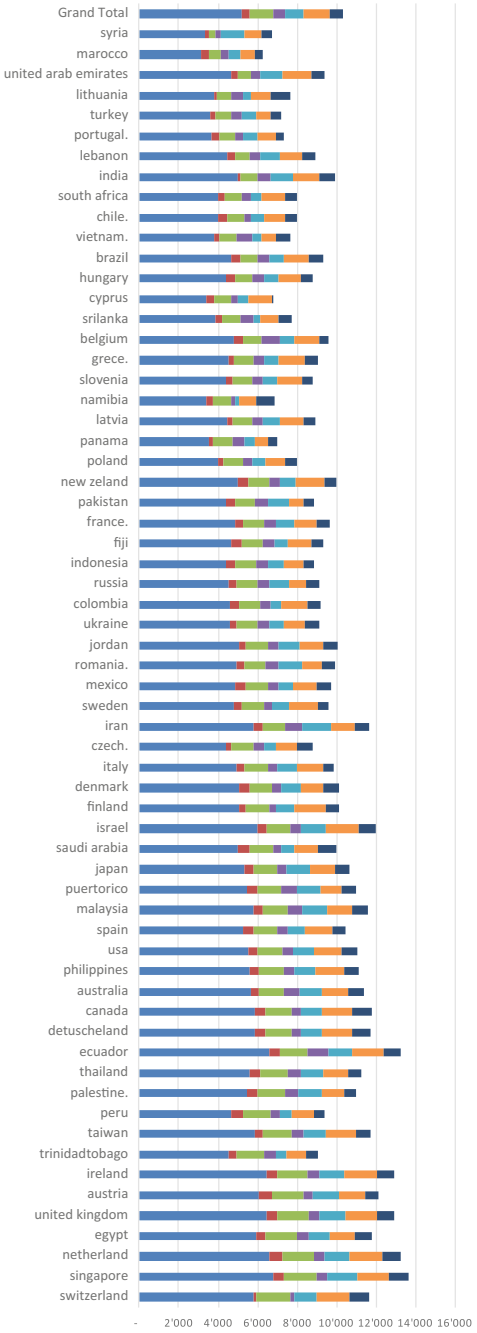

Fig. 5 Green Metric Ranking for 2015 ordered per ascendant Average_Energy and Climate Change (*green stack*) per Country

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Definition and Frameworks on a Life-Cycle Negative Growth Rate for Energy and Carbon in an Academic Campus

Somayeh Tabatabaee and Benjamin S. Weil

Abstract

The construction sector accounts for 30–40 % of the world's energy use and produces 40–50 % of the greenhouse emissions, and therefore construction techniques with low environmental emissions have been studied and developed. Most low-energy and net-zero energy building (NZEB) concepts defined by international agencies primarily use operational energy and greenhouse gas emission reduction strategies to minimize the impact of new buildings on global warming. The increase in the embodied energy of buildings has not been included in most NZEB definitions. A definition including life cycle zero energy and emissions is a more reliable approach to address the total environmental impact of new buildings. This study defines a framework which integrates life-cycle analysis of energy and greenhouse gas emissions at a campus level to evaluate the relative portion of embodied energy in the campus energy and emissions growth and also outline optimal conditions for extensive energy retrofits in existing campus buildings and net-zero-capable new construction within a life cycle approach. The implications of a life-cycle-based definition of "net-zero energy" can run counter those derived from net-zero energy definitions that focus on the use and operation portion of the building lifecycle. In this paper we develop a method for a comparative analysis of different scenarios for a reduction in embodied energy and operational energy and addition of renewable energy supplies. With the implementation of these methods, the goal of producing a campus with a negative life-cycle emission growth rate while increasing the number of buildings is explored.

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Life cycle assessment · Net zero energy · Campus energy · GHG assessment · Embodied energy · Life cycle zero energy

1 Introduction

On Earth Day, 2016, 175 countries, representing more than 55 % of the world's greenhouse gas emissions signed the UN Paris Climate Accord with a commitment to keep global temperatures "well below" 2 °C above pre-industrial levels. To accomplish this aggressive but vital goal (within 66 % likelihood), global emissions must be limited to a maximum of 1000 Pg C (IPCC 2013). The world's energy consumption has been projected to increase 56 % from 2010–2040 (EIA 2013). The construction sector has a major impact on worldwide energy consumption, as buildings use 30–40 % of primary energy and produce 40–50 % of greenhouse gas emissions (Asif et al. 2007). This has motivated the development of construction technology and building designs with low environmental emissions and high potential economic and social gains, and has brought the role of the built environment to the center of global perspectives on sustainable development (Ramesh et al. 2010).

This paper begins with a normative proposition that built infrastructure decisions should be made with regard to total life-cycle environmental emissions and not projected operational emissions. The important metric in the end is total emissions in absolute terms. Ratio measures such as energy intensity or reductions in the rate of increase in emissions are useful heuristics, but can enable suboptimal decisions especially with respect to impacts on the global climate system. In order to contribute to an early peak in global emissions, decisions about buildings should be made with a goal of Lifecycle Net-Zero Emissions (LCNZE). Planners, building authorities and regulators have three basic levers in their portfolios if they pursue lifecycle net zero emissions:

1. *Existing buildings*: These can be demolished to make way for higher performing buildings, improved with traditionally "cost-effective" energy efficiency measures (EEMs), or retrofit to dramatically improve building performance through major changes to envelope, HVAC, and lighting systems.
2. *New buildings*: These can be required to perform to a variety of standards from minimal building code compliance to LEED ratings to the Living Building Challenge, which requires net positive energy and imposes strict requirements on materials.
3. *Renewable energy*: Energy use of existing and new buildings can be offset by the installation of new renewable energy sources either on-or-off site. There are cost, intermittency, and electric grid interconnection factors that may limit the potential of renewable energy systems to offset the energy demands of new and

existing buildings. There is no practical way for new or future renewables to off-set previous emissions related to the manufacture and transport of materials used to build a new building.

Academic campuses are a natural site to explore the implications of a lifecycle net-zero emissions approach to development. Campuses are like small cities, with residential, office, teaching, laboratory, and public services and utility buildings. Like small cities, many campuses are growing rapidly but also have legacy—and historically significant buildings. Unlike most municipalities, however, many academic campuses have been monitoring and calculating their buildings operational energy and carbon emissions—in some cases for decades—in response to state mandates and internal campus energy reduction goals. As student enrollment and research activity increase, campuses add new buildings and improve existing teaching spaces. In many cases these new buildings are very high performance and energy efficient, but their addition nonetheless adds add energy use and emissions to the campus. Older buildings may be retained or demolished, but embodied energy (EE) relating to the construction of new buildings are not typically included in the calculations. Thus, even as a campus constructs new high-performance buildings, the overall rate of emissions growth can increase even as the rate of operational energy use decreases or becomes negative. Since it is total life cycle emissions that impact the environment including the climate system, a method is needed to evaluate new building construction, existing building retrofit or deconstruction, and renewable energy that integrates LCA into campus energy and emissions goals.

In following sections of the background information, we will first discuss campus energy, some current definitions of a low and net-zero energy buildings, and the importance of existing buildings in a lifecycle zero energy process.

2 Campus Energy

State mandates or internal policy on many campuses require pursuing net-zero emissions growth in order to meet overall emissions or energy use targets. Yet, especially in the case of public universities, there is a strong expectation that campuses will expand to serve the growing population of students and to fulfill an increasingly important role of university research in state and national economies. A survey done by Zhou et al. (2013) of 98 colleges shows a steadily increasing growth rate of 10.58 % per year for energy from 2006 to 2010 due to the growth in enrolment and improvement of teaching spaces. Enrolment in US higher education is expected to increase between 2010–11 and 2022–23 by 22 % in bachelor, 23 % in masters and 45 % in doctoral degrees (Hussar and Bailey 2014).

It is possible to grow campus built facilities while decreasing energy use and related emissions. By converting to renewable energy sources, renovating existing buildings, and reducing individual energy consumption through energy competition programs, some campuses are making incremental steps to reduce emissions

(Small 2012). Standard energy conservation measures supported by Energy Services Companies (ESCOs) on campuses, shopping malls, hotels, and office buildings can reduce CO_2 emissions by up to 25 % (Zhou et al. 2013).

Some campuses are beginning to take more aggressive measures to target energy use reduction. The MIT campus, for example, is focusing on targeting net-zero carbon with reduction in energy use through retrofitting existing buildings rather than just using renewable supplies (Nakano 2014). University of Michigan has added 23.3 % more square footage since 2003, while reducing annual energy consumption by 8 % for six years with energy management policies (Mudali 2015). Efficient lighting, refrigeration, and hybrid heating systems used in the Olympic swimming pools and showers at a campus resulted in a 7.5 % reduction of energy and 11.3 % of GHG from a Mexican campus (Escobedo et al. 2014). Electricity and water sub-metering can significantly improve the energy-saving potential of a campus through targeted commissioning and behavioral programs (Zhou et al. 2013). Using holistic decision analysis for a campus, it is possible to combine energy conservation measures and renewable energy to structure a low-carbon campus (Ho et al. 2014).

Very high performance, low energy demand, buildings are becoming increasingly common on US campuses, but the focus on high-performance new buildings leaves older high energy consumption buildings unimproved and continuing to operate. By definition, existing buildings are responsible for the current energy use of the building sector in a campus. Therefore, unless existing buildings are decommissioned or significantly improved, no addition of high performance buildings—even zero energy buildings—can reduce emissions in absolute terms.

2.1 Zero Energy Definitions, Net Zero Energy Building and Campus

Sartori and Hestnes (2007) define a low-energy building as one that has been designed with lower-energy operations and life-cycle energy demand than conventional buildings, with total end-use primary operating energy between 11 kWh/ft^{2}y (120 kWh/m^2 year) and 19 kWh/ft^2 year (200 kWh/m^2 year). A net zero energy building (NZEB) involves a low-energy building that produces renewable energy equal in annual production to the building's energy consumption (Cellura et al. 2014). In the US, the Energy Independence and Security Act (EISA) (US Public Laws 2007) supports the goal of net zero energy for all new commercial buildings by 2030, 50 % of existing ones by 2040, and all buildings by 2050 (Pless and Torcellini 2009). The European Directive on Energy Performance of Buildings (EPBD 2010) sets a goal for all new public buildings to be NZEB by 2020 (European Parliament 2010). However, until recently there has been no standardized method and procedures for the calculation of NZEB, and most of calculations were developed for specific cases (Marszal et al. 2011).

The most recent definition for zero-energy buildings (ZEBs) by the U.S. Department of Energy (DOE) states that a ZEB is an energy-efficient building

where, on a source/primary energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy (Peterson et al. 2015). This definition stresses the use of an electric grid or other energy networks for transferring any surplus of the on-site renewable energy. DOE also provides for a definition of a zero-energy campus by drawing the system boundary around a group of buildings in a specific locality that have renewable energy production systems owned by a given institution where the actual annual delivered energy is less than or equal to the on-site renewable exported energy (Peterson et al. 2015).

While the DOE definition focuses on energy, using primary energy to account for off-site losses, others indicate greenhouse gas emissions (GHG) as their metric of balance (net-zero emissions building) to minimize the impact of buildings on global warming (Georges et al. 2015). Some other definitions like those by (Cellura et al. 2014) and (Hernandez and Kenny 2010) maintain the focus on energy but integrate the elements of life-cycle analysis as a part of their definitions (Georges et al. 2015). Material choices may be driven by the potential to sequester carbon (wood) or, like concrete, may emit carbon in its production or extraction unrelated to energy use. Thus, a lifecycle net zero carbon emission goal is more comprehensive with regard to the climate effect of direct concern.

2.2 Life-Cycle Assessment

Life-cycle assessment (LCA) defined by the International Organization of Standardization (ISO) 14040-14044 standards is a leading method that accounts for all energy inputs and environmental impacts of the materials through their life-cycle stages:

1. *Product stage* (Raw material supply, transport, and manufacturing),
2. *Construction process stage* (Transport and construction-installation on-site processes),
3. *Use stage* (Use, maintenance, repair, replacement, refurbishment, operational energy use, and operational water use), and
4. *End-of-life stage* (Deconstruction-demolition, transport, waste treatment, and final disposal).

The LCA perspective requires making a complete evaluation of a building's environmental impacts in terms of energy and other emissions, and identifying the most sustainable material and system solutions (de Larriva et al. 2014) in the most frequently used life span of 50 years (Berggren et al. 2013). By applying LCA methodology to decision-making on materials and performance and construction planning, environmental performance of the building can be improved (Tillman 2000; Ramesh et al. 2010). When combined with lifecycle cost accounting, LCA often helps to identify the best technical solution to lower environmental impact at the lowest cost (Zabalza et al. 2013). Importantly, LCA has shown that energy-intensive materials or techniques aimed at improving the energy efficiency of a building may actually increase total emissions (Bribián et al. 2009).

2.3 Life-Cycle Assessment Approach in a Net-Zero Energy Context

While the energy consumed during the operational phase of the building life cycle still accounts for the largest portion of total lifecycle energy, as energy for operation (EO) is reduced the environmental impacts of the other phases become more important. In particular, embodied energy (EE) of materials and activity in the production phase of buildings is more important relatively and absolutely (Berggren et al. 2013; Thiel et al. 2013). The end-life phase accounts less than 1 % of the total-life phase energy (Kotaji et al. 2003), so building demolition is likely a better environmental choice than continuing to operate an unimproved and high-energy consumption existing building. However, for new buildings EE has become an increasingly important consideration.

Increasing use of energy-intensive building materials, greater refurbishment frequency and larger buildings, the EE of building materials and systems have grown fast (Langston and Langston 2008). Industrialized building materials and methods have increased the EE and carbon footprint of the modern construction process much higher than traditional approaches (Huberman and Pearlmutter 2008). High energy use and GHG emissions associated with manufacture of steel, aluminum, glass, cement, and foam insulation is now compounded by significantly greater transport distances even compared the 1980s in the US when there were higher contributions from available local raw materials and human energy (Cellura et al. 2014; Blengini and Di Carlo 2010; de Larriva et al. 2014). For new EO buildings, EE can range from 31 % (Bribián et al. 2009) to 60 % (Huberman and Pearlmutter 2008) of total primary energy in a building's life cycle. For conventional buildings EE accounts for 10 %–20 % of total life-cycle primary energy (Ramesh et al. 2010), but depending on materials chosen and climate conditions, the range is much broader—between 9 and 46 % (Sartori and Hestnes 2007). Of all building elements, the structure has by far the highest EE (Danatzko et al. 2013), so the clearest paths toward reducing lifecycle emissions include re-using existing structures (Dong et al. 2005) and employing lower EE—and carbon sequestering—structural materials such as fly-ash concrete and engineered wood (Oliver et al. 2014). In lower OE buildings, LCA plays a larger role in comparing different energy—and emission—reduction scenarios (Dixit et al. 2010). However, the introduction of LCA adds a complexity to the energy balance calculation, and so it should be considered a key issue in the energy demand evaluation of low-energy and zero-energy contexts.

3 A Framework for a Life Cycle Zero Energy and Carbon Neutral Campus

Use of LCA in assessing environmental performance of higher education institutions is relatively recent (Lukman et al. 2009). Current literature shows that academic campuses are mostly monitoring and calculating their buildings energy and

carbon emission based on state mandates and their campus energy reduction policies. However, the embodied energy and emissions added to campuses each year due to construction of new buildings are not typically included in these calculations. Broadly, the relative significance and magnitude carbon emissions due to campus growth are unknown. In this section, we develop a framework to calculate the campus energy and carbon growth rate with a life cycle perspective and begin to quantify the contribution of embodied energy. Then we introduce a method to compare scenarios such that campus lifecycle emissions growth rates can become negative with deeper energy retrofits of some existing buildings, removal of others, and construction of new facilities using lower emissions materials.

At a campus level, achieving a net zero emissions impact involves the following strategies:

1. Reductions in EE by using alternative materials with lower energy and carbon impacts for new construction and renovation of existing buildings.
2. Reductions in EO of existing and new construction using enclosure and façade strategies, HVAC, and lighting while considering the addition of their EE.
3. Reductions in EO through the removal of existing buildings.
4. Renewable energy supplies considering the addition of their EE.

Figure 1 illustrates the balance of embodied and operational energy that must be accomplished for new construction to have a lifecycle net zero energy impact on overall campus energy and emissions.

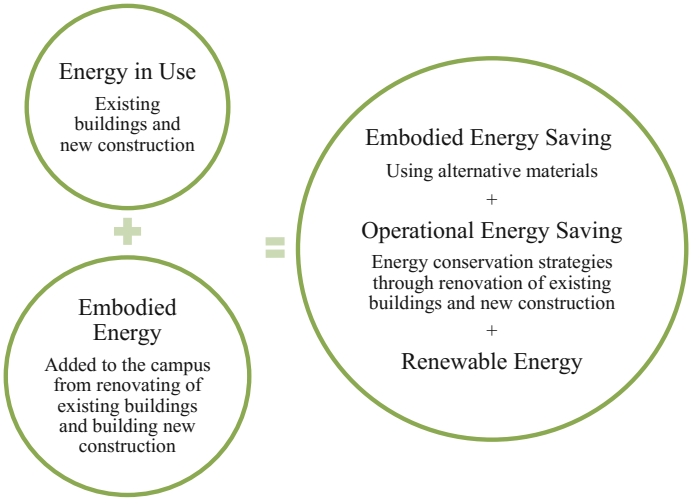

Fig. 1 Life-cycle, zero-energy campus

3.1 Metric of Balance

Environmental impact correlates closely with the primary energy demand of buildings throughout the life cycle (Ramesh et al. 2010; Cellura et al. 2014), and the most common expression of data in the LCA of building products is primary energy (Sartori and Hestnes 2007). Also, as Marszal et al. (2011) note, primary energy is clearly the most favored metric among NZEB standards and definitions. The definition of a "near-zero energy building" from the DOE and EPBD (Energy Performance of Buildings Directive) clearly use primary energy as the metric for energy balance. These metrics are heavily dependent on conversion factors between the final and primary energy based on the energy carriers used for energy generation and the system's efficiency. While closely related, however, for calculations of lifecycle environmental impacts over long periods, primary energy may be a poor proxy. As electricity grids become cleaner, and less carbon intensive, the environmental effects of primary energy may decline, while on-site combustion of fuels —even at high efficiency—becomes relatively more impactful. Equally important, the embodied primary energy of materials may relate poorly to their lifecycle impacts. For example, carbon emissions related to aluminum production may be directly related to electricity, but carbon emissions from concrete production are inherent to the process and do not relate to energy consumption.

For this reason, an increasingly favored metric is the carbon equivalent emission as indicated by most net zero energy literature (Marszal et al. 2011). Global warming potential measures mass of greenhouse gases produced and sent into the atmosphere weighted relative to greenhouse effect impact of an equivalent mass of carbon dioxide (de Larriva et al. 2014). Reduction in greenhouse gas emissions is the main motivation for developing net zero energy development (Wilford and Ramos 2009), so it is reasonable to directly estimate impacts in terms of greenhouse gas emissions. Because GHGs, especially CO_2, have long atmospheric residence times and a cumulative effect, a thorough accounting of campus climate impacts will use life-cycle analysis of carbon dioxide equivalent (CO_2e) emissions as the primary metric.

3.2 Estimates of Embodied Emissions and Reduction Strategies

For the purposes of planning, buildings that have already been built have no future embodied emissions. These emissions have already happened and cannot be retrieved. Buildings that have not yet been built provide the only opportunity to reduce EE. For near-term building projects with existing plans and designs, it is possible to estimate EE with some accuracy, and possibly make design or material selection changes to reduce lifecycle emissions. However, in campus planning, there are many buildings that must be planned, but for which only a function, program, and approximate size and location are specified in a campus master plan. For these, projections of EE are needed.

To estimate the addition of EE during a specific future year of campus construction we make the assumption that future construction will be similar to the most recent, highest-performing buildings on a specific campus of the similar type to the projected buildings in a campus master plan. There are a variety of tools for conducting life-cycle assessment. One of the most commonly used, ATHENA Impact Estimator (2014), provides a cradle-to-grave assessment for buildings with specifications from North American databases. Based on ISO 21930/31, the tool's outputs estimate a variety of impacts including global warming potential (CO_2e) and fossil fuel consumption. We use these outputs and normalize by floor area for each building type.

Values derived from literature give ranges to check the software-based estimates. For example, Cellura et al. (2014) indicate an EE range of 0.9–9.0 kWh/ft^2 year (10–100 kWh/m^2 year) for low-energy buildings. This order of magnitude range, gives an indication of the potential for reducing EE. By modeling recently constructed buildings with as-built specifications and drawings, we are able to estimate the impact of changing particular building elements.

Materials and processes installed to reduce operational GHG emissions by retrofitting existing buildings can also be evaluated for EE impacts using the same bottom-up approach.

3.3 Estimates of Operational Emissions and Reduction Strategies

Operational emissions are almost entirely due to energy use (though refrigerant leakage is non-trivial). For existing campus buildings, these and can be determined through collection of metered energy data. For near-term future buildings, energy usage projections based on building energy simulation models are the next best option. With careful, detailed and specific input specifications including applying weather file compensation factors, building energy models can produce results with less than 0.2 % deviation from actual energy use (Fiocchi et al. 2014). For longer-term future energy use, we make the same assumption as we did with EE, that future construction will be similar to the most recent, highest-performing buildings of a given type.

Besides the addition of renewable energy sources discussed in the next section, the primary tools for reducing emissions from buildings are retrofits with higher performance systems or deconstruction, demolition, and building removal. With energy models of existing older buildings, we can systematically simulate the impact of a range of practical energy retrofit scenarios, from minor HVAC and lighting upgrades to major changes in HVAC system and envelope and façade renovations. Engineering studies on the University of Massachusetts Amherst campus have shown that at relatively low cost, some buildings can be retrofitted to perform at a level roughly equal to the very most energy efficient new buildings (Fiocchi et al. 2012). The energy performance and related materials data can then be supplied as inputs to ATHENA Impact Estimator to compare the lifecycle

emissions and cost impacts on a campus-wide level associated with the renovation of an existing building compared to investing in a new high-performance building. Careful building energy simulations can also be useful for retrospective investigations of recent energy efficiency renovations. Operational and commissioning errors and thermal bridging, for example, have been shown to eliminate the expected savings of some major campus building renovations (Tabatabaee et al. 2015). Similarly, such studies can indicate buildings that cannot affordably or easily be retrofitted to high-performance and should be considered for removal.

3.4 Renewable Energy Potential and Integration to a Framework Towards a Lifecycle Zero Carbon Emissions Campus

Each campus faces restrictions to total possible on-site renewable energy facilities due to local climate characteristics and available surface areas. Available appropriate roofs, parking canopies, etc., limit solar energy collection potential. Wind resources on campus owned properties are often below economically viable thresholds. Many campus-planning entities have already contracted for solar, wind, and other renewable energy resource studies. In most cases, the technically feasible renewable energy potential will never be built-out, but the resource studies set a hard cap on potential renewable energy that could be deployed.

With the options for energy savings, new buildings, existing buildings to be retrofit, maintained, or removed, and renewable energy potential estimated, it is possible to examine alternatives and determine the optimal set of options to be pursued as part of a zero emissions campus goal. The net energy ratio metric (NER) aids in the selection of the best scenario with lower EE while achieving higher EO reductions and lowest total life-cycle energy and carbon impacts (Hernandez and Kenny 2011). Two NERs summarize the options for energy savings and renewable energy production.

- $\text{NER1} = \dfrac{\text{Energy saving through faËcade renovation and other EO reduction strategies}}{\text{FaËcade renovation and other strategies EE additions}}$
- $\text{NER2} = \dfrac{\text{Renewable energy systems' annual energy production}}{\text{Renewable energy system embodied energy additions}}$

Multiple scenarios can be constructed and summarized by the associated NERs. Figure 2 shows a conceptual model of how to apply the data described above to a decision-making framework with the areas of focus easily compared: reduction in EE of building materials in new constructions, reduction in EO of new constructions and existing buildings, and use of renewable energy supplies. The EE reduction strategies for new constructions involve comparisons of different scenarios of alternative low-energy, recycled content, and carbon sequestering materials in structures, envelopes, and interior finishes. For EO reduction, extensive

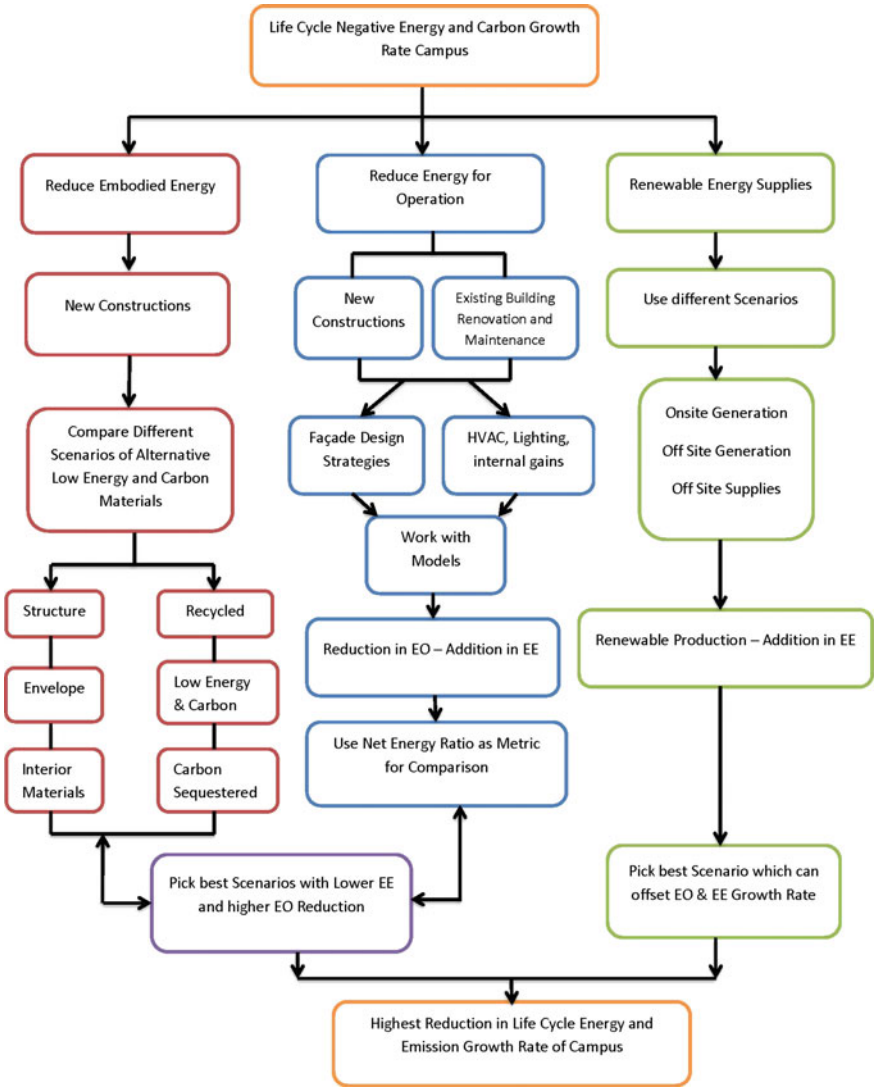

Fig. 2 Conceptual model

work needs to be done on façade design, HVAC, lighting, and internal gains by using energy models and considering the addition of their EE. Renewable energy scenarios can be modeled along side the EO and EE reduction scenarios allowing for the scenarios with lowest impact to be chosen using a NER metric.

As with any prospective approach, this planning framework is limited by the large uncertainty associated with projecting future technologies and future choices. Asserting a hard cap on local renewable energy resources is fraught with

uncertainty, since new technologies may be developed more efficiently to transform solar, wind, or thermal gradient resources into useable electrical or thermal energy. Similarly, analysis of CO_2e emissions depends on multipliers relating to the local electrical grid. However, this is a static analysis, and the carbon intensity of regional electric grids can change. There are ongoing limitations to lifecycle-based methodology due to the incomplete evaluation and assessment of materials, and lack of extensive environmental product declarations of materials. As Khasreen et al. (2009) highlight, extensive and agreed LCA inventories of materials are largely lacking and there may be order of magnitude discrepancies for given materials between databases. For comparing energy performance of future retrofits of existing buildings or future new buildings, the range of practical options is at least partially limited by the creativity, knowledge, experience, and biases of the investigators and planners. Especially in retrofit situations, conventional HVAC and envelope solutions—such as those available in many wizard-driven energy modeling software packages—may not provide the requisite performance. However, the approach described above provides at least a heuristic to help drive campus planning decisions that can put a campus on the path towards net zero emissions related to all campus activity including campus growth and construction.

4 Conclusion

Most campus energy mandates and NZEB definitions focus on annual operational energy, and neglect the life cycle perspective that would include the embodied energy and emissions of materials and processes involved in building construction. At the individual building level, many studies have shown the importance of life-cycle analysis in accounting for overall energy and carbon impacts. Understanding buildings as components contributing to a whole-campus energy and climate impact places additional weight to lifecycle analysis, as ongoing energy demand due to continued operation of high-energy and low-performance buildings figures heavily. Opting to re-use buildings or parts of buildings can result in significant embodied energy and emissions savings especially if retrofitted for high-performance. Some materials or process choices for new buildings may add more than others to emissions for which the campus is responsible. Due to embodied energy, any new building—even a NZEB—will increase overall emissions growth. Reductions in operational energy for existing buildings, or their decommissioning, can offset this growth. To achieve a campus with net-zero emissions or just zero emissions growth rate as campus built space continues to grow, campus planners require access to a decision framework that includes all options including building removal, renovation, new construction, and renewable energy.

The framework described in this paper provides a method for accounting for life-cycle emissions associated with the full range of options available to campus planners. By computing and comparing different scenarios of life-cycle energy and

carbon reduction strategies, we can learn which level of energy efficiency, what type of materials in existing and new buildings, and which renewable energy options will offset the campus life-cycle energy and carbon emission growth rate while increasing the overall built space on campus. Future research should employ and test this framework on a variety of campuses in a range of climate zones and settings. In particular, this work can develop an inventory of materials, construction techniques, and retrofit strategies optimize alternatives with the lowest impacts. Further research can also focus on policy approaches to operationalizing the life-cycle net-zero emission framework. Policies such as carbon taxes, revisions to state building mandates, and municipal building ordinances can all draw on this framework.

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A Systems Approach to Sustainable Development Examination and Research in Russia

Ken Sik To

Abstract

Education of stakeholders plays an important role in sustainable development. Effectiveness of education for sustainable development processes is contingent upon approaches and methods applied. This paper describes the systems approach and business simulation games as the methodological basis of examination and research of sustainable development. On the one hand, the systems approach allows of presenting the entire variety of sustainable development processes. On the other, it helps to emphasize and understand the quintessence of these processes, and shows that managing sustainable development requires an interdisciplinary approach. The author analyzes business simulation games in sustainable development research and examination. He then describes "Stakeholders and Sustainable Development" game developed based on the systematic presentation of sustainable development, and discusses its practical results. Furthermore, the author discusses the benefits of business simulation games in education and training, and substantiates effectiveness of business simulations in sustainable development processes research. This paper will be helpful to scholars, professors and students, as well as to representatives of government bodies, businesses, and social organizations interested in sustainable development matters.

Keywords

Business simulation game · Education · Examination and research · Russia · Stakeholders · Sustainable development · Systems approach

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1 Introduction: Difficulties in Sustainable Development Examination and Research

The purpose of the paper is to provide and substantiate application of the systems approach and business simulation games to examination and research of sustainable development. The concept of sustainable development is rather wide and complex by its content (Balobanov 2007). Everything happening in society may be considered as pertinent to sustainable development, which is one of its many complexities. On the one hand, it is well-grounded. On the other hand, it interferes with understanding of the quintessence of sustainable development. Furthermore, it blurs the essence of sustainable development and complicates the purposeful practical realization of sustainable development ideas. It is therefore important to approach sustainable development processes with a methodology that would reveal their diversity and facilitate isolating and comprehending the crux of these processes. Achievement of this goal would allow of obtaining a holistic view on sustainable development and forming a framework that may further be supplemented with a more detailed analysis of its various aspects. In order to achieve the purpose stated above, the author offers a methodology that includes the systems approach and business simulation games (To and To 2014).

2 Systematic Presentation of Sustainable Development Processes

Sustainable development processes can be presented as a system designated for transforming various types of activities undertaken by society into its living conditions, as presented in Fig. 1 (To 2011).

Objectives Transition to sustainable development requires substantial modification of priorities and objectives for society. Decision-making mechanisms must be oriented towards respective priorities, take into account consequences of implementing these decisions in economic, social, environmental spheres, and provide a comprehensive estimate of related costs, benefits, and risks. Control over achieving sustainable development objectives, management of this process, and assessment of effectiveness of resources used, requires setting appropriate measures. Sustainable development indices and indicators are used as relevant measures (Tarasova and Kruchina 2006).

External Environment Given that the internal environment includes a combination of economic, environmental, and social spheres, the external environment encompasses factors that influence each of these spheres. Generally, the external environment of the sustainable development system is a system of a higher rank relative to this community, which exists and evolves constantly interacting with the external environment. In order to function, the system must account for the external environment factors, measure them, and adequately react to changes.

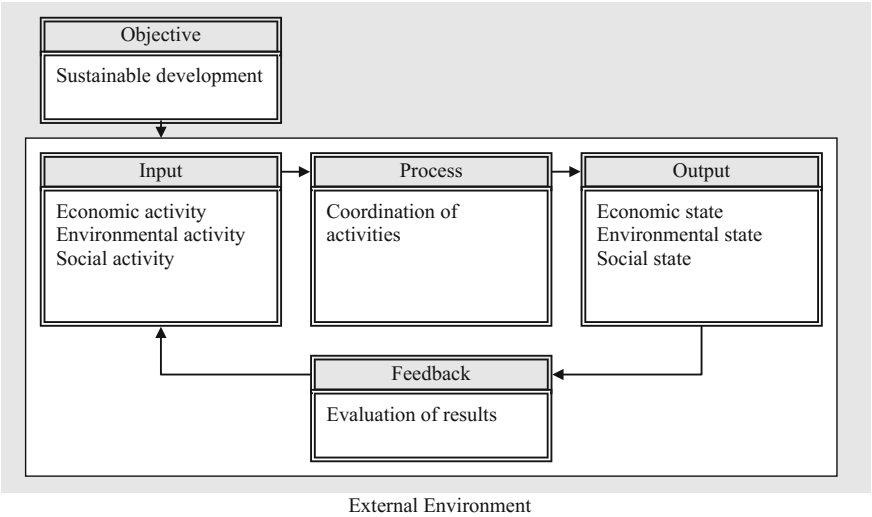

Fig. 1 Sustainable development of society as a system

Outcome ("Output") Every type of activity is reflected in economic, environmental and social states of a given community (municipality). Each sphere aspires to achieve its internal objectives and is evaluated by indicators characterizing its state.

Components ("Input") Based on the objectives of social research from the sustainability point of view, the components (subsystems) are economy, environment, and community. Each subsystem has its interests and objectives. Respective activities are undertaken within each of the subsystems, which require certain resources that are then used (transformed) in order to produce results. Such presentation is suitable for economic, environmental, and social activities.

Process is coordination of types of activities necessary to ensure sustainable development. When making decisions, sustainable development necessitates taking into account interests of all stakeholders representing economic, environmental, and social spheres. A decision within one sphere should be aligned with decisions in others. In the last decade the matters of partnership interaction between the three social sectors have been given much attention to considering formation of civil society and changes in government and business' functions in socio-economic development. Partnership is an effective mechanism for coordination of interests of various stakeholders in the sustainable development process. This mechanism is the most comprehensive and encompasses all stakeholders in the process. Why partnerships specifically? The means of solving problems used by just one sector have been tested before and proved to be insufficient. Working separately, each sector makes isolated efforts and frequently competes against the others, duplicating their actions and wasting scarce resources. Isolated efforts lead to "blame culture", when a failure to solve a problem and inertia are shifted onto someone else's shoulders.

The partnership approach is based on a conviction that sustainable development initiatives will be innovative, consistent, and will contribute to solving particularly complex problems of social development only when there is a meaningful and widely spread cross-sector collaboration. Accordingly, the partnership approach creates new opportunities for social development through better understanding of working conditions and capacities of each sector, as well as through pursuit of new ways of their utilization for the common welfare's sake. Many partnership projects existing in various countries have proved that cross-sector collaboration can be effective and sustainable (Tennyson 2003).

Feedback compares the actual state of a social system with the target model and identifies deviations. Analysis of the substance and ramifications of deviations allows of developing, if needed, managerial decisions aimed at correcting sustainable development processes. Realization of these decisions could bring the actual Output of the system closer to the target or lower the deviation to an acceptable level.

The systematic presentation of sustainable development processes shows that managing sustainable development requires an interdisciplinary approach. A comprehensive analysis necessitates application of models produced in various disciplines, as different matters of sustainable development implementation are studied in economic theory, nature management, sociology, political science, law, psychology, and other disciplines (Danilov-Danilian and Piskulova 2015). Presentation of sustainable development processes as a system allows of overcoming the obstacles described above. On the one hand, any process within society can be "fitted" into the system; on the other hand, the quintessence of sustainable development, i.e. the coordination of activities of various stakeholders for achievement of sustainable development objectives, is emphasized.

Application of the suggested systematic presentation is fruitful for examination and research of sustainable development processes.

3 "Stakeholders and Sustainable Development" Business Simulation Game

3.1 Overview

The systems model of sustainable development processes presented above was used to develop a business simulation named "Stakeholders and Sustainable Development", which is designated for examination and research of sustainable development matters (To 2014).

The simulation can be conducted in educational courses on the essence of sustainable development, among experts researching sustainability-related problems, as well as among real stakeholders (government bodies, businesses, social organizations) for making specific managerial decisions related to sustainable

development. The business simulation was based on the approach described in the work of a number of authors, including Komarov (1989).

The scenario of the business simulation is as follows. A project related to construction of an oil-refining plant on the municipal territory is being evaluated. The plant will be built over the course of 5 years. The most convenient location for the plant is by a lake in a forest park zone. There is a small town close to the proposed construction site. An operator company (hereinafter, "Operator") can utilize either its own or local workforce, or attract labor from other regions of the country/world. If the Operator was to utilize the local workforce, it would have to conduct relevant training first. There is a high unemployment rate and low income level among the local population. Lake and forest resources are essential for a significant portion of the local population in order to make a living. Further, lake and forest are the major recreational zones. Local authorities are concerned about improving the welfare of the population and environmental issues.

In the business simulation it is assumed that representatives of local authorities, businesses and the community diligently fulfill their responsibilities related to local governance, business management and community service, respectively. These aspects are considered to be fixated. The simulation is used to model coordination of interests of various stakeholder groups in order to implement sustainable development. Participants make decisions related to this particular function. There are sustainable development boards in the simulation. Each team is a board that includes representatives of various stakeholder groups, such as local authorities, businesses and social organizations. The goal of each team is to make decisions that will yield the maximum sum of economic, environmental and social indicators for the community. The team that achieves the highest sum of aforementioned indicators over the span of five years wins. The goal of each participant is to achieve the maximum result over the simulation period. Every conditional year, in order to achieve these goals, participants make the following decisions: economic (construction of the industrial plant), environmental (nature conservation measures), and social (community projects). Economic, environmental and social decisions impact sustainable development characterized by the sustainable development index.

Preparation and contents of the business simulation vary based on its objectives. If practical objectives are pursued, the simulation experiment is divided into three stages (preparation, simulation, and conclusion). The preparation stage encompasses finalization of the list of participants, copying handouts, specification of the time-table and rules, etc. Other activities during this stage include: formulating the sustainable development problem; outlining alternative solutions; identifying problems that would need to be solved in order to execute the best alternative; and developing action plans on conducting participant surveys, examining the environment and conditions.

The simulation is viewed as a methodological means of solving identified problems and tasks. On the one hand, the simulation helps to examine the environment and conditions, individual attitudes, and preferences. On the other hand, the simulation facilitates generation of ideas and proposals aimed at solving identified problems. As such, the simulation requires thorough and careful preparation,

both in respect to selecting participants and compiling the list of researched matters. During the conclusion stage (within the problem scenario), the participants of the business simulation make recommendations to stakeholders using various methods of group work (such as brainstorming). While developing these recommendations, the participants utilize the experience gained through the game scenario of the business simulation, as well as their own expertise and knowledge. All the recommendations provided during the discussion and the plenary session are summarized by facilitators of the business simulation in the form of a special report. This report is used in practical work for developing an action plan for sustainable development implementation.

From the research standpoint, the preparation stage incorporates formulating (refining) the research hypothesis; forming a group of experts on sustainable development; and selecting relevant methodical materials. Within the problem scenario, the experts discuss the business simulation model and clarify the research hypothesis. The research cycle utilizing the business simulation is reiterated, if necessary. The simulation game is based on two elements, namely seriousness and playfulness. The functioning process of examined organizational and economic systems is imitated within the game scenario (i.e. the simulation). The research problem is essentially solved through the analysis of the outcome of the simulation, which includes observation over participants, inquiries of experts, and special group work sessions. Such understanding of business games allows of its application in addressing the following tasks:

- Collecting phenomenological information through conducting simulation experiments with the examined organizational and economic system;
- Verification of hypotheses and theories within the conditions of a laboratory experiment;
- Initiation of specialists' interaction in interdisciplinary studies;
- Developing a theory through an uncommon approach, i.e. by constructing an imitational game model.

The game includes the following major fragments.

1. *Sustainable Development Board session*. Construction of the oil-refining plant on the municipal territory is discussed during the session. The purpose of the session is to make decisions in connection with the construction and all matters (environmental, social) brought about by it. During the session each player (Board member) must substantiate and defend his/her position in accordance with the corresponding game role.
2. *Making decisions*. It is imperative to reach a coordinated decision based on discussions during the Sustainable Development Board session. This decision must take into account economic, environmental, and social aspects of the activity. Every type of decision is granted a certain number of points. The Board makes decisions by simple majority voting. Decision type classifiers are used when making decisions.

3. *Decision results (evaluation of economic, environmental, and social indicators)*. Based on the decisions made, the teams evaluate the results reflected by economic, environmental, and social indicators. Values of the indicators are determined taking into account the sustainable development index.
4. *Results of the economic system (calculation of the sustainable development index)*. The position of the economic system is reflected by the sustainable development index, an integrated weighted index that characterizes the sustainable development position of a municipality. Current year decisions impact the index. The value of the index for the current year, in turn, influences the indicators for the following year.
5. *Stakeholder group meeting (discussion of problems)*. Stakeholder meetings are held separately by each stakeholder group, i.e. amongst representatives of local authorities, businesses, and social organizations. Agendas for the meetings include exchange of opinions, assessment of the current situation, and development of joint strategies. Participants of these meetings may discuss problems pertaining to their respective areas. Other matters related to the simulation system may be discussed as well.

Strategies developed by participants are analyzed at the end of the business game (To 2014).

3.2 Benefits of Business Simulation Games in Teaching Sustainable Development

There are certain obstacles in teaching sustainable development. First of all, research and various events dedicated to sustainable development demonstrated that representatives of different fields approach the syllabus differently. Thus, economists tend to focus primarily on economic aspects of sustainable development, sociologists—on social aspects, and ecologists, naturally, tackle environmental problems. As a result, only one side of the essence of sustainable development is addressed. In most cases, it pertains to the environmental aspect, and everything comes down to environmental preservation matters. Therefore, the object of sustainable development research is defined ambiguously, while the very essence of sustainable development slips away ("not see the forest for the trees"). Second of all, it's not very clear what practical implementation of sustainable development entails, and the interest towards sustainable development diminishes as a result.

Considering the two factors listed above, teaching sustainable development requires uncommon approaches within the educational process, business simulation games being one of the examples.

Business simulation games in the sustainable development educational process have a number of benefits (Khrutsky 1991; Lifshitz 1989):

- The interest towards classes and training sessions in general, as well as towards the problems being simulated in particular, grows;

- Cognition during the simulation is improved, as students/trainees obtain and process more information when it's based on examples of specific situations;
- The attitude of students/trainees towards those specific situations arising during the process of sustainable development implementation changes, and it's not a seldom occurrence when it changes significantly. The attitude towards people (characters in the game) changes too, as their motives and incentives are understood better.
- Self-appraisal of students/trainees transforms as they become more objective.

Business simulations play an important role in the teaching process for adults, i.e. stakeholders in sustainable development processes. Students/trainees are given an opportunity to gain a general idea both in terms of "time and space" in respect to sustainable development processes, which is impracticable while they are fulfilling their job duties and responsibilities. Knowledge and experience accumulated during the simulation can be utilized in their actual jobs to refine the assessment process for possible real-life situations. Furthermore, business simulations produce the "condensed timeline" effect, which allows of tracking relationships between actions and consequences within sustainable development management. Dynamic situations created by the business simulation and underlying conditions may be tested almost simultaneously with the assessment of the set of factors that were used to produce them. Relative importance of sustainable development components may be assessed "more realistically" within business simulations.

Accordingly, "Stakeholders and Sustainable Development" business simulation game is aimed to overcome the obstacles listed above and to examine sustainable development processes systemically. Furthermore, it enhances decision-making in respect to practical solutions providing an opportunity to "touch" the sustainable development processes with your own hands.

3.3 Benefits of Business Simulation Games in Examination and Research of Sustainable Development Processes

The effectiveness of business simulations in research is determined by the combination of three research methods, namely analytical, expert, and experimental. The analytical method is applied to construct the simulation. Such "construction" includes analyzing substantial factual material; determining the most significant elements and factors and relationships between them; and formulating hypotheses and theoretical frameworks in respect of the essence of sustainable development. Through engaging professionals as participants and experts the potential of the expert method is being used. The experimental nature of business simulations is defined by reenactment of functioning of the simulated system (the sustainable development system) multiple times. Hence, hypotheses and assumptions can be verified experimentally.

There are certain limitations of the outlined methodology. The major limitation is that facilitators and academics might not possess the required knowledge of the systems approach and business simulation games in particular.

4 Educational and Partnership Experience for Sustainable Development of the Sakhalin Region in Russia

Sakhalin State University has been actively engaged in sustainable development matters since 2005. Teaching undergraduate and graduate students, as well as stakeholders in the region is an important part of it. The course named "Basics of Regional Sustainable Development" has been taught since 2007 for undergraduate students of various specialties, and the course named "Sustainable Development: Issues" has been taught since 2009 for graduate students of the University.

Since 2005, Sakhalin State University has undertaken a number of educational programs on sustainable development for municipalities of the Sakhalin Region. These programs were completed by top- and middle-level managers, experts from local government bodies, and representatives of social organizations of the Region. The programs were facilitated by the staff of Sakhalin State University and the Living Earth Foundation (London, UK), as well as by regional and municipal government officials, business and social organizations representatives.

Realized sustainable development programs are based on the following key premises:

- Active teaching is the most suitable educational technique. It implies that participants themselves are a valuable source of experience and expertise. One of the elements of these programs is the "Stakeholders and Sustainable Development" business simulation game.
- Result-oriented teaching. Anticipated results pertinent to acquired knowledge and skills are determined in the beginning of the educational process. The educational process has a clearly defined structure aimed at achieving these results.
- Partnership and consensus. The focal point of the sustainable development model introduced in these programs is mutual trust among major stakeholders, which is essential to reach a consensus on main issues. Enhancing mutual trust is a prerequisite for sustainable development.
- The programs are based on the region and municipalities' real-life scenarios related to sustainable development. This is achieved by inviting experts working in regional and local government bodies, representatives of various businesses and social organizations, as well as by visiting affected sites (United Nations Development Programme in the Russian Federation 2010, 2013).
- International experience.
- "Total immersion" principle. Sessions are not held in university auditoriums, but rather "out of town", where the participants are not distracted and give their undivided attention to sustainable development matters.

Educational programs on sustainable development introduced in the Sakhalin Region based on the aforementioned principles demonstrated greater effectiveness compared to traditional forms of sustainable development processes examination. Another important benefit of educational programs is establishing partnerships between the participants along with a better understanding of interests and problems of other stakeholders by each participant.

Discussions of sustainable development problems in the Sakhalin Region are held in the form of round-table meetings. In 2014, Sakhalin State University hosted a round-table meeting "Implementation of Sustainable Development Principles in Municipal Administration Practice in the Sakhalin Region: Experience, Problems, and Prospects". The round table was attended by representatives of the government of the Sakhalin Region, municipalities, businesses, social organizations, and Sakhalin State University. The participants expressed various points of view on sustainable development of municipalities in the Sakhalin Region and were unanimous on urgency of the sustainable development concept for the Region, which was the most significant result of the meeting.

The experience of social partnerships in the interest of sustainable development in the Sakhalin Region is rather valuable too (Limonzo et al. 2006). Thus in 2006, Sakhalin State University in cooperation with Sakhalin Energy Investment Company Ltd. ("Sakhalin Energy") established Sustainable Development Department. Sakhalin Energy is developing oil and gas fields off the north-eastern coast of Sakhalin Island in the far-eastern part of Russia (Sakhalin-II Project). The purpose of the department is to promote the sustainable development culture and assist in the dialog between the University and academic community, as well as to lead the research in sustainability-related matters. The department organizes theoretical and practical conferences (both domestic and international) and contests of research projects related to regional sustainable development.

The partnership between Sakhalin Energy and the Administration of Korsakov City District is also significant for sustainable development of the Sakhalin Region. In 2004, the Sakhalin Energy's initiative resulted in creating the Korsakov Partnership Council on Sustainable Development, which is an open organization structure based on voluntary union of stakeholders' representatives. Its main purpose is review of sustainable development projects in the Korsakov City District on a regular basis as part of Sakhalin Energy's "Sustainable Development and Social Investments Program", as well as assistance in implementation of these projects. The Council was established under the cooperation agreement between the United Nations Development Program in the Russian Federation and Sakhalin Energy in order to support Company's sustainable development initiatives.

Participation in operation of the Partnership Council is an example of implementation of sustainable development principles in practice.

Sustainable development ideas have begun to spread purposefully in the Sakhalin Region in mid-2005. In the past 10 years the Region's community has made its way from realizing the importance of sustainable development ideas and educational programs to execution of actual projects. Accumulated knowledge, skills, and experience have necessitated the transition from the isolated and discrete

approach to the systematic and integrated implementation of sustainable development at the level of specific territories. On the one hand, there are theoretical frameworks on how to tackle sustainable development processes, and there is certain practical experience, while on the other hand, practical implementation of sustainable development principles requires tailoring existing methodological frameworks to the needs of particular territories. This explains why the perception of education for sustainable development has altered. It should be more practical and "hands-on" throughout, meaning that the participants must understand how to implement sustainable development principles in practice upon completion of their education. This is important, since the very participants of educational programs and other projects will be key players in bringing sustainable development into reality. Education must facilitate integration of sustainable development into the everyday life of territories (Sustainable Development Fund 2012).

Since 2008, Sakhalin State University has been actively engaged in implementation of sustainable development into municipal administration in the Sakhalin Region. Research has been conducted on the relevant implementation mechanism resulting in formulating a concept on municipal administration based on sustainable development principles. The University organized and facilitated a training course ("Municipal Administration Based on the Sustainable Development Principles in the Sakhalin Region") with both theoretical and practical purposes.

The program of the training course was lined up starting from the essence to the principles of sustainable development, moving on to municipal sustainable development. The course was broken down into two stages. The first stage was dedicated to theoretical aspects of municipal administration based on sustainable development principles, which incorporated examination of the systems model. The second stage of the course was concentrated on practical aspects. Specifically, the trainees participated in "Stakeholders and Sustainable Development" business simulation game and analyzed the matters of partnership between stakeholders. Further, the second stage of the course also included the contest of projects on main aspects of transition to municipal administration based on sustainable development principles.

The most significant results of the course are as follows:

- The trainees deepened their knowledge of the essence and principles of sustainable development;
- The trainees obtained a comprehensive view of a pilot project;
- Facilitators refined their research hypotheses;
- Both trainees and facilitators acknowledged the importance of the transition to administering a municipality based on the sustainable development principles.

Conducted research, which included testing of the business simulation, as well as the practical experience related to sustainable development, was used as a prerequisite for developing and implementing of the pilot project. The objective of the project was to form and establish the system of municipal administration based on sustainable development principles in the Sakhalin Region.

Potential benefits of the pilot project are outlined below:

- Decision-making focused on both current and future development factors, which ensures balanced, long-term, and effective operation of the municipality;
- Optimal resource utilization, rapid and effective adaptation to changing circumstances and conditions of a modern life;
- Improvement of self-awareness and education across the community;
- Improvement of competence of municipal workers;
- Involvement of all stakeholders in the quality of live improvement across the municipality;
- Establishment of the social partnership system and, consequently, evening-out of contradicting interests and avoidance of conflicts;
- Establishment of the system of municipal strategic management;
- Improvement of the investment attractiveness of the territory;
- Opportunity to look at existing problems from a different point of view and, hence, to find solutions to these problems.

In the end, implementation of the pilot project will contribute to sustainable development and improvement of the quality of life of the municipality.

5 Conclusion

The effectiveness of education for sustainable development is significantly improved through

- Applying the systems approach as a methodological basis for examination and research of sustainable development processes;
- Developing a simulation model and a business game based on the systematic presentation of sustainable development processes;
- Conducting experiments utilizing the business simulation game.

This is verified through the practical realization of educational programs using methodology described above among various categories of participants (undergraduate and graduate students, stakeholders in sustainable development processes).

The systems approach to examination and research of sustainable development processes, as well as the series of experiments conducted using the business simulation game allowed of performing a comprehensive analysis of the essence of sustainable development, i.e. understanding the complexity on the one hand, and emphasizing the most important and essential in these processes on the other. This methodology has a vast potential for analyzing various aspects of sustainable development.

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Author Biography

Professor Ken Sik To has spent 10 years teaching, researching, and implementing projects on sustainable development. He received his doctorate in economics in 2006 where he researched, inter alia, the matters of sustainable development of an industrial enterprise. He is the author of over 20 research papers on sustainable development, including monograph "A Systems Approach to Examining and Managing Sustainable Development Processes". He developed "Stakeholders and Sustainable Development" business simulation game. Prof. To oversees educational programs on sustainable development in Sakhalin State University. He is the developer of the pilot project on municipal administration based on sustainable development principles in the Sakhalin Region.

Education for Sustainable Development and Belarusian Higher Education: When the State Dominates

Aliaksandr Novikau

Abstract

This study analyzes the evolution of higher education for sustainable development (ESD) in the Republic of Belarus during the United Nations Decade of Education for Sustainable Development—from 2005 to 2014. Although this process is still ongoing, and Belarus, like many other countries, has made a commitment to include ESD in its post-2014 development agenda, after a decade of ESD implementation in Belarusian universities, it is now possible to identify public policies, significant achievements, and the best ESD practices in the country. The purpose of this study is to analyze the major phases, actors, and factors that influenced the development of ESD in Belarusian higher education.

Keywords

Education for sustainable development · Belarus · State

1 Introduction

As stated in the Universal Declaration of Human Rights, education is a fundamental human right (United Nations 1948). Moreover, education is an essential tool for good governance and democratic decision-making (UNECE 2005). Due to an ongoing world environmental crisis, the exhaustion of supporting ecosystems, and the fear that future generations may not be able to meet their needs, education is

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increasingly viewed as a prerequisite for achieving sustainable development goals (United Nations 2003). Education for sustainable development (ESD) means integrating key sustainable development issues into teaching and learning. The purpose of ESD, therefore, is to motivate and empower learners and shift their values in order to change their behavior. Correspondingly, it develops and strengthens the capacity of individuals, groups, communities, organizations and countries to make sustainable choices (Leal Filho 2010a). Ultimately, it empowers people to take action for sustainable development and to make our world a safer, healthier, and more comfortable place. This can improve the quality of life of all human beings (UNECE 2005; UNESCO 2015).

Universities, where new generations receive their higher education, play a key role in their countries' progress towards sustainable development goals (van Weenen 2000; Martin and Jucker 2005; Leal Filho 2010b). ESD is especially important in Europe, the continent with the highest concentration of industrialized nations (Leal Filho 2010a). This need is even more urgent for post-Communist European countries because they have a long history of extensive, unsustainable development during the communist era. Many economic and political factors were responsible for environmental degradation in Eastern Europe under the communist regimes, including natural resources inefficiency, the unwillingness of leaders to implement the appropriate standards to control pollution, censorship in the media, and limited public participation in policy-making (Dominick 1998).

All countries, even those located in a same geographic region, tend to be characterized by the heterogeneous nature of their approaches to ESD in higher education, but even among Eastern European countries, Belarus has a unique history of environmental degradation, distinctive political and social systems, and, most importantly, a very specific approach to public policy-making, including education. Essentially, the Belarusian government still holds almost a monopolistic place in higher education and actively excludes other, non-state actors from educational processes. This makes Belarus an interesting case study of the complex relationships between political structure, dominant social values, international factors, environmental history, and ESD.

The purpose of this study, therefore, is to analyze the major phases, key actors, and factors that influenced the development of ESD in the Republic of Belarus. The goal of the study is to go beyond just giving a description of ESD in Belarusian higher education, however. This case study attempts to explain the broader phenomena of causal relationships between political and social factors, both domestic and international, and the local ESD dynamics.

2 System of Higher Education in Belarus

The Belarusian system of higher education is a successor to the Soviet system and preserves many of its features. As of 2016, there are 52 institutions of higher education in the country. Among them, 33 institutions officially hold the title of

university. The current system of higher education in Belarus is heavily regulated by the government. Most of the institutions of higher education are embedded in the structure of the Ministry of Education. State-run universities and institutes dominate in number (43 vs. 9 private) and in the number of enrolled students (328,300 students in state-run institutions vs. 34,600 in private ones) (Ministry of Education 2016). Like other state owned organizations, Belarusian universities have a clear hierarchical, highly bureaucratic structure, with little, if any, academic freedom. Most importantly, the Belarusian state totally controls academic life by appointing the heads of the institutions and approving curricula. This influence is also present in the private institutions of higher education, albeit to a lesser degree.

Isolationist tendencies in Belarusian foreign policy inevitably affect relationships between the Belarusian system of higher of education and international organizations and universities. Although Belarus participates in many international agreements, and ESD is a good example of this, its involvement in international co-operation, especially with the European Union and other Western countries, is weak. For instance, Belarus did not join the European Higher Education Area (Bologna Accord) until May 2015, after all other European countries. Furthermore, because of the extremely high level of state monopoly on international relations and higher education, all international contacts of the Belarusian universities, and especially those receiving foreign aid, are strongly supervised by the authorities. In most cases, the state's approval for foreign finance is required (Pospieszna 2014).

3 Methodology and Limitations

For this study, I use a qualitative, case-oriented research design. A case oriented approach tends to explore a small number of cases, and then, by developing theoretical explanation to gain knowledge about large class of similar phenomena (Ragin 1992, 2000). The case-oriented approach considers each country as complex and therefore unique social and political entity. Hence, increasing in the number of countries brings about an increase in the number of external variables too. This is why generalization and theorization are provided by "ideal types", or abstract models of real life phenomena, rather than by statistical calculation. This can lead to a refining of the existing hypothesis or to the creation of a new hypotheses (Vennesson 2008). In this study, the methodological approach imposed some limitations. Specifically, the findings of the study are limited to the Republic of Belarus in a particular period from 2004 to 2014. The findings cannot be generalized to the entire international system, which is composed of diverse nations with potentially differing approaches to ESD.

The research method used in this study consisted of document analysis using written records. Specifically, I used episodic records that are not part of any systematic record-keeping program. This data collection process resulted in some limitations as well (Johnson and Reynolds 2005).

4 Results and Analysis

4.1 History of ESD in Belarus

The history of education for sustainable development in Belarusian institutions of higher education can be traced back to the early 1990s when the first environmental educational programs were implemented in Belarusian universities. In March 1991, the Council of Ministers of Belarus approved the Program for Environmental Education for 1991 through 1995 and made environmental sciences courses compulsory in all educational institutions, including universities. The law "On Environmental Protection" of 1992, among other measures, required the creation of systems of continuous public environmental education and environmental awareness. It also mandated the incorporation of fundamentals of environmental protection and natural resource management into academic programs of Belarusian universities.

Another important step in integrating ESD into the Belarusian system of higher education was the 2004 adoption of the National Strategy for Sustainable Development for the period to 2020. The Strategy included provisions to improve education in order to achieve sustainability goals such as public knowledge of legal and ethical standards towards the environment and society, and the ability to apply this knowledge in professional activities and everyday life. Moreover, the document specifically addressed the importance of environmental education for sustainability and had a chapter explicitly devoted to it. The Strategy emphasized the need for a system of continuous environmental education—beginning from pre-school to higher and post-graduate education (National Sustainable Development Commission of Belarus 2004).

Yet, until the mid-2000s, the term ESD was almost never present in Belarusian educational discourse. ESD as an official concept was included in official educational lexicon in Belarus shortly after the Meeting of Environment and Education Ministries in March 2005 in Lithuania. During that event, the United Nations Economic Commission for Europe (UNECE) Strategy for Education for Sustainable Development was adopted by many European countries. The mandate to develop the Strategy derived from the statement made by the UNECE Environment Ministers at their fifth conference "Environment for Europe" in 2003. In particular, the Strategy obligated the signees "to develop and incorporate ESD into their formal education systems, in all relevant subjects, and in formal and informal education" (UNECE 2005 p. 2). The Strategy specified that "Higher education should contribute significantly to ESD in the development of appropriate knowledge and competences" (UNECE 2005 p. 5). It emphasized that it is especially important to integrate principles of sustainable development in early teacher training.

In April 2005, ESD was officially launched in the post-Soviet region, and at that time, the prospects for ESD in Belarus were quite optimistic. Like the other Eastern European countries, Belarus had good pre-conditions for implementing the Strategy, including high levels of literacy among the lay public and a developed system of higher education with world famous academic institutions employing

professional educators and scientists (UNECE 2005). Moreover, because of steps made in the 1990s, the country already had some experience in implementing environmental educational programs in higher education.

4.2 Legal and Institutional Frameworks

After Belarus joined the UNECE Strategy for Education for Sustainable Development, changes were immediately made to the legal acts and institutional structure of Belarusian higher education.

The Ministry of Education, a primary governmental agency responsible for public educational policies, including higher education, was assigned responsibility for ESD implementation in Belarusian universities. Specifically, the Ministry has become accountable for the coordination of all ESD activities, development of academic programs, approval of curricula and handbooks, and professional development of teachers. In 2007, the Inter-Agency Coordination Center for ESD was created at the Ministry of Education. It consisted of representatives of several ministries, educational institutions, NGOs, and the mass media. Additionally, in the same year, "The National Program for Environmental Awareness for 2007–2012" was approved. The Ministry for Natural Resources and Environmental Protection was given responsibility for its implementation.

At the same time, however, many important legal acts that direct higher education in Belarus were not amended with provisions concerning ESD. For instance, the Education Code of the Republic of Belarus postulates main principles of the system of education, including environmental orientation in education. Yet the term *education for sustainable development* is not mentioned in the document. There are no definitions of *environmental education* and *education for sustainable development* in any other legal documents of the Ministry of Education and the Ministry of Natural Resources and Environmental Protection.

In 2015, a new National Strategy of Sustainable Social and Economic Development of the Republic Belarus until 2030 was adopted. In contrast to the National Strategy of 2004, this version includes the Chapter "Education for Sustainable Development," which prioritizes a quality system of environmental education that would fulfil requirements for the country's post-industrial economy and sustainable development. As in the earlier Strategy, it prescribes a system of continuous education, including higher education (Economy Research Institute 2015).

4.3 ESD Curricula

In Belarus, all academic programs must be developed and implemented according to national educational standards and the Education Code. Although a development of ESD curricula can be initiated by universities, at the next stage, the drafts of curricula must be forwarded to the Ministry of Education and have to be approved

by its Presidium of the Scientific and Methodological Council. However, the Belarusian educational standards do not have provisions concerning ESD. Although some elements of ESD, such as natural resource management, healthy lifestyle, and biosphere assessment are included in educational goals, there is no systemic approach to including sustainable themes in academic curricula.

As a result, ESD in Belarusian higher education is chiefly addressed through special programs and courses. For example, the special course *Sustainable Development* was developed at Belarusian State Economic University. This course is targeted to college students majoring in economic and environmental sciences. It presents a modern model of global development; shows the scientific and methodological approaches to the development of criteria and indicators for measuring the stability of social, environmental and economic systems; and recounts the main provisions of national strategies for sustainable socio-economic development of Belarus. At Belarusian State University, a course *Sustainable Development and Environmental Policy* was developed for the Master's in Geoecology (Environmental Geology) program.

4.4 International Sakharov Environmental Institute

The Chernobyl nuclear accident of 1986 determined the focus of Belarusian environmental policy (Novikau 2015). Even though the Chernobyl Nuclear Power Plant was located in neighboring Ukraine, Belarus suffered the most among all Soviet republics from the massive releases of radioactive materials because of the prevailing winds and rainfalls in the first days after the nuclear accident. As a result, about 23 % of the Belarusian territory was contaminated by radionuclides that caused serious health risks for thousands of people. More than 100,000 people were relocated to other regions. Yet hundreds of thousands Belarusians remained in the territory contaminated with radionuclides, which led to greater awareness about environmental risks, especially from radiation, and new approaches to sustainable living in the contaminated territories.

One of the follow-ups of the Chernobyl disaster was the establishment in 1992 of the International Sakharov Higher College on Radioecology at Belarusian State University. This institution of higher education was focused on teaching specialists in the areas of radiation protection and nuclear physics. The College soon became an educational institution with—for that time—revolutionary levels of academic freedom, independent curriculum, student governance, and international cooperation. In 1994, the College spun off from Belarusian State University and became an independent educational institution—the International Institute on Radioecology. Since then, the scope of the institute has been extended, and new majors in environmental, medical and biological sciences, and information technologies have been introduced. Gradually, the Institute has become a national leader in the field of environmental education and research. Consequently, in 1999 it was renamed International Sakharov Environmental University.

Not surprisingly, International Sakharov Environmental University was appointed as the national leader of the UNECE Strategy for ESD. In 2005, the conference of ministers of education of the Commonwealth of Independent States designated International Sakharov Environmental University as its base organization for environmental education. In 2008, by the decision of the Inter-agency Coordination Center for ESD at the Ministry of Education, International Sakharov Environmental University became the base for the Coordination Center "Education for Sustainable Development," which was created to research and disseminate international and Belarusian ESD experience. The Center is responsible for researching and developing new forms and methods of ESD in the education process; organizing conferences, seminars, and round tables on ESD and environmental education; and collaborating with all ESD stakeholders such as educational institutions, NGOs, and the media.

Meanwhile, beginning in the late 1990s, the university has lost many of its initial innovative features, including its vast international contacts, academic freedom, and student governance. Steadily, the university has become totally incorporated into the hierarchical, bureaucratic state educational system with little if any difference from other classic state-run universities. Finally, in May 2015, the Council of Ministers ordered the removal of International Sakharov Environmental University from the list of universities, merged it again with Belarusian State University, and re-named it International Sakharov Environmental Institute.

4.5 Baltic University Program

Another important initiative that has heavily influenced the dynamic of ESD in Belarus is the Baltic University Program, which was established in 1991. Currently, it is a network of more than 200 universities in the Baltic Sea region, coordinated by the secretariat at Uppsala University, Sweden. One of its goals is to promote and support ecological sustainable development in the region (BUP 2016). The program assists those who teach courses related to sustainable development. The Baltic University Program has developed the following courses and relevant teaching materials: Baltic Sea Environment/Environmental Science, Peoples of the Baltic/Regional Development, A Sustainable Baltic Region, Sustainable Water Management, Environmental English, Environmental Management, Ecosystem Health, and Sustainable Agriculture (BUP 2015). On a regular basis, the program also runs methodological seminars and conferences for instructors and student environmental camps. Twenty-seven Belarusian universities participate in the program. The Department of Environmental Management (Institute of Continuing Education) at Belarusian State University serves as the National Center for the Baltic University Program in Belarus.

4.6 ESD Funding

After joining the UNECE Strategy, the Belarusian state has participated in financing ESD development in Belarus. For instance, from 2005 to 2010, the government of Belarus gave $150,000 for ESD research and development. However, the government has never been a primary source of funding of ESD in Belarus. The majority of projects have been funded by intergovernmental and international organizations such as the United Nations Development Program, the European Commission, the Organization for Security and Cooperation in Europe, and the governments of Germany, the Netherlands, Norway, and Sweden (UNECE 2010).

4.7 Problems and Areas of Concern

Numerous factors influenced the development of ESD in Belarusian higher education. Yet, all of Belarusian ESD's successes and challenges in higher education are associated with the structure of Belarusian higher education and the country's general approaches to public policies.

Governmental agencies can play a positive role in promoting and implementing ESD in higher education. Addressing diverse themes in ESD requires coordination and collaborative efforts among many stakeholders, including state-run organizations. National governments can produce guidance documents on ESD that direct a general understanding of ESD's place in the educational system, its goals, and the means to achieve them. In addition, national governments can positively affect ESD by establishing official inter-agencies structures at the Ministerial or Sub-Ministerial levels. These structures can coordinate ESD efforts throughout the country. Finally, the state can provide financial support to ESD projects (Leal Filho 2010a).

On the one hand, because of the highly hierarchical structure of the system of education in Belarus, the government had the ability to address ESD relatively easily through top-down commands. In fact, when Belarus joined the UNECE Strategy and the top governmental officials made a decision to implement ESD in higher education, the required steps were made in a timely fashion. First, the Ministry of Education established inter-agency structures such as the Inter-Agency Coordination Center for ESD at the Ministry of Education and the Coordination Center "Education for Sustainable Development" at International Sakharov Environmental University. Second, government funding, albeit quite limited, was provided for ESD research and development. Finally, steps were made towards the development of the National Action Plan for Implementation of the UNECE Strategy for ESD.

On the other hand, the top-down nature of public policy in Belarus has also had a clearly negative impact, and, in many respects, is responsible for higher education's status as the weakest link in the system-wide implementation of ESD. The absence of flexibility at the lower, university, and individual educator levels created a

situation in which college professors were just passive transmitters of the top-down decisions. The top-down approach to policy making is also responsible for an absolute dominance of theoretical concepts in Belarusian ESD over their implementation into everyday practices. For instance, there is a very low transfer of sustainable development concepts from university auditoriums to the student's life (e.g., development of environmentally friendly projects on campuses).

It is significant that the development of ESD in Belarus was triggered and supported by foreign factors such as joining the UNECE Strategy and the ongoing financing of ESD projects from foreign sources. Although the Belarusian government provided some financing for ESD projects, its share is insignificant compared to the funding from foreign institutions. As a result, development of ESD in Belarus has become extremely depended on external funding.

The UNECE Strategy assumes that Europe universally "has a wealth of experience in international cooperation on education, especially in higher education. A number of national and sub-regional networks, education, working groups, networks and associations of universities, programs and partnerships have started work on the development of multidisciplinary forms of education to devise solutions to the problems linked to sustainable development" (UNECE 2005 p. 12). Unfortunately, many of these optimistic assumptions do not apply to Belarus.

For instance, the UNECE strategy explicitly requires multi-stakeholder cooperation and partnership, in particular, with NGOs (UNECE 2005). In Belarus, this cooperation between state-run universities and NGOs is complicated because of difficult relationships between the Belarusian state and civil society. The state views environmental NGOs as incompetent, intrusive, and sometimes hostile agents and actively excludes them from the decision-making process (Novikau 2015). As a result, state-run universities often refrain from collaboration with NGOs.

After ten years, there is still very weak collaboration even among the relevant governmental agencies. Although coordination between the Ministry of Education and the Ministry of Natural Resources and Environmental Protection is mentioned in many official documents, in fact, coordination between these governmental agencies is tenuous. Collaboration among Belarusian universities in the area of ESD is also a challenge because Belarus's institutions of higher education sometimes view each other as competitors for external resources, and they rarely share their findings and best practices.

Another area of concern is related to the definition of goals of ESD and their reflection in Belarusian official documents. According to the UNECE Strategy for ESD (2005), sustainable development includes numerous key themes such as, "poverty alleviation, citizenship, peace, ethics, responsibility in local and global contexts, democracy and governance, justice, security, human rights, health, gender equity, cultural diversity, rural and urban development, economy, production and consumption patterns, corporate responsibility, environmental protection, natural resource management, and biological and landscape diversity." Yet, because of the authoritarian nature of Belarusian politics, explicit pro-democratic aspirations such

as "democracy and governance," "human rights," and "justice" can provoke a hostile reaction from the Belarusian authorities (Pospieszna 2014). As a result, these key provisions for ESD were removed from many official documents and reports, and were not implemented.

5 Conclusion

Even after 10 years of ESD implementation in Belarus, ESD remains a peripheral and opaque element in Belarusian higher education. In Belarus, ESD is not included in national curricula and national standards, so it is not present at all levels of formal education. In fact, ESD has been chiefly implemented in the system of secondary and vocational education and has been almost completely absent in the system of higher education. The only exception has been the International Sakharov Environmental Institute, where ESD has become of part of the environmental curricula. The existing official systems to assess and improve higher education do not support ESD, however. The implementation of ESD in Belarus was heavily influenced by the dominant role of the state and its agencies in the system of higher education.

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Building Climate Change Resilience in East African University Campuses

Denise Galvin, Walter Leal Filho, Cristina Beans and Roberto Escarré

Abstract

Strengthening climate change resilience in Africa is of real concern. Energy demand across the continent is on the rise due to expanding populations, economic progress and lifestyle changes. Without a sustainable increase in supply, much needed economic growth will be reined in. Africa, because of its renewable energy resource base, is in a unique position to pursue sustainable energy development which can be a determinant of climate change resilience. However, the eastern region of the contintent is facing serious energy deficits and high energy costs. The ENRICH and the SUCCEED Network Projects, funded through the European Union's EU—ACP cooperation S&T and Edulink II instruments, aim to plant the seeds of change through increased capacity in sustainable energy development. Output from these projects takes the form of an STI support network and development of university campuses as 'living laboratories'. These new and 'dynamic systems' have inbuilt engineered resilience to foster efficiency and as they evolve, natural resilience to promote rapid adaptation to cope with existing and emerging knowledge and informational vulnerabilities. This paper considers how such responses at campus level can strengthen resilience at national level to mitigate the effects of climate change.

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Climate change resilience · Vulnerability · STI support network · Living laboratories · Adaptation

1 Introduction

Climate change threatens human development, by increasing risks to human health, social and economic welfare, and availability of natural resources. Therefore, countries must be prepared to respond to these threats today and in the future. For example, the European Union has been investing 20 % of its spending over the 2014–2020 period in instruments that contribute to strengthen energy security and build a low-carbon, resource-efficient and climate resilient economy (CDP 2014). The concept '**resilience**' originated within ecology and when applied in the field of social-ecological systems (Gallopın 2006) is defined as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change" (IPCC 2007). **Climate resilience** is the capacity of a system to "anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions" (IPCC 2012). It also refers to the capacity of a system for learning (Walker et al. 2002) and to proactive capabilities to change, search for new options (Obrist et al. 2010), and 'expect the unexpected' (O'Brien et al. 2012).

Despite the fact that a society may be able to cope with change from a social perspective (e.g. increasing agricultural subsidies), a resilience approach also implies the inclusion of the sustainability of the adaptation from an ecological perspective (e.g. the ecological impacts of increased farming and groundwater pumping) (Folke 2006). System vulnerability to climate change and climate variability (e.g. extreme events) directly depends on the degree of system resilience (USAID Global Climate Change Office 2014). The less resilient a system is, the more it is vulnerable to smaller disturbances that could be previously coped with. Moreover, gradually changing conditions (e.g. nutrient loading, climate, habitat fragmentation) can surpass threshold levels, triggering an abrupt system response (Resilience Alliance 2016).

Exceeding thresholds or tipping points associated with social and/or natural systems poses limits to resilience (IPCC 2012). Another challenge to enhancing system resilience is to determine how responses to any single stressor influences the system's ability to absorb shocks or perturbations, adapt to current and future changes, and learn (O'Brien et al. 2012). Among the sources of resilience, the authors name the following factors:

- Social networks;
- Remittances and social security payments;
- Lessons learned from similar past events, (e.g. honed emergency mechanism) or/and past mistakes;

- Promotion of urgent learning from each experience accompanied by a willingness to learn from national and international support networks; and
- Intense awareness of critical thresholds.
- The ability to adapt increases together with sources of resilience (Nelson et al. 2007).

Resilience in Universities Universities address the subject matter of climate resilience in different ways. In the academic and research realm, they have been extending the curriculum by integrating courses in climate change adaptation and resilience, environmental site assessment, sustainable community planning, and building sustainable organizations as the Antioch University New England (USA) (Antioch University New England 2016), or by conducting extensive research in adaptation to climate change and experiments on the resilience of forest and rangeland ecosystems to climate changes to help inform adaptive management of natural resources as the University of Arizona (USA) (Higher Education Climate Adaptation Committee 2011). They have also been addressing issues such as energy, which have a strong climate focus.

The Institute for Climate Change and Agriculture (ICCA) at Cornell University (USA) facilitates research, education, and outreach, to help farmers to become more resilient to climate change (Cornell University 2013). The University of Manchester (UK) in the framework of the RESIN project participates in the development of approaches to enhance the resilience of Europe's cities and urban critical infrastructure to extreme weather and climate change. Among its key contributions are:

- Creating and testing a 'city typology' that will characterise cities according to factors linked to adaptation and resilience; and
- Cooperating with the Association of Greater Manchester Authorities (AGMA), and other bodies across the Greater Manchester region, to explore the climate resilience of the conurbation's critical infrastructure systems and support the development and testing of decision support tools (University of Manchester 2016).

Universities also collaborate with leaders of local communities to improve the resilience of the region's infrastructure, energy, water, food, and transportation systems (Higher Education Climate Adaptation Committee 2011). For example, Cornell University is a partner of local, regional, and state-wide planning initiatives that address challenges posed by climate change and increase resilience (Cornell University 2013).

Colleges and universities also take various steps to improve resilience of their campuses, namely, to increase their capacity to anticipate, prepare for, continue operations during, and recover from natural disasters, or other human-caused crises. In the United States university leaders joined together to endorse the **Alliance for Resilient Campuses initiative** (ARC) focused on climate adaptation and resilience on campuses (Solutions 2014). Among the components of the alliance are:

- **Evaluation of risk and vulnerability for campuses and sharing insight to assessing risk**, along with valuation adaptation priorities; and
- **Evaluation of progress and filling of knowledge gaps** and development of a prototype or tools to track and measure success in increasing resilience and adapting to a changing climate (National Association of College and University Business Officers 2014).

ARC, which is also a partner with the Resilient Communities for America, provides a platform for developing flexible and state-of-the-art guidance and support for assessment, learning, implementation, and evaluation with respect to adaptation and resilience (Solutions 2014).

Another example is establishment of the Disaster Resilient Universities (DRU) Network hosted by the University of Oregon Emergency Management Program. The network facilitates open communication, discussion, and resource sharing (e.g. templates or examples, After Action reports, lessons learned, best practices, case studies) to increase communication, coordination, and collaboration between universities to make campuses more disaster resilient (University of Oregon 2016).

Independently, universities also take measures to increase their resilience. For example, **Cornell University** as a part of its Climate Action Plan conducts vulnerability assessments and climate adaptation planning to minimize disruptions to campus as a result of extreme weather events and increased flood risks (Cornell University 2016). The **Massachusetts Institute of Technology** (USA) along with **Harvard University** (USA) and the City of Cambridge, founded the Cambridge Compact for a Sustainable Future. Under the umbrella of the Compact, a Climate Resiliency Working Group was launched. One of the goals of the group is to build a common language of metrics, definitions, and objectives around climate resilience, as well to make a clearer picture of what a collaborative, cross-sectorial climate resiliency plan could look like (MIT Office of Sustainability Massachusetts Institute of Technology 2015).

Among the goals stated in **Harvard University's Sustainability Plan** for the years 2015–2020 are:

- Development of standards for climate preparedness and campus resilience that apply to new and existing building design and critical infrastructure by 2016; and
- Development of a University-wide Climate Preparedness and Campus Resilience Plan by 2020 (Harvard University 2015).

Boston University is currently planning to develop a campus climate risk and preparedness assessment and resiliency strategy and incorporate climate resilience planning for new projects (Boston University 2013). These are just a few examples of the kinds of initiatives established in higher education sectors across the globe to assist with building climate change resilience.

2 Setting the Scene—Energy Development and Energy Needs in Africa

Moving away from climate change and from the industralised world, and zooming towards developing nations and in at energy issues in particular, it can be seen that the commendable GDP growth rates and investments in energy generation recently observed in Africa are particularly symbolic for future energy development strategies. Due to a lack of private sector capital, governments have been willing to bear the investment, financial and operational risks involved in such large projects —albeit under significantly limited capacity constraints. Despite this unprecedented economic growth and investments in the energy sector the African continent lacks adequate infrastructure, and severely underperforms in the generation of and access to energy in a global context. According to the International Renewable Energy Agency (IRENA), average per capita electricity consumption in sub-Saharan Africa (excluding South Africa) is just 153 kWh/year, which is roughly 6 % of the global average. Furthermore, IRENA notes that the continent will need to add around 250 GW of capacity between now and 2030 to cope with a continuously increasing demand. This implies that capacity additions will have to roughly double to around 7 GW annually. In fact, the incumbent President of the African Development Bank has stated that unless this energy deficit can be solved in the short-term, the prosperity of the continent is under serious threat (Financial Times October 2015).

While electricity generation has increased in most countries across the continent, distribution issues and disruptions limit the extent to which the general population have benefitted from increased capacity. In many countries the overall electrification rate remains low. In addition, frequent disruptions to supply translate into detrimental effects on industry which in turn affects commercial output. The inadequate transmission and distribution networks in most African countries generally only allow for electrification in urban centres. Consequently, in many countries the majority of the population still has no access to electricity. The Quality of Electricity Supply in Africa in 2007 versus 2015 graph provided in Fig. 1 compares the results from the World Economic Forum's (WEF) 2014/15 Global Competitiveness Report (GCR) with that of the GCR 2006/07 to illustrate any deterioration or improvement in the quality of electricity supply score. Despite the gloomy scenario painted at continental level, some African countries, most notably Zambia, Uganda, Gambia and Kenya have taken significant steps to improve their scores over the period.

Notwithstanding these improvements, Fig. 1 clearly illustrates there is considerable variation in electricity generation between African countries. While South Africa and Egypt accounted for nearly 60 % of the continent's total generation in 2012, twenty seven countries—which represents more than half the African nations—only contribute around 1 % of the continent's overall generation. Kenya, which has East Africa's most developed economy performs commendably in terms of electricity generation in an African context. However, with an estimated annual per capita electricity usage of 150 kWh and when compared with the estimated

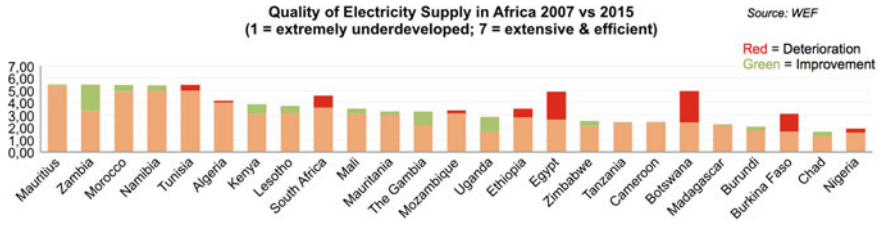

Fig. 1 *Source* World economic forum global competitiveness 2014–2015, published in KPMG Sector Report Power in Africa 2015

global average annual figure of 2550 kWh, the Kenyan performance is quite poor. It also needs to be noted that much of the generated electricity flows directly to the extractive industry, bypassing a significant percentage of the population.

Although electricity generation has steadily increased on the African continent, rising by 48 % to reach just over 680 billion kWh in 2012 electricity consumption has followed a similar path, increasing by 47 % over the period to reach 600 billion kWh. As electricity consumption is much higher than generation capacity in some countries, there is a tendency to import electricity to maintain current consumption levels which pushes up end user costs thus affecting access capacities, as well as the ability to pay on the consumer end of the supply chain. Subsequently, there is a real need for greater investment in innovative solutions from indigenous renewable energy sources with which to exponentially increase off-grid supply.

A snapshot of the renewable energy generation landscape, reveals that hydro-power accounts for the highest renewable energy investment across the continent, but current projects (with total capacity of around 24 GW) only generate 5 to 10 % of the total technical potential, equivalent to 10 to 20 % of the total economically feasible potential. This is because, generally speaking, hydro-power projects can be very costly to operate. Biofuel energy production remains limited, despite the fact that the sector grew to an estimated 300 million litres in 2012. On the other hand, wind production is booming, with East Africa seeing a major bump in wind energy generation. Wind energy commitments in Kenya increased from zero in 2011 to $US1.1 billion in 2012, underscored by the Lake Turkana Wind power project which will provide 300 MW to the Kenya electrical grid. In rural Rwanda, mini-solar projects provide energy access to local schools and farmers, who would otherwise be without power.

Geothermal energy presents the greatest challenges as exploratory costs are very high for foreign investors due to the limited knowledge and informational capacity of the sector. The $US66 million Geothermal Risk Mitigation Facility for East Africa established by the African Union, the European Union-Africa Infrastructure Trust Fund and the German Ministry for Economic Cooperation, supports surface studies and exploration drilling (KPMG 2015). The hope is that this kind of risk management capital and support could bode well for the geothermal sector in the near future, potentially changing assertions of hope into reality (Davis, K. Jr, Africa.com). And, there is a real need for governments to implement legislation to

manage off-grid solar energy projects at both trans-boundary and national levels before any significant activity will occur in this sector.

The regulatory environment in Africa's energy sector is quite complex and uncoordinated, differing significantly between countries (KPMG 2015) as well as at the regional level. These regulatory impediments have come about largely due to the diversity between national economies and the plethora of attitudes shared by countries towards regional integration. Subsequently, there is a distinct lack of institutional or fiscal capacity with which to mobilise the private sector to participate in sustainable energy development which in turn poses a serious risk to the realisation of the benefits to be derived from regional integration (AFDB 2011).

Despite the recent significant advances made in renewable energy production in some of the East African countries, the region—which is home to a population of 145.5 million (2010) with a GDP of $147.5 billion (EAC Facts & Figures Report 2015)—is facing serious energy deficits and high energy costs. At national level there is a very shallow pool of infrastructure with which to produce, store and distribute energy in a sustainable way which is further exacerbated by limited regional co-operation or co-ordination when it comes to matters of energy production and usage. Moreover, national knowledge and informational capacity is severely limited and much needed foreign investment potential is hampered because of political instabilities and cross-border conflict. Subsequently, there is still a high dependence on fossil fuels which, when coupled with energy insecurity, high-carbon emission systems, as well as other critical risks and emerging vulnerabilities related to climate change, provoke a tenuous situation for the region.

3 Energy Deficits and High Usage in East Africa

Energy deficits and energy poverty have become a major obstacle to economic growth and sustainable development in East Africa. Of the twelve countries that form the East Africa region, only three have made significant steps towards increased energy output. Uganda and Kenya lead the way. However, few countries have established the necessary regulatory and institutional reform required to attract private capital to invest in new or innovative energy technology (AFDB 2015) which would seem to hold the key to increased climate change resilience for the region. In addition, there is very little tangible input or support from research institutes and academia to assist with easing the supply/consumption dilemna in the region. Yet, at the policy level, various countries in the region recognise this limited knowledge/informational capacity and have stressed the importance of quality research and innovations as being critical to improve sustainable energy development. Although there are hands-on initiatives undertaken by global NGOs to improve access to renewable energy in the region, the present mismatch between national and regional obligations for the energy sector, political decisions and societal requirements needs to be urgently addressed at the local level.

One of these iniatives, Energy+, focuses on Kenya and Tanzania, two countries that are taking significant steps towards sustainable energy access and energy efficiency. The International Energy and Climate Initiative program Energy+ supports efforts to achieve universal access to sustainable energy and reduce greenhouse gas emissions in developing partner countries by scaling up access to renewable energy sources and increasing energy efficiency. Energy+ relies on investment from public sources in order to mobilise commercial investors. Energy+ builds on the success and conceptual framework of REDD+ (reducing emissions from deforestation and forest degradation) and adopts a phased approach. Programmes such as Energy+ will go some way to both improving energy access and energy efficiency thus building climate change resilience for the populations of Kenya and Tanzania. However, other more culturally compatible at the coal-face approaches could well be the least costly and therefore preferred options for the region.

Perhaps a far more sustainable alternative would be that the governments of the East Africa nations are endowed with the capacity to develop and implement policy that supports bottom-up financing and investment in renewable energy off-grid activities in order to curb the deficits in access to energy that plague the region. IRENA (2013) has suggested that the present scale of rural demand in the region often does not justify the cost of grid expansion, rather that mini-grids and stand-alone off-grid solutions can offer a viable solution. Energy related policies need to focus on mini-grid and off-grid solutions to create the environment in which rural entrepreneurs can become small power producers, and eliminate rural access deficits. The best technical solutions for the region will be in the form of innovative approaches to ensure grid-compatibility so that at some future time mini-grids can be expanded and even integrated with the central grid. It would appear that the way forward for the countries of the East Africa region is to develop renewable energy from indigenous sources not only to improve energy self-sufficiency but to become climate change resilient.

If a country is self sufficient the countries' exposure to the price and supply volatility of imported energy is considerably reduced, and the economic vulnerability associated with the impact of volatility are more easily mitigated. Renewable energy technologies suit the East African geographic contexts as the most economical solution for off-grid and mini-grid electrification in remote areas, as well as for grid extension. While not all of the countries that make up the region are able to initiate the alternative of large-scale renewable energy projects that unlock economies of scale and improve diversification in energy generation, increased knowledge and informational capacity would help to open the doors to foreign investors who could facilitate this aim. Other tangible benefits for countries that have to deal with relatively high levels of poverty is that there is direct and indirect job creation in the renewable energy sector. Renewable energy pilot programmes can create a virtuous cycle where trained technicians become renewable energy entrepreneurs, creating new jobs and passing on their skills to others (IRENA 2013). The challenge in East Africa is to develop a cost-effective and sustainable

energy safety net for the poor and vulnerable as presently, over 50 % of the population live below the poverty line (less than $US1/day) (AFDB 2015).

These recommendations from IRENA and the AFDB are unlikely to be realised unless the distinct lack of sustainable energy development capacity in the HEI sector is corrected. There are very few relevant and updated inter-disciplinary courses in Renewable Energies and all aspects of energy efficiency across the region. For example, most resource mapping in these countries is static and therefore does not allow for all of the stakeholders to prioritise high quality renewable energy areas for development (Wu et al. 2015) because only a few universities in the region are able to offer relevant courses covering some energy topics. Although a few East African HEIs have some joint initiatives promoted by Inter-University Council for East Africa (IUCEA), relatively few are in the field of energy. Currently no HEI network exists at the regional level covering sustainability and energy topics, which leads to limited interaction between universities and the other local, regional and national stakeholders in the field of energy.

Given the somewhat limited energy knowledge and informational capacities of East African universities it is clearly apparent that if the energy emergency in the region is going to be resolved in a sustainable manner there needs to be increased support and input from this educational sector. Increased HEI and research institute capacities can help governments to develop a broader view that highlights the importance of building national climate change resilience through greater societal involvement, create institutional structures that deploy conducive policy environments framed from new knowledge and informational approaches gained in the superior education sector. Another significant benefit would be in the form of increased intellectual and technical capacities that assist managers at all levels of society to link the diverse range of adaptation options to the multiple livelihood-vulnerability risks faced by many East Africans as highlighted by Africa National Adaptation Programmes of Action and the case of the Least Developed Countries or National Climate Change Response Strategies (Niang et al. 2014) which are reporting processes that document how, why, where and the preferred course of action needs to be taken and in this case for the ongoing development of sustainable energy access and efficiency for the region.

4 Sustainable Energy Access and Efficiency for East Africa

The World Energy Council maintains that there is an energy “trilemma”—energy security, energy equity and environmental sustainability—and has stressed the importance of energy as a standalone Sustainable Development Goal, because of enduring challenges, such as the expected continued dominance of fossil fuels in the energy mix in 2050 (UN SE4ALL 2014) Sustainable energy, therefore, can be a driver of poverty reduction, social progress, equity, enhanced resilience, economic growth, and environmental sustainability (UNDP Sustainable Development Goals 2015). Energy is a master key to ensuring poverty eradication, fostering prosperity

and building climate change resilience at the same time, and thus must be a part of the Sustainable Development Goals.

Nevertheless, a commonly accepted definition of Sustainable Development is still missing from the literature. In fact, academics, professionals and community members alike agree that after working with this new social norm for many decades it is still tricky to implement in a practical sense (Galvin et al. 2006). Therefore, when it comes to linking sustainability with a dynamic and ever-changing scenario such as climate change, the concept must become a *work in progress* that encompasses the participation of all members of society. The response to the call from the World Energy Council has come in the form of the United Nations Decade of Sustainable Energy for All 2014–2024 which was launched in Kigali in May 2014. The process is underpinned by three inter-related objectives all of which need to be achieved by 2030 (United Nations 2014)

I. Ensuring universal access to modern energy services;
II. Doubling the global rate of improvement in energy efficiency;
III. Doubling the share of renewable energy in the global energy mix.

The hope is that sufficient awareness will be raised so that more renewable off-grid energy solutions emerge, that the sustainability problems related to energy production and usage will become decentralised with more bottom-up energy solutions and smaller-scale technologies that will replace high end investment mega-infrastructure energy generation projects. In other words, the raison d'être of this initiative is to encourage all levels of society to identify creative solutions that help to promote sustainable access to and efficiency in the use of energy in their home, neighbourhood, village or city. Here, energy efficiency is defined as a way of managing and restraining the growth in energy consumption. Improvements in energy efficiency can bring multiple benefits, such as enhancing the sustainability of the energy system, supporting strategic objectives for economic and social development, promoting environmental goals and increasing prosperity (IEA, Energy Efficiency 2016).

From a realistic standpoint, none of the sustainable energy development goals that form the core of SE4ALL process will come to fruition in East Africa at least unless countries are disposed to create a policy environment that is conducive for sustainable energy development. Such a move requires a national political will that is committed to the ongoing creation of an institutional context from which a conducive policy environment can emerge. This sounds like a very simplistic solution applied to solve a highly complex problem and indeed it is. Conducive policy environments that aspire to support sustainable access to and efficient usage of energy can only be created by governments whose ministries, researchers, academics, managers and professionals are able to identify the wide spectrum of energy issues that impact other types of climate change vulnerabilities. Then, to apply creative solutions to strengthen resilience that supports socio-ecological systems to adapt to existing and new climate change conditions.

Leading on from this premise, recent studies undertaken by the IPCC have identified that societies or ecosystems can be predisposed to a vast range of environmental, economic and social vulnerabilities that arise from the effects of changing weather patterns. Vulnerability is dynamic and context specific, determined by human behavior and societal organisations, which influence for example the susceptibility of people (e.g. by marginalisation) and their coping and adaptive capacities to hazards (see IPCC 2012). In this regard coping mainly refers to capacities that allow a system to protect itself in the face of adverse consequences, while adaptation—by contrast—denotes a longer term process that also involves adjustments in the system itself and refers to learning, experimentation and change (Oppenheimer et al. 2014; Angeler et al. 2011; Folke et al. 2005; Holling and Gunderson 2002).

Vulnerabilities can affect multiple interacting systems and stresses or can be emergent such as those attributable to any future land-use change emissions. Vulnerabilities are also considered to be indirect, trans-boundary and long-distance impacts. Considering the spatial convergence of multiple impacts (Oppenheimer et al. 2014) from a systemic approach, the identification of areas of compound risk could be achieved by overlaying spatial data of impacts in multiple sectors, but this cannot indicate synergistic influences and dynamic changes in these influences quantitatively as the criteria for assessment of key vulnerabilities as they are currently understood are constituted by:

(i) Exposure of a society, community, or social-ecological system to climatic stressors
(ii) Importance of the vulnerable system
(iii) Limited ability of societies or social-ecological systems to cope with and build adaptive capacities to reduce or limit the averse consequences of climate-related hazard
(iv) Persistence of vulnerable conditions and degree of irreversibility of consequences
(v) Presence of conditions that make societies highly susceptible to cumulative stressors in complex and multiple-interacting systems (Oppenheimer et al. 2014)

Subsequently, those charged with task of identifying these threats will need to be able to assess impacts from a multi-disciplinary perspective, which is an essential plank of Sustainable Development and therefore of Sustainable Energy Development.

In addition, governments need to put mitigation measures into place in order to shore-up resilience to deal with indirect, trans-boundary and long distance impacts of vulnerabilities (Oppenheimer et al. 2014). In order for societies to cope, or even better to adapt to this ongoing accretion of highly complex vulnerabilities, responses will have to underpinned by efficient learning processes that can deal with events at multiple scales, discontinuous socio-ecological structures, active learning and socio-ecological systems that have the flexibility to shift to new equilibriums in order to survive (Carpenter et al. 2002). Societies will also have to

be able to identify alternative pathways to Sustainable Energy Development (Oppenheimer et al. 2014). Given the magnitude of the energy problems in East Africa, it logically follows that only those national or regional socio-ecological systems that have the knowledge and informational capacities embedded in the system will have the adaptive capacity to overcome energy generation and usage vulnerabilities that weaken climate change resilience.

Energy access and energy efficiency (just like climate change issues) will need to mainstreamed not only into economic planning documents (Niang et al. 2014) but also other significant planning instruments such as Poverty Reduction Strategies, national Sustainable Development Charters, Africa National Adaptation Programmes of Action or any other strategic planning document that purports to establish the ground for regional or national efforts to embrace Sustainable Energy Development for the nations of East Africa. However, this kind of change will only remain in the form of a meta-physical aspiration unless practical and context appropriate action is invoked that supports the SE4ALL process. The question therefore becomes one of: what are the appropriate capacity building measures to be taken to ensure not only sustainable energy development but also climate change resilience for the East Africa region?

5 Towards Increased Climate Change Resilience—Enrich and Succeed Network Projects

Through the European Union ACP S&T and Edulink II funding instruments, which provide capacity building and technical assistance to HEIs in Africa, the Caribbean and the Pacific, two projects were launched in 2013 and 2014 to increase capacity in sustainable energy development in the region. Both the ENRICH and the SUCCEED Network projects aim to improve the capacity of five East African HEIs to take a step towards increasing climate change resilience by making a significant contribution to improve sustainable access to energy and vastly increase efficiency in energy usage. The primary output of both projects will develop into social systems that, because of their purpose, will need to be able to adapt quickly to deal with existing and emerging energy access and efficiency vulnerabilities at local, regional, national and global levels. Accordingly, these new systems have inbuilt engineered resilience to foster efficiency and as they evolve it is hoped natural resilience will promote rapid adaptation to cope with current and emerging key knowledge and informational vulnerabilities. While these two systems exist independently of each other at national level, the interlocking process that occurs through the ENRICH Project ensures that feed back from the STI support web portal and centres is directed to the on campus living laboratories.

The first is the ENRICH Project that is spread across three campuses located in Kenya, Tanzania and Uganda and also includes the African Virtual University (Nairobi). The purpose of this Project is to strengthen STI support and co-ordination between stakeholders, provide the ímpetus for the creation of three STI centres and

training in the form of capacity building measures for HEI senior management, researchers, policy makers and professionals. The network (web portal) which is already operational provides an informational framework in which new knowledge can emerge and be disseminated amongst all stakeholders. The philosophy of the Project is that through quality science, technology and innovation (STI) support services much needed co-operation between academia, researchers, industries and policy makers who work in the energy sector at national and regional level will emerge.

Project activities have been designed to proceed in three overlapping phases to ensure the quality of all Project output. The first of this three phased approach is a scoping exercise to establish the situation with research and innovation activities and to identify the way forward. This exercise is levelled at senior management of HEIs, ministries of education, science and technology, energy and industry. A second training phase strengthens capacity for HEI senior managers and researchers in the technology and innovation gaps identified in Phase 1 and supports the establishment of national STI centres. The final phase supports the knowledge enhanced trainers to adapt new information and knowledge to local contexts and the development of a regional web portal to facilitate information exchange and encourage regional cooperation. In addition, through two national round-tables and two supranational conferences with the involvement of the ministries of education, science and technology from Kenya, Tanzania and Uganda will encourage greater and on-going collaboration and dialogue at the policy making level. National workshops and round-tables will reach around 240 participants, covering representatives from the main actors of the 3 higher education systems.

The SUCCEED Network Project spreads across campuses at Makerere University, Uganda, Moi University, Kenya, Mzumbe University, Tanzania, Université de Burundi, University of Rwanda. Most unfortunately, because of the political instability in Burundi, little progress has been made to date with implementation of Project activities. The Project is geared to establish these university campuses as "living laboratories" for energy access and energy efficiency in usage. New knowledge, sustainable energy development competences and creative, as well as innovative technology will emerge through sustainable campus development platforms that foster collaborative learning and action research. The idea is to provide an on campus hands-on environment through the creation of energy efficiency units to improve capacity in policy and process for HEIs, technologies and tools, energy audits, to attract funding for projects, innovation in renewable energies and to design on-line courses. The underlying principal is to promote campus sustainability in all areas of energy access and efficiency in usage.

The flow on effect will be many more researchers, professionals, technicians and students who have acquired experience that can be applied directly to solve their real world energy issues. Internal Roundtables promoted by the Project will reach around 600 staff and students from East African partner universities. Added value takes the form of increased academic cooperation between campuses, strengthened co-operation activities in the field of energy between HEIs, as well as the relevant public and private stakeholders and an East African Higher Education Network on

Sustainable and Energy Efficient Campus Development which any other university in the region is welcome to join. Increased cooperation between campuses and external parties will be boosted by specific Roundtables with local stakeholders, reaching around 1600 participants during the life of the project.

The synergy between the systemic outputs of both projects will strengthen natural resilience at national and regional level through more frequent joint roundtables between the researchers and the policymakers, which should result in increased climate change resilience for the region through **the avoidance of lock-in** (policy decisions, technological decisions, economic decisions) as discussed by Wim Kuijken at the Deltas in Times of Climate Change Conference, 2010 (Kuijken 2010). Also, HEIs and other interested stakeholders are to be trained on how to seek out and write proposals that attract funding for future projects. Increased engineering resilience comes in the form of sustainability plans that take advantage of the energy efficiency units, dissemination of monitoring and evaluation systems, identification and sharing of good practices and energy audits. As a final engineering resilience measure online courses can be expanded to include aspects of STI support on energy access and efficiency. Online courses are expected to reach 240 students at the partner universities during the life of the project, but a multiplier effect is also expected at the end of the action. The credits from these modules will count towards degree programmes. All of this of course is supposition because not all of the activities will be ticked off until later in 2016.

5.1 Progress

Probably the most rigorous manner in which to gauge levels of Project progress thus far is to determine how campus level resilience contributes to the mitigation of the key risks and vulnerabilities that have been identified in national Rapid Assessments and Gap Analyses as part of the SE4ALL process. In this context strengthening of renewable energy and energy use efficiency capacity in the STI support centres and the on-campus living laboratories—now referred to as 'living systems'—denotes increased resilience. Campus resilience is controlled by four different kinds of mechanisms which have been built into the 'living systems' to ensure efficency (engineered resilience) and at the same time existence (natural resilience) which allows the systems to quickly adapt to new states (Holling and Gunderson 2002). Efficiency controls take the form of institutional and academic mechanisms. Networking and sustainability controls aid the living systems to adapt to new levels of stakeholder cooperation—or long term existence and support **adaptation potential**.

Presently, the literature abounds with varying definitions of risk and vulnerability as these occur in the various social, ecological or other contexts that affect the livelihoods of human or natural systems. Here the definitions of both key risks and vulnerability as applied by the IPCC have been adopted because sustainable energy development is one of the variables that will determine whether or not societies can become resilient in the face of climate change. During the classification process the

Table 1 Key system efficiency and existence risks/vulnerabilities

	Risk/vulnerabilities that affect efficiency of the system at national level	Risks/vulnerabilities that affect the existence of the system at national level
Kenya	Governance (institutions policies and enforcement capacity) Inadequate investment strategies leads to high cost of energy provision High cost of technology transfer Long lead time for geothermal power development	Lack of information relating to energy efficiency Cultural barriers to adoption of new practices; lack of local technical capacity; standards mismatch between market needs and curriculum; lack of specialised training on all aspects of renewable energies Lack of awareness and incentives perceived high risk by potential private investors
Rwanda	Governance and policy issues Financial sustainability of the eletricity generation investment Reliance on thermal energy for domestic usage Access to electricity Lack of energy efficiency	Human capacity and awareness
Tanzania	Regulatory/enabling/enforcement capacities Reliance on thermal energy for domestic usage Commercial viability for investors + tariffs	Human capacity and awareness
Uganda	Access to finance	Awareness and knowledge sharing is limited between government and stakeholders

Sources Republic of Kenya (2013); Republic of Rwanda (2014); Tanzania (2013) and The Republic of Uganda (2015)

Key Risks were weighted according to magnitude, timing, irreversibility or persistence, inhibiting ability to reduce magnitude and frequency of hazardous climatic events and trends, as well as the socio-ecological consequences of climate change (Oppenheimer et al. 2014). A first round of classifications reveals that, in East Africa where at least fifty per cent of electricity demand is met by back up generators (OECD/IEA 2014), the Key Risks were largely associated with the lack of adequate governance and policy structures which hampered access to finance to support technological advances for sustainable energy development. Table 1 provides the detail of the Key Risks that predispose East African society to vulnerabilities which have inherent social-political thresholds of concern.

In Kenya the STI support web portal is well underway and the centre has been established. These two initiatives are critical to the efficiency and longevity of the living laboratory. However, as the energy efficiency unit is not yet functioning much needed feedback required as input for on campus energy audits which have yet to be initiated is missing from the efficiency control mechanism. Also, the high cost of technology transfer and inadequate investment strategies affects the

development of alternative indigenous geothermal energy sources. Deficiencies in natural resilience have been identified as inadequate governance leading to inappropriate policy for energy issues, as well as cultural barriers to the adoption of innovative solutions to energy deficits. On the other hand, some progress has been made to ensure that natural resilience exists in the form of good practices and the development, as well as the implementation of on-line courses that hopefully, will go some way to resolving the lack of local technical capacity, eliminate the present mismatch between international and national standards and eradicate the lack of specialists in all aspects of renewable energy.

As Rwanda and Burundi are not partner countries in the ENRICH Project they do not directly benefit from the STI support web portal or the presence of a national centre. Nevertheless, access to the knowledge and information available from the web portal is available to any African university who may also provide experts and/or join the project's *East Africa Energy Access and Efficiency Network*. As mentioned above, little progress has been made in Burundi due to the political instability and they have just begun with the creation of the energy efficiency unit. In Rwanda, regarding the progress with output from the living laboratory, presently only the energy efficiency unit has been established. Rwanda therefore has to gain some ground in terms of being able to provide efficiency and existence feedback to overcome prevailing risks such as a reliance on thermal energy for domestic usage, lack of access to renewable off grid alternatives and the human capacity and awareness that will nurture suitable governance structures and the related policy output.

On the other hand Tanzania is able to take the direct benefits from the functioning of the STI support web portal and its STI national centre. Also, the on campus living laboratory receives much needed feedback from an already established energy efficiency unit, knowledge and informational cross-fertilisation from networking activities—albeit limited—and increased human capacity and awareness from the development and implementation of on-line courses. All of which should directly increase the natural resilience potential of governance structures and energy related policy output. Uganda is in a similar position with the added benefit of the adoption of good practices and greatly improved capacity in energy efficiency related to on campus energy audit experience.

6 Conclusions

Climate-resilient development helps minimize the costs and consequences of climate impacts. It looks forward and plans for the future, identifies climate stressors, utilizes appropriate climate information, reduces vulnerability, promotes flexibility and robustness. It also requires integration of new information about climate stressors into responses and development of new response options (USAID Global Climate Change Office 2014). Some of the ways that governments and organizations are adapting core systems for climate resilience are:

- Water: Increasing protection for wetlands, installing permeable pavement, and green roofs;
- Ecosystems: Planning for movement of habitat, and changes in local plants and animals;
- Agriculture: Shifting to drought resistant crop varieties, emphasizing local agriculture;
- Energy: Protecting or moving production and distribution facilities vulnerable to flooding, extreme heat, drought or weather events;
- Land Use: Changing building codes, planning 'retreat' from sea level rise; and
- Infrastructure: Ensuring current public investments, considering climate change trends and projections (Higher Education Climate Adaptation Committee 2011).

As far as energy issues are concerned, it is apparent that Africa has many coal-abundant countries, and many are facing crucial policy dilemmas relating to the use of fossil fuels, as compared to the use of renewable energy sources. Whereas African countries are concerned with the production of energy to meet their economic requirements, the pressing need to reduce CO2 emissions means that a balance needs to be found. This state of affairs is forcing African countries to define an energy strategy that departs from over-reliance on coal-generated electricity, and more towards renewable energy. Yet, it is one thing for global processes such as the United Nations' SE4ALL to aspire to deliver sustainable energy to each and every one of us and for IPCC Synthesis Reports to call on countries to find the ways in which to build climate change resilience. The reality is that in some East African countries at least the first and very complicated step is to find the means with which to overcome political, economic, social, cultural and technological barriers—amongst other key risks and vulnerabilities—that impede the replacement of thermal energy sources with indigenous renewable energy supply.

As this paper has demonstrated, the key risks/vulnerabilities that expose Burundi, Kenya, Rwanda, Tanzania and Uganda to a considerable degree of climate change related vulnerability need to be better understood and tackled. In the field of energy, there is a perceived need for stronger institutional frameworks and a conducive policy environment to address the issue of greenhouse emissions adequately. Both the ENRICH and SUCCEED Network Projects are an attempt to address this gap, but further activities are needed so that universities may be able to fulfil their role in respect of fostering a more sustainable use of energy resources and; inter alia, supporting global efforts to address climate change.

Nevertheless, university campus resilience in all areas of energy access and efficiency in usage is only the first point of departure with which to achieve these aims. Campus resilience could be co-opted by governments and other influential stakeholders as an input to help frame new governance structures, legislation and policy to focus intense awareness on key vulnerabilities, as well as to encourage a national and regional willingness to learn from other similar resilience support networks. Such a move would allow governments to identify both energy access and energy efficiency **adaptation potential** at all levels of usage. Thus avoiding

political, economic, and technological lock-into solutions that weaken national and regional resilience.

However, the required strengthening of resilience will not manifest unless East African university campuses receive additional manpower and financial backing. Strengthening of resilience at campus, national and regional levels is also inextricably linked to a notable move towards the creation of far more multi-disciplinary degree programmes that equip tomorrow's researchers, professional and technicians to think, analyse and act in a way that does not compromise ongoing sustainable energy development for the African continent. Namely, to increase their capacity to anticipate, prepare for, continue operations during, and recover from natural disasters, or other human-caused crises invoked by climate change.

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Higher Education and Sustainable Development: An Exploratory Study of Indian Management Institutions

Neetu Yadav and Vanita Yadav

"Education for Sustainable Development is not an option, but a priority".

—UNESCO

Abstract

The objective of this paper is to explore the applicability of sustainability education in the Indian higher education sector. Specifically, we examine Business Management curriculum innovation for sustainability education with an emphasis on course design, content, and delivery mechanism. This study is exploratory in nature and adopts content analysis methodology for analyzing primary data from semi-structured interviews and secondary data from university websites and reports. Our findings reveal that sustainability education initiatives in Indian Business Management schools and departments attempts to create an understanding and build competence on social, environmental, and sustainable aspects of business. But there is still a very long way to go. The objective of self-reflection in students for the betterment of community and planet earth is yet to be achieved by the way of participative and engaged learning.

Keywords

Higher education · Sustainable development · Indian management courses · Content analysis · Sustainability education

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1 Introduction

Indian higher education has played a pivotal role in strengthening the country in terms of creating numerous managers, leaders and entrepreneurs. In particular, evolution of premier management institutions in India, like the IIMs (Indian Institutes of Management), has helped realize the vision of educating and creating successful business leaders in India. Management education in these premier Indian institutions has catered to the ever-changing demands of business environment through their inter-disciplinary curriculum. Management institutions in India have realized their responsibility to equip future managers with business skills along with moral values. As a result, graduate level education on Business Ethics and CSR (Corporate Social Responsibilities) have become mainstream in many management education institutions and management departments in Indian Universities.

In December, 2002, the United Nations proclaimed 2005–14 as *UN decade of Education for Sustainable Development* (DESD) emphasizing education as an indispensable element for achieving sustainable development (UNESCO 2005). The goal was to "integrate values, activities and principles that are inherently linked to sustainable development into all forms of education and learning" (UNESCO 2007: p. 5). Various efforts have been undertaken to redefine the kind of education that would bring about changes for sustainable development (Scott and Gough 2003; Sarabhai 2005; Sterling 2009). Sustainable development concept has evolved beyond just recycling and installing solar panels to encompass individuals and communities that engage with the planet in a positive sustainable manner. In line with this thinking, premier Indian management institutions have initiated numerous courses, modules and specialized MBA programs pertaining to the concept of sustainability and sustainable development.

The research objective of this study is to explore the applicability of sustainability education in India. The scope of this study is the higher education sector, specifically the premier Business Schools and Management departments in India. We explore Business Management curriculum innovation for sustainability education with an emphasis on course design, content, and delivery mechanism. The article is structured as follows: the first section details the background of the study and the second section discusses the major developments in sustainability education in Indian higher education. The third section describes design of the study and section four presents the analysis of data. Section five highlights the major findings of the study and finally conclusions are drawn in the last section.

2 Sustainable Development Education

2.1 Relevance of Sustainable Development in Higher Education Worldwide

The classical definition of "sustainable development" given by Brundtland Commission report (1987) states: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN 1987, p. 24). This concept requires higher education to think of integrated ways to inter-link natural and cultural environments (Chhokar 2010). For the business, it has been realized to look beyond merely one bottom line, i.e. profit to triple bottom line, i.e. *people, planet, and profit* (Elkington 1997).

There is a pressing need to adopt sustainable development as a legitimate requirement for the industry today as there are concern for societal issues and UNSCO initiatives. As a result, sustainability concept has evolved in higher education and management curriculum. Report and Declaration of The Presidents Conference (1990) suggests that "Universities educate most of the people who develop and manage society's institutions. For this reason, universities bear profound responsibilities to increase the awareness, knowledge, technologies, and tools to create an environmentally sustainable future". Education for sustainable development emphasizes to rebuild educational programs and systems for lifelong learning and recognizes the fact that educational system can change people over a lifetime.

As per agenda 21, the United Nations plan to achieve global sustainable development in the 21st century aimed at promoting sustainable development at community and local levels. United States was one of the 70 countries that convened a national council for sustainable development in response to this agenda. This council perceived that the role of education was to "give people the tools, skills, and experience they need to understand, process, and use information about sustainable development" (PCSD 1996a). The education term was broadly referred to formal and non-formal mechanism and could be relevant to sustainable development in two ways: first through a minimum background condition for sustainability, and second through a tool for pursuing sustainability (PCSD 1999). Action plans of this council for education for sustainability aim at (i) green schools, (ii) professional development, (iii) essential learnings, (iv) public awareness, (v) sustainable development extension network, (vi) community visioning and assessment, (vii) workforce development, (viii) lifelong learning, (ix) state and federal policy changes, (x) technology and information, (xi) multi-cultural perspective, and (xii) global perspective (PCSD 1996b).

2.2 Relevance of Sustainable Development in Indian Higher Education

In India, higher education has always been acknowledged as one of the most important drivers of economic, cultural, and spiritual development (Education Commission 1966). In 1998, rural higher education institutions experimented by introducing environmental and sustainability education called "*Samvardhan"* (means "to nurture") in India. This was primarily based on Gandhian philosophy of educating youth to bring about developments in their villages.

Togo (2009) suggests that it is important to redefine sustainability locally for higher education as sustainable development issues crucial for developing countries are different from those of developed countries. Realizing the relationship between environmental concerns and development, the Government of India mandated an undergraduate "environmental education" course as the first step to introduce sustainable development to higher education in the 1990s. This directive is a step towards making sustainability education a reality in undergraduate and postgraduate institutions in India. Although this initiative has been facing numerous challenges, like less student involvement, larger class size, scientific orientation towards course, lack of student interest, missing links between concept of sustainable development and associated pedagogic approaches, etc. (Chhokar 2010). Indian higher education policy emphasizes on moral value education and the inculcation of a sense of social responsibility (Government of India 1998).

There are some government level efforts underway in India to implement the *UN decade of Education for Sustainable Development* (DESD). The Ministry of Human Resource Development (MHRD) of the government of India is responsible for implementing DESD in India, which includes an expert committee of members from Government, NGOs, civil society and academia (Government of India 2007). Currently, there is a growing focus on sustainability education in India, which is driven by emerging needs of industry and society.

There is growing adoption of *Green Curriculum* and *Green Campus* concepts in India. Numerous institutions of high repute and universities have introduced green campus practices, courses and modules catering to sustainability issues. Some of them are, Masters in sustainable development offered by Jadavpur University, Masters in Public policy and sustainable development offered by TERI University, Leadership program on Nutrition Security and Sustainable Development by Indira Gandhi Open National University, and others discussed later in the paper.

Further, UNESCO and the Government of India have initiated a major partnership to create a category 1 institute, named *Mahatma Gandhi Institute of Education for Peace and Sustainable Development*, as a UNESCO's specialized education institution in India. It is the first of its kind in the Asia-Pacific region (UNESCO 2015). In 2014, the President of the United States of America and the Prime Minister of India collaborated to start a collaborative US-India Climate Fulbright Fellowship Program aimed towards building long-term capability on climate change related issues in both the countries. The United States India Education Foundation administers this in India as the Fulbright-Kalam Climate

Fellowship Program for doctoral and postdoctoral scholars. On the whole, there have been many experiments and initiatives made by the Government of India and Indian higher education institutions to inculcate sustainability concepts in students who can potentially serve as future leaders. Given the greater challenges of sustainable development in developing countries, it is critical to explore such initiatives in detail in the Indian higher education sector.

3 Research Design and Data Collection

This study is exploratory in nature and we used *content analysis* as a method for analyzing textual data (Cavanagh 1997). Content analysis goes beyond merely counting words to examining language for the purpose of classifying large amount of texts into an efficient number of categories that represent similar meaning (Weber 1990). In this study, the text represents largely the course curriculum and its content. The source of secondary data is websites of Indian management institutions and primary data is personal interviews with select faculty employed in these institutions.

All management institutions or/and other institutions offering management education constitute the population for the study. In India, there are premier management institutions named as IIMs (Indian Institutes of Management) that offer specialized management degree/diploma programs. Besides this, there are numerous IITs (Indian Institute of Technology) that offer management programs. There are other private institutions/universities offering management and technical education. The websites of 78 institutions/universities have been visited to see their program design and course structure. Any program/course(s) with the keyword(s) "Sustainability", "Sustainable development", "Environmental management", "Green", etc. have been short-listed for further analysis.

Unlike many foreign universities, very few Indian institutions provide detailed course content on their websites. Keeping this in mind, initially websites of shortlisted institutions have been explored for course content. The details about course coordinator(s) have been obtained from websites and where the course content is not available, these coordinators have been contacted through mails and telephones. However, only three coordinators/course faculty responded to repeated reminders and requests to participate in the study. Further, telephonic conversations were carried out with few course coordinators and discussions on course design and delivery mechanisms were manually recorded during these telephonic conversations.

The limitation of this study is that the results presented in this paper are exploratory in nature and do not cover all the management institutions in India. Further, the participation in this study was on a voluntary basis and we had lower response rate despite repeated reminders. Our research needs to be followed up by pan India study covering all the higher education institutions to draw more

conclusive results. Even though the study is based on the limited data available, the paper can build the foundation for future research in this area.

4 Data Analysis and Results

PDF word count and frequency statistics software was used to carry out content analysis of the collected data on course curriculum. As the name suggests, PDF word count takes data in '.pdf' format and gives information about frequency of each and every word. It provides some other information such as total number of words, total number of lines, characters with space, character without space, etc. This was helpful in identifying the major keywords and themes highlighted in the sustainability related course curricula.

Interestingly, we observe that Indian management institutions offer numerous exclusive programs on sustainability management. The following sub-sections present a detailed analysis of program structure, courses, course curriculum, and pedagogy.

4.1 Sustainability Education in India—Program Structure Analysis

We find that 5 management institutions in India explicitly offer sustainable development focused graduate level degree programs. Amongst these, TERI (The Energy and Resources Institute) University's MBA and Ph.D. program in *Business Sustainability* is considered as a pioneer in this field. Some other offerings are—MBA in Energy and Environment Business by Symbosis Institute of International Business, PGP (Post Graduate Program) (equivalent to MBA)-Sustainable Management by IIM Lucknow, MBA in Sustainability Management by Xavier University, and PGP in Energy Management by MDI Gurgaon. Table 1 provides detailed information on these programs in terms of credit requirements and unique feature(s).

TERI University offers an M.B.A. in Business Sustainability, which combines conventional MBA curriculum with new sustainability challenges. This is a two-year full time residential MBA program structured in four semesters. With some conventional MBA courses, it has some unique and sustainability focused courses, like Principles and Concepts of Sustainability, Energy Policy and Management, Sustainable Business Strategy, Sustainability Reporting and CSR, Community Relationship and others. Some of the unique features of TERI University are that it not only offers sustainability education but also showcases in reality the concept of a 'Green Campus'.

Xavier School of Sustainability at Xavier University has a mission of creating and nurturing next generation managers and leaders who can anchor and accelerate sustainability as a strategy for connecting business and society. It offers MBA and

Table 1 Sustainability education: dedicated Masters and Ph.D. Programs at Indian Management Institutions

Institute name	Program	Credit requirements	Unique feature(s)
TERI (The Energy and Resources Institute) University	MBA in Business Sustainability Ph.D. in Business Sustainability	98	Green Campus
Symbosis Institute of International business	MBA in Energy and Environment Business	100	Courses - Industrial waste management Green buildings and rating systems
Indian Institute of Management (IIM), Lucknow	PGP (equivalent to MBA degree) in Sustainable Management	[a]	Systems thinking course; Integrated projects in all three terms of second year; and Cross-sector collaboration
Xavier University	MBA in Sustainability Management Ph.D. in Sustainability Management	105	Sustainability Discovery Program; Personal learning and reflection paper; Sustainability Gallery
Management Development Institute (MDI) Gurgaon	PGP (equivalent to MBA degree) in Energy Management	[a]	Industry-focused program; Accreditations by Association of MBAs

[a]Details not available

Ph.D. in sustainability management. The two year MBA degree program has core courses with the sustainability focus on human development, climate change and natural resource management, sustainable energy, sustainability leadership and social entrepreneurship, whereas elective courses focus on specialized concepts like Earth Climate System, Green accounting and Carbon finance, Environmental risk and Impact analysis, Green building and sustainable urban development, Innovative business models for sustainability, sustainability strategy and management, renewable energy resources and technologies, etc. The unique feature of this program is a *SDP* (*Sustainability Discovery Program*), which is a four week program offering students an opportunity to engage in cutting edge sustainability projects. Next, the *Sustainability Gallery* helps showcase student learning from these projects and presents a snap shot of the host organization's work. Finally the students are asked to prepare a *Personal Learning and Reflection Paper* that reflective in nature and focuses on the students' self-learning process.

In 2015, IIM Lucknow (Noida Campus) introduced a two-year full time, residential Post Graduate Program (equivalent to MBA) in Sustainable Management. The focus of this program is to help managers develop an ethos of environment and social responsibility, and to equip them with holistic thinking and skills to handle

varied sustainability challenges in the present dynamic business environment. Some unique courses being offered in this program are—*systems thinking, business certification for sustainability, human dimension of sustainability, social entrepreneurship, Public policy process and institutions,* etc. India has 13 Indian Institutes of Management (IIMs) spread across different states in India. IIM Lucknow is the first IIM that has introduced a full program related to sustainability education and the program includes an integrated project spreading over all three terms of the second year.

4.2 Sustainability Education in India—Course Analysis

Even though many management institutions in India have realized the sensitivity towards environment and longevity of its natural resources, not every management education institution is convinced about offering a graduate level two-year exclusive program on sustainability. Therefore, numerous management institutions have integrated sustainability education in their mainstream MBA curriculum in the form of specific core and elective courses that focus on environment management and sustainable development. Many IIMs and other Indian B-schools have introduced courses like Sustainable Development, Green Marketing, Sustainability Strategies, etc. as elective courses. Looking at the list of courses presented in Table 2, it is evident that most of sustainability courses are elective courses, whereas environmental management courses are core courses.

One of the most popular and innovative courses *Sodh Yatra* (meaning "journey of explorations") offered by IIM Ahmedabad is a journey for the search of knowledge, creativity and innovations at the grassroots level (http://www.sristi.org/cms/shodh_yatra1). Students reach out to the most remote parts of the country to unearth traditional knowledge and grassroots innovations. It also aims at mutual exchange and sharing of knowledge with villagers. Students meet villagers, farmers, artisans, etc. individually and a report is prepared collectively based on each person's experience. During this journey, new methods of crop protection, cattle rearing and improved implements developed by villagers have been discovered. Till 2015, 35 Sodh Yatras have been conducted to various parts of the country.

4.3 Sustainability Education in India—Content Analysis of Course Syllabi

To carry out content analysis of course curriculum, course contents have been collected through websites and personal contact approach. As already stated, unlike foreign universities, very few Indian universities publish their course content in public domain. Among these selected institutions, only TERI University has published course content details on its website. For others, personal contact approach was used where the course coordinators contact details were collected from the institute's website and then they were contacted through mails. Unfortunately, this

Table 2 Sustainability education: core and elective courses at Indian Management Institutes

Institute name	Course(s)	Core/elective	Content availability (Y/N)	Source of information
IIM Ahmedabad	1. Managing Sustainability	Elective	Y	Personal Contact Website
	2. SodhYatra		Y	
IIM Calcutta	1. Sustainable Development: Challenges for business	Elective	N	Website
IIM Kozhikode	1. Environmental Management	Core	N	Website
IIM Indore	1. Green Business Management	Elective	N	Website
IIM Shillong	1. Environmental Management & Sustainability 2. Corporate Sustainability Strategy 3. Sustainable Innovation and Entrepreneurship	Elective	N	Website
DMS[a], IISc Bangalore	1. Management of Technology for Sustainability	–	Y	Website
ISB[b] Hyderabad	1. Leaders and Sustainable Development 2. Sustainable Manufacturing and Operations	Elective	N	Website
IMI[c] Delhi	1. CSR and Sustainable Development	Core	N	Website
SOM[d], IIT Bombay	1. Business and Sustainable Development	Core	Y	Personal Contact
IMT[e] Ghaziabad	1. Green IT and Sustainable Technologies	Elective	N	Website
IMT[e] Nagpur	1. Green Marketing	Elective	Y	Personal Contact
IRMA[f] Anand	1. Natural Resources and Sustainability	Core	Y	Personal Contact
	2. Sustainability and CSR Compliance Mechanism	Elective	Y	
S.P. Jain Institute of	1. Sustainability and Distributive Justice	Core	N	Website

(continued)

Table 2 (continued)

Institute name	Course(s)	Core/elective	Content availability (Y/N)	Source of information
Management & Research				
Christ University	1. Green Operations	Elective	Y	Website
Great Lakes, Chennai	1. Sustainable Business Operations	Elective	N	Website
LBSIM[g], Delhi	1. Business Sustainability and CSR	Elective	N	Website
Birla Institute of Management Technology, Noida	1. CSR and Sustainable Development	Core	N	Website
	2. Lean Sustainable Supply Chain	Elective		
Xavier School of Management, XLRI	1. Introduction to Sustainable Development and Corporate Sustainability	Core	N	Website
	2. Advanced Environment Management and Green Marketing	Elective		

[a]Department of Management Studies
[b]Indian School of Business
[c]International Management Institute
[d]School of Management
[e]Institute of Management Technology
[f]Institute of Rural Management Anand
[g]Lal Bahadur Shastri Institute of Management

approach resulted in collection of few course contents. Despite repeated reminders, soliciting responses over email resulted in a low response rate for our study. Based on the responses received, telephonic contacts were made with willing course coordinators for seeking course content details. However, not much detail could be collected as few course coordinators expressed their inability to share course details quoting lack of time, institution policies, copyright issues, etc. Therefore, we finally included course contents of eleven courses for content analysis.

The content analysis software helped in giving the frequency count of all the words available in the text. The keywords with higher frequency were selected as key themes and are listed in Table 3. It is evident from the table that some special attention has been given to keywords like 'social', 'stakeholders', 'green', emphasizing the inclusion of society and larger set of stakeholders. Since many businesses consider 'sustainability' as a part of CSR, it has also been included in these curricula. 'Green' word has also shown a greater appearance in these courses as 'green marketing', 'green supply chain', 'green economy', or 'green buildings'.

Table 3 Frequency count of keywords

Keyword	Frequency
Business	58
Corporate	28
CSR	23
Development	36
Environment	28
Environmental	38
Green	53
Management	59
Reporting	33
Social	38
Stakeholders	36
Strategic	42
Strategies	76
Sustainable	51
Sustainability	99
Waste	12

4.4 Sustainability Education in India—Pedagogy Analysis

These programs largely follow case teaching pedagogy. The case method is used in combination with interactive lecture sessions, group discussions, industry interactions, action learning, discussion forum, role-plays, guest lectures from industry experts for course delivery. Advanced Information and communication technologies use while delivering the courses help in integration and making learning more effective. Summer internship programs, industry projects, group assignments are also common features of these programs for practical exposure.

Some of the unique pedagogies that we discovered are immersion based learning through journeys to remote parts of India, sustainability discovery program, self-reflection paper, leadership talks, and display mechanisms as exhibitions and sustainability gallery.

5 Key Findings and Discussion

The whole globe is concerned about climate change, global warming and ill effects of industrialization. This is clearly evident from the success of COP21 at Paris in Nov. 2015. To prepare future generations for a long-term common vision of conservation, growth and equality, the link between quality higher education and sustainable development is self-evident. The objective of this article is to present a comprehensive overview of sustainability education initiatives occurring in India. Specifically, we analyze program structure, courses, curriculum and pedagogy. We

found that there have been numerous initiatives in India by the Government, higher education institutions and management institutions in particular. This study reveals that various courses on the themes of "environmental management" and "sustainable development" have successfully been introduced in management institutions in India. It is worth mentioning that these developments are recent and these sustainability related courses are not older than five to seven years.

While exploring exclusive MBA and Ph.D. programs on sustainability, we found that these innovative program structures enabled students to learn conventional management and functional area courses by integrating them with important concepts of environment and sustainability. Some of the innovative courses identified in these programs are *Human Dimension of Sustainability, Green Accounting and Carbon Finance, Sustainability Reporting, Social Entrepreneurship, Green Building and Sustainable Urban Development, Innovative Business Models for Sustainability* and others. Some of the common courses identified across different programs in Indian management institutions are *Sustainability Measuring and Reporting, Environment Impact Assessment,* and *Social Entrepreneurship.*

Content analysis of the course syllabi of sustainability related courses offered in Indian management institutions highlights that the dominant keywords used in these courses are social, stakeholders, green, development, strategies and other. It is evident that major emphasis of these courses are to shift focus from shareholders to stakeholders, short-term view to a long-term vision, conventional strategies to green strategies and shift towards equality and holistic development through education. We found that 10 management institutes in India (from our sample) offer core courses in the area of "environment management" and "Sustainability". To develop interest and awareness among students it is proposed that more core courses must be offered on sustainable development.

Some of the other key findings from semi-structured personal interviews with six course co-ordinators in Indian management institutions reveals that incorporating issues pertaining to environment management and sustainable development in graduate programs are beneficial in increasing awareness of sustainable development concepts. However, the holistic goal of self-reflection by students themselves for the betterment of the community and our planet is yet to be achieved. It can be made possible by adopting innovative pedagogical approaches that encourage participative and engaged learning. Students usually have a short-term vision that focuses solely on their immediate career prospects. As a result, they are not able to appreciate the relevance of sustainability education courses. In addition, delivering the sustainability concepts by establishing their linkage with India centric case studies was also one of the key challenges.

Further, there is lack of professional courses for faculty development on sustainability education in India. Such professional development courses and workshops are essential for management faculty to remain updated on the current happenings in this area. The lack of qualified academic professionals in these specialized fields is also one of the key challenges faced by Indian management institutions. Developing a strong research base in the sustainability field, adopting green campus practices, inculcating conservation habits, encouraging social

equality among students are some of the possible solutions for developing and nurturing this area. TERI University in India has taken lead in not only imparting education on sustainability but also practicing this learning in its modern green campus buildings. The case of TERI is discussed in brief in the next sub section.

Case: TERI University's Green Campus

TERI University puts its theory into practice by building an energy efficient campus that showcases the concept of modern green building. The campus is aesthetically designed with several features of passive solar design, energy-efficiency, and water and waste management systems. Some green features of campus are:

- Solar water heating system
- Waste water recycling with STP
- Insulation of external walls with rock wool
- 48 kWp solar rooftop system
- Earth air tunnel, thermal mass and VRV system for cooling the building
- Efficient artificial lighting system

TERI as an institution of excellence has gained global popularity and with its green buildings initiatives and has created benchmarks for other Indian institutions. However, there is still a long way to go towards adoption of global universities green practices.

6 Conclusions

Undoubtedly, higher education and universities have a major role in transforming the society and enable people to lead an ecologically sustainable lifestyle. Not only adopting *Green Curriculum* but also practicing engaged learning approaches that promote cultural adoption, and self-reflection can help achieve sustainable development goals.

According to Leal Filho (2010), in order to claim excellence in the field of sustainable development universities need to fulfill the following six criteria:

1. Existence of core staff with formal qualification in the related fields of environment management and sustainable development
2. Integration of sustainable development in campus activities and operations (Campus greening)
3. Implementation of principles of sustainable development as intrinsic part of university teaching program
4. Existence of robust research program with externally-funded projects on sustainable development matters

5. Existence of publication profile on sustainable development issues published in international journals
6. Existence of a program of extension on sustainable development topics, for non-student public

Indian management institutes have a long way to go in terms of adopting green campus practices, using faculty resources from multiple disciplines, hiring specialized faculty staff trained to deliver these specialized courses, developing awareness and interest among students, and adopting innovative delivery mechanisms. Scott (2002) offers suggestions that can be adopted for effective pedagogy. This involves demonstrating to the students why sustainability is important to them, by helping students gain a diverse perspective on what sustainability means, and by providing learning opportunities through appropriate curriculum choices. Besides this, a focus on developing a strong research base related to management issues of sustainability, sustainable business strategies, policy designing and analysis could help unfold new avenues and encourage research in this field. In India, TERI University and Xavier University have taken lead in research by offering Ph.D. courses in the related fields. "SodhYatra" model of learning grass root innovations at IIM Ahmadabad also offers an innovative framework for immersive field based learning.

Collaborations with foreign universities from Asia, Europe and USA for curriculum design, collaborative research projects, and guest lectures could be some of the ways to integrate perspectives on sustainability education at a global level. Lastly, there is tremendous scope of exploring research initiatives on sustainability education in the Indian management context to advance the field. This paper is exploratory in nature and offers important contributions towards uncovering the sustainability education scenario in India. This study can be considered as stepping stone towards examining opportunities in developing countries for academia, research, practice and policy making in the area of sustainable development education.

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Part III
Engaging Different Stakeholders

Science, Technology and Innovation for Sustainable Development in the Post-2015 Agenda: The Role of Women: Some Proposals from BAWS & OWSDNC Bangladesh

Shahida Rafique

Abstract

The new global 2030 roadmap and Sustainable Development Goals (SDGs), approved by UN Member States on 25 September 2015 have been reviewed. Analysis of the proposed goals and targets, collectively and individually, show that they are equipped with evidences, and address the economic, social and environmental dimensions of sustainable development in an integrated way but they could be more specific in terms of Science, Technology and Innovation (STI) and the role of Women to be effectively implemented and monitored. It is seen that there still exist the "*Missing links – gender equity in science and technology for development*". It is felt that some socio-technical issues regarding women and science may be included. It is suggested that Women Particularly Women scientists are to be involved in Sustainable development, both at the global, regional and country level. The participation and creativity of man & women as well as the new advances in scientific knowledge, discoveries and innovations are required for long term sustainable development. For main-streaming women in SDG Agenda: the "gender lens approach "may be adopted at each stage of the SDG target. Concrete recommendations are put forward for consideration in refining the goals and targets or in planning for their implementation.

Keywords

Bangladesh Association of Women Scientists (BAWS) · Organization for Women in Science for the developing world (OWSDNC) · SDG · Women in science · Technology and innovation · Gender · Justice · Equity · Partnerships

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1 Introduction

Women can play a vital role in acheiving SDG in all society. Promotions of sustainable and inclusive development are impossible without a full consideration of issues of STI & Women. Gender mainstreaming can make SDG Agenda more effective and including women in SDG targets can enhance women's contribution to sustainable development. Some essential STI issues need to be tackled simultaneously in the post-2015 development agenda. First: Innovation driven Growth: some developing countries have achieved significant economic growth through the creation and deployment of STI capacity. Next, STI should be integrated into public policy goals, giving particular focus to the women, culture, education and development.

STI needs to be made more participatory and inclusive so that there is public engagement in the scientific endeavor from the full spectrum of social actors, including women, young people and indigenous communities. Use of technology, promoting innovation & integrating women may be a major issue of the post-2015 global Agenda.

Science plays an important role for sustainable development from informing the formulation of evidence-based targets and indicators, to assessing progress, testing solutions, and identifying emerging risks and opportunities. Major issue at the forefront of science, technology and Innovation is gender equity & a, high quality of life that is equitably shared and sustainable"

If science, technology & Innovation are to have a meaningful impact on the post 2015 development agenda, we need to recognize the role of women in human development, in science-based activities, in the Industrial Revolution, in the Computer Revolution, Medical Revolution, Green Revolution, and in the Agricultural Revolution. On one hand, these Science-based Revolutions have brought unprecedented economic progress and welfare for all; on the other hand Women's contributions are not recognized logically. The Post-2015 Agenda needs to provide both the vision and the commitment to address and resolve the big issues of our time, such as: women's backwardness in STI, extreme poverty, lack of peace and security, unavailability of safe and sufficient food & drinking water, sustainability of energy, environmental pollution, water and environmental resources management, disease control, mobility, natural and man-induced disasters, population growth, urbanization and sustainable/livable cities. A suitable framework has yet to be developed that takes account of the most urgent research areas needed in SDG-2015 that addresses women.

In this connection, some Gender based science issues are reported. For delivering the sustainable development goals, the essential elements are: The Planet, the people, Energy& environment, Economy, Justice, Equity and partnership. To address these, Key challenges are: eradication of poverty (SDG 1), end Hunger (SDG2), ensuring Healthy lives and well-being for all (SDG3), quality education, lifelong learning opportunities (SDG4), gender equality (SDG5), achieving Clean water and sanitation for all (SDG6), Access to modern energy for all, (SDG7, promoting economic growth and decent work for all (SDG8), building resilient

Infrastructure and innovation (SDG9). Reducing inequalities (SDG10), making Sustainable cities (SDG11), ensuring sustainable consumption and production (SDG 12), combating Climate change (SDG13), conserving Marine resources for sustainable development (SDG14), protecting and restoring terrestrial ecosystem (SDG15). Providing Peace and access Justice to all levels (SDG16), strengthening and revitalizing the Global partnership (SDG 17) by 2030.

Use of modern technology to increase the productivity and equitable treatment of women are fundamental to eradicate poverty. Providing agricultural technology, leads to increased agricultural productivity. Women in agriculture can contribute to global food security. ICT is the tool for health applications. Inclusion of women in health sector is vital to achieve healthy lives for all. Science education should be a part of basic education curricula, to develop a science-literate population which is the basis for a workforce. Education for women is important to achieve basic literacy. Technology can be an agent to improve women's daily work, by providing access to clean water and improved sanitation. Women's role is central in Water and sanitation system. Sustainable energy resources must be developed using Renewable energy Technologies. As primary energy managers in households, women could play powerful roles in sustainable modern energy. Women must have access to economic growth processes, productive resources and economic decisions. Infrastructure in a broad sense includes ICT, and scientific research. Targets must be related to ICT. Women's need in relation to land, housing, services, transport, sanitation is central to the planning of sustainable cities. Women's accesses to basic needs form the basis of sustainable production and consumption. Developing resilience and adaptive capacity to gradual changes in the climate system is necessary. Women's participation in relation to production and social reproduction are central to making climate change initiatives sustainable. Women's role in community conservation, preservation of biodiversity and environmental decision-making is important. Essential ecosystem services must be provided to Biodiversity and terrestrial ecosystems. Women, as essential players in preserving our planet need to be included in decision-making on ecosystem use at all levels. By fully protecting all of women's rights, peaceful societies will be achieved. Strengthening institutional, financial, scientific, technological capacities is the key to the success of the SDGs. Concrete recommendations are put forward in tabular form for consideration their implementation.

These include identifying the missing links, data gaps, key issues and critical shortcomings for women in STI. The strategic challenge today is to ensure not only that both Women and Men benefit from the opportunities presented by STI's, but also that new STI's are to be used to support greater socioeconomic, scientific and political equality. However the central role will be played by the High-level Political Forum on Sustainable Development (HLPF). This proposal is placed from BAWS & OWSDNC Bangladesh, to address the Women in science perspective (Table 1).

Table 1 Proposals on post 2015 development agenda

Goals	Role of STI	Role of women in science perspectives
Goal 1 *End poverty* in all its forms everywhere Comments	Scientists are to be mobilized to collaborate & tackle these issues in partnership with policy-makers and stakeholders, to provide the knowledge needed to end poverty	The end of poverty can only be achieved with the end of gender-based discrimination. All over the world, gender inequality makes and keeps women poor, depriving them of basic rights and opportunities for well-being
Goal 2 End Hunger, achieve food security and improved nutrition & promote sustainable agriculture	Science and technology can help addressing this issue STI can develop technology, & plant and livestock gene banks to enhance agricultural productive capacity in developing countries	Women play a central role in Agriculture, food security, and nutrition. Women working in agriculture can contribute to greater global food security
Goal 3 *Ensure* healthy lives and promote wellbeing's for all at all ages	STI for health applications includes: Disseminating healthcare information directly to the population through traditional and new media increased access to basic health and nutrition Information through ICT	The highest attainable standard of health is a fundamental right of every person This requires health systems to become fully responsive to women and girls, offering higher quality, more comprehensive and readily accessible services
Goal 5 Achieve gender equality & empower all women and girls	Promoting gender equality in science, technology and engineering education workforce and leadership is the key issue for this agenda	Goal 5 is known as the stand-alone gender goal. Gendered inequalities are the most pervasive of all inequalities. Without attention to women and to gendered inequalities, sustainable development is impossible. Women's empowerment is a pre-condition for this
Goal 6 Ensure availability and sustainable management of water and sanitation for all Comment:	This goal is based upon extensive use of STI to get fresh water supply and sanitation management to improved health, wellbeing and economic productivity	Ensuring water and sanitation for all is the goal; achieving it must take all dimensions specific to women and girls on board, and involve them directly in the process Women play a central role for sustainable Management

(continued)

Table 1 (continued)

Goals	Role of STI	Role of women in science perspectives
		of Water and sanitation for all
Goal 7 Ensure access to affordable, reliable, sustainable and Modern energy for all	This goal needs clean-energy research and technologies. RET can be used for developing sustainable energy resources	Universal access requires energy to be affordable and reliable for all living beings Women are often the primary energy managers As primary energy managers in households, women could play powerful roles in extending sustainable modern energy
Goal 8 Promote sustained, inclusive & sustainable economic growth, full and productive employment and decent work for all	Sustainable Growth is driven by energy and materials & the use of relevant technologies Substantial structural changes and innovation is needed to improve resource use efficiency	Women must have equal access to decent work, productive resources and financial services, as well as an equal voice in economic decisions Gender stereotypes often define 'women's work', in many countries
Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Infrastructure, industrialization & innovation are the key areas to achieve this goal STI, financial services and Scientific research, are essential for fostering economic and social development.	Women's participation in infrastructure development, industrialization, Innovation and its links to resources, is central to Build resilient infrastructure & sustainable development. Women must have equal opportunities in building a shared, sustainable future
Goal 10 Reduce inequalities within and Among countries	To reduce inequalities by 2030 between and within the nations, per capita income has to be optimized in each country Statistical data (gender, ethnicity, social status) is needed	Gender discrimination makes women prone to deeper disparities. The reduction in inequality is the surest way of reducing gender inequalities and increasing the empowerment of women and children
Goal 11 Make cities and human settlements inclusive	Targets are related to ICT or connectivity. It is preferable to use appropriate technology to achieve the goal GIS may be used to map geospatial data for systems	Women's and children's needs are to be addressed in the planning of sustainable cities All elements of urban governance, planning and finance need to actively embed gender equality measures. And women

(continued)

Table 1 (continued)

Goals	Role of STI	Role of women in science perspectives
	analysis that draw the urban dynamics on which Sustainable development rests	deserve equal roles in making decisions about an ever more
Goal 12 Ensure sustainable production and consumption patterns Comment:	Sustained provision of natural resources is critical to human basic needs, such as land, water, food, and energy is to be searched by proper searching algorithm	Women's and children's access to basic needs—land, water, food and energy—form the basis of sustainable production and consumption Women in consumption and production must have equal access to means such as land and technology that can boost their standard of living. Women at large must assume equal leadership in striking a better balance—in parliaments, in their communities and families
Goal 13 Take urgent action to combat climate change and its impacts	Developing resilience and adaptive capacity to gradual changes in the climate system is necessary. STI can be a tool to develop this	Climate change seriously affects women, children & elderly people Women can offer valuable insights into better managing the climate and its risks. They also have a right to all capacities needed to protect themselves, and to participate in decisions with profound implications for people and the planet
Goal 14 Conserve and sustainably use oceans, seas and marine resources for sustainable development.	Scientific knowledge, research methodologies & marine technology is to be applied to improve ocean health and to enhance the contribution of marine biodiversity for sustainable development This is supported by a significant amount of natural and social science	There are synergistic links between women and nature Women face the risks of ocean degradation with fewer assets and alternatives for livelihoods, and less resilience against the loss of natural resources. All strategies for conservation and sustainable use need to respond to these vulnerabilities. Women's limited representation in marine science must be corrected towards tapping all perspectives for fair and durable solutions

(continued)

Table 1 (continued)

Goals	Role of STI	Role of women in science perspectives
Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystem, sustainably manage forests, combat desertification, halt and reverse land degradation & halt Biodiversity loss	Biodiversity and terrestrial Ecosystems are essential for providing ecosystem services and benefits to society that support different dimensions of human wellbeing	There are synergistic links given women's roles in community Conservation, the preservation of biodiversity and environmental decision-making women play a critical role as stewards of the land, comprising much of the agricultural labour force in developing countries
Goal 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective and accountable and inclusive institutions at all levels	Sustainable use of land and land-based resources, including ecosystems and biodiversity, are absolutely essential to sustainable development	Without women's engagement in peaceful development initiatives sustainable development is not possible By fully protecting all of women's rights, without exception, in all laws and practices, peaceful and inclusive societies will be within reach
Goal 17 Strengthen the means of Implementation and revitalize the global partnership for sustainable development	Requires access to science, technology and innovation, and enhance knowledge sharing on mutually agreed terms	Without the implementation of sustainable development for women, sustainable development in many other sectors will fail Gender equality is central to all of the SDGs

From Bangladesh Association of Women Scientists. (BAWS) & OWSDNC Bangladesh

2 The Initiatives & Actions of BAWS and OWSDNC

BAWS has focused on improving and enhancing the relationship between science and Women by initiating various programs that aim to improve the public's awareness to become more involved in science, technology & Innovation.

One of the benefits of this approach has been the establishment of OWSDNC and actions plans that aim to promote research by, for and about women in science and technology.

BAWS was established in 1979 as an Association of Women Scientists from National representatives and gender experts from different Academic, Administrative and scientific Institutions. Its mandate is to promote the participation and equality of women in the sciences and provides a forum for dialogue about National policies.

The BAWS grew out of the recognition that women's talents are underutilized in the National science system and that women are significantly absent from science policy-making and advisory bodies in Bangladesh. The action plan includes:

Establishment of a Bangladeshi platform of women scientists.

The Bangladeshi platform will bring together networks of women scientists and organizations Committed to gender equality, monitoring progress towards gender equality in science.

A set of gender indicators will be produced in cooperation with the statistical correspondents of UIS on Women and Science to measure progress towards gender equality in Bangladesh research.

3 OWSD Objectives

- To increase the participation of women in scientific and technological research, teaching and leadership in developing countries.
- To promote the recognition of the scientific and technological achievements of women scientists technologists in developing countries.

4 Recommendations

1. Equity must be established in science and technology education, research and in professional field.
2. Obstacles to women must be removed in scientific and technological careers.
3. Make science responsive to the gender dimension.
4. Make STI in decision-making process more gender aware.
5. Relate better with local knowledge systems.
6. Address ethical issues related to gender in science and technology.
7. Improve the collection of gender disaggregated data for policy-makers.
8. Identify Problems in gender issues in society, the need for improvement of the situation of women and men, the need for statistics from different Fields and from the available statistics.
9. Specify the Need for improvement of content, Goals for equal opportunities.
10. Investigate the Quality relative to need possible sources,
11. List relevant statistics and indicators,
12. Collect New Data and Compile Statistics to be analyzed
13. Analyze Present & Disseminate.
14. Let talent of all the human beings, be the key factor for STI, competitiveness and growth in Post 2015 Agenda.

5 Conclusion

The critical role of science, technology and innovation (STI) and women for the implementation of the future post-2015 sustainable development agenda is proposed. Gender equality is central to all of the SDGs Women in science must be integrated into the post-2015 development agenda by acknowledging their significant role for poverty eradication and for sustainable development.

SDGs should be based on an integrated scientific approach. The SDGs also need to address the social, economic and environmental dimensions of sustainable development in an equitable manner.

Governments should acknowledge the potential of women in science to different systems, disciplines and findings and to contribute to an integrated understanding and a knowledge basis in the pursuit of the SDGs. The international community should aim at establishing national minimum target investments for women in STI, including special allotments for the promotion of basic science and science education and literacy. SDG-2015 is an Agenda for all. The key issues logically addressed are Poverty, Sustainable Development, Peace and Security. The strategic challenge today is to ensure not only that both women and men benefit from the targets presented by SDGs beyond 2015, but also that new targets are effectively used and successfully implemented to support greater socioeconomic, scientific and political equality. The 169 targets are believed to be well developed, but they could be strengthened specifically by addressing women's issues. Increased participation of women in policy level is suggested to finalize the documents. Furthermore women's roles are to be recognized & specifically women scientists could be included in chalking out STI policy beyond 2015. Future generations are to be prepared for their role in the sustainable Green World.

Finally, a long term vision of a sustainable world is needed where, by mid-century, 9 billion people can live a decent quality of life within the planet's limited resources. The UN system should be strengthened for the purpose of implementing the new generation of Sustainable Development Goals.

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UN Decade of Education for Sustainable Development: Perceptions of Higher Education Institution's Stakeholders

Ana Marta Aleixo, Ulisses Miranda Azeiteiro and Susana Leal

Abstract

The purpose of this study is to investigate how the main stakeholders of Portuguese Higher Education Institutions (HEIs) perceive the commitment of HEIs related to: (a) teaching sustainable development Sustainable Development (SD) across all courses, (b) encouraging research and dissemination of SD knowledge, (c) implementing green campuses and supporting local sustainability efforts, and (d) engaging and sharing information with international networks (as defined in Higher Education Sustainability Initiative, United Nations). Through a qualitative approach (semi-structured interviews and content analysis), we explore the perspectives of twenty stakeholders from four Portuguese public HEIs (leaders, faculty, staff, students, and external stakeholders). The results show that all stakeholders see teaching SD across all courses as a necessity, but they have different visions about how to implement it. Concerning the research and dissemination of SD knowledge, they defend that both should be encouraged and transversal to all HEIs. About implementing green campuses and supporting local sustainability efforts, stakeholders agree that is important, but the practical

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results, in the Portuguese HEIs analysed, fail to achieve an acceptable degree. As a long term objective, the motivation for engaging and sharing information with international networks is latent.

Keywords
UN Decade of Education for Sustainable Development · Education for Sustainable Development · Sustainability · Portuguese Higher Education Institutions

1 Introduction

The focus of the UN Decade of Education for Sustainable Development (UN-DESD) is "a world where everyone has the opportunity to benefit from education and learn the values, behaviour and lifestyles required for a sustainable future and for positive societal transformation" (UNESCO 2005, p. 11). To help reach these goals, Higher Education Institutions (HEIs) must contribute for Education for Sustainable Development (ESD) and learn with the participation of its main stakeholders.

At the end of UN-DESD (2005–2014), it is pertinent to assess if Portuguese HEIs are implementing practices that promote Sustainable Development (SD), namely those that are seen as "good practices" (UNESCO, UN-DESA, UNEP, Global Compact, and UNU). These good practices are promoted by international initiatives (for example, the Higher Education Sustainability Initiative) and can be looked upon as a guide on what HEIs should do. Such initiatives help to achieve the UN-DESD (2005–2014) objectives.

This work explores the perceptions that key stakeholders have about the importance of SD integration in HEIs' systems regarding the following aspects: (a) teaching SD across all disciplines of study, (b) encouraging research and dissemination of SD knowledge, (c) implementing green campuses, (d) supporting local sustainability efforts, and (e) engaging and sharing information with international networks. HEIs have a role to play in achieving "The future we want" (United Nations 2012) during the next decade (2014–2025). As stated by Beynaghi et al. (2014), the UN-DESD should continue after completion of the initial decade (2005–2014). Therefore, this study intends to assess if the stakeholders consider the main areas of intervention of HEIs in the domain of SD pertinent, and reflects on how SD can be implemented in Portuguese HEIs.

The relevance of this work is based on the fact that empirical knowledge in this field in Portuguese HEIs' context is scarce (Aleixo et al. 2016). A qualitative analysis was conducted through semi-structured interviews. The sample embraces twenty stakeholders of four Portuguese HEIs, including leaders, faculty, staff members, students, and members of society.

This paper is a part of an ongoing, cross-sectional research project that aims to investigate: (a) the amount of SD practices formally communicated in the websites of the Portuguese HEIs (Aleixo et al. 2016), (b) the stakeholders perceptions about

the conceptualization of SD, Sustainable Higher Education Institutions (SHEIs) and the role of HEIs in the promotion of SD, as well as about the barriers, challenges, and drivers to SD in HEIs, (c) the SD practices adopted and implemented in the Portuguese HEIs.

With this in mind, we structure the paper as follows. We start by clarifying the importance of the UN-DESD in HEIs, then we define who the main stakeholders in HEIs are, and later we reflect on ways of integrating SD in HEIs. In the end, we present the main conclusions, the study's limitations, and suggest avenues for future research.

2 Literature Review

2.1 The Decade of Education for Sustainable Development in HEIs

As stated by UNESCO (2005, p. 27), "Education is held to be central to sustainability". In this context, the UN-DESD has seven strategies to achieve it, which are the following: (a) vision-building and advocacy, (b) consultation and ownership, (c) partnership and networks, (d) capacity-building and training, (e) research and innovation, (f) use of Information and Communication Technologies (ICTs), and (g) monitoring and evaluation (UNESCO 2005, p. 17).

Recognizing the role of education in the change of mentalities and attitudes related to SD, the United Nations General Assembly, in December of 2002, adopted the Resolution 57/254, and from there started the UN-DESD for 2005–2014 (Wals 2014). As stated by Wals (2014, p. 8) "the DESD seeks to provide an opportunity to promote a vision of a more sustainable and just global community through different forms of education, public awareness and training activities".

For UNESCO (2006), Higher Education has a particular role in the promotion of SD through learning, research, and leadership. In this context, "higher education should emphasize experiential, inquiry-based, problem-solving, interdisciplinary systems approaches and critical thinking. Curricula need to be developed, including contents, materials and tools such as case studies and identification of best practices" (UNESCO 2006, p, 23).

As stated by Sammalisto et al. (2015), the role of HEIs in ESD has been encouraged by several declaration and initiatives. Amongst these initiatives and declarations, we could list the following: The Higher Education Sustainability Initiative, the Rio + 20 Treaty on Higher Education, Talloires, Earth Charter, and the Declaration of University Leaders for a Sustainable Future.

As stated by Leal Filho (2015, p. 4), EDS is the "Educational process characterized by approaches and methods aimed at fostering awareness about the issues pertaining sustainable development". Moreover, this process is not only about environmental issues but—through interdisciplinary thinking—it is also about social, political, economic and ecological issues.

2.2 Main Stakeholders for the ESD in HEIs

There are several stakeholders that can influence the ESD, namely: faculty, staff, leaders, students, and external stakeholders. The faculty and staff are the changeable agents who can and will engage in the ESD (Sammalisto et al. 2015). Additionally, leaders, faculty and staff are the stakeholders who could improve the ESD in HEIs' activities (Sammalisto et al. 2015). In the campus context, there was an increased participation of students in environmental initiatives (Figueredo and Tsarenko 2013) and, consequently, students are also SD key stakeholders (Nejati and Nejati 2013). External stakeholders are equally relevant regarding the ESD because HEIs establish partnerships with them for research, services, and regional development.

2.3 Integration of SD in HEIs

Several authors defend the integration of SD into HEIs' systems (for example, Alonso-Almeida et al. 2015; Cortese 2003; Disterheft et al. 2013; Jorge et al. 2015; Kościelniak 2014; Leal Filho 2011, 2015; Lozano 2010; Nejati and Nejati 2013; Popescu and Beleau 2014, Waas et al. 2010). Several authors claimed this integration into the whole system: curricula (education), research, campus operations, community outreach and partnerships, and assessment and reporting. As stated by Alonso-Almeida et al. (2015) the development of SD in HEIs means not only statements but also actions. Cebrian et al. (2015) advocate the connection of the whole system and not its compartmentalization.

For Sibbel (2009, p. 75) the challenge for HEIs is to redesign curricula to "prepare graduates with the necessary knowledge and values, a capacity for critical thinking and the motivation to deal with the multitude of diverse problems associated with non-sustainable states". Several authors defend the integration of the SD concept in the curricula for the development of new skills, values, attitudes and competencies (e.g., Popescu and Beleau 2014). In this context and as stated by Jorge et al. (2015) the integration of operations and curricula should be integrated into mainstream HEIs.

Wyness and Sterling (2015) argue that the curriculum review needs to undertake the agenda of sustainability in HEIs. For the authors, this happens if there is an institutional commitment, staff knowledge, and motivation. According to Lozano (2010) the introduction of the SD concept in the curricula could help HEIs to develop a further balanced academic system in synergistic, interdisciplinary and holistic terms, thus increasing the probability of students participating in the construction of a more sustainable society.

For Waas et al. (2010), the research on SD should have various levels (from the local to the global scale), various time perspectives (from the short to the long term), different SD dimensions (economic, environmental, social and institutional), and all the academic group should share full responsibility. HEIs have the

responsibility to encourage SD research and the development of new tools and models for a SD world (for example, Popescu and Beleau 2014).

Regarding community outreach and partnerships, one must consider the relationships between HEIs and enterprises and other institutions. Alonso-Almeida et al. (2015) identified HEIs' contributions to the social and economic development of the community as engagement or outreach.

For Jongbloed et al. (2008) there are three institutional barriers which interact with HEIs: (a) the determination of the research agenda and education offering; (b) the internal reward structure, and (c) the lack of an entrepreneurial culture. As stated by Jongbloed et al. (2008), despite the continued lack of knowledge about what HEIs can provide to enterprises, the development of these partnerships can result in new research, development of new products, relationship strengthening, obtaining patents, and solving technical problems. These partnerships with enterprises intend to obtain funds for research (equipment, human resources, and others) and to enable research testing (Jongbloed et al. 2008). Besides these aspects, partnerships, services and collaborations with the community also represent improved relationships with local authorities and civil society.

In what concerns assessment and reporting, Alonso-Almeida et al. (2015) argue that only some HEIs publish sustainability reports under the Global Reporting Initiative (GRI) Framework. Several authors argue about the scarce HEIs' reports regarding SD (for example, Alonso-Almeida et al. 2015; Disterheft et al. 2013). Nevertheless, Alonso-Almeida et al. (2015) report the importance of GRI framework in terms of social impact.

In the campus context, and about the integration of SD in HEIs, Krizek et al. (2012) suggest four campus phases: (a) grassroots, (b) executive acceptance of the business case for sustainability, (c) visionary campus leaders, and (d) fully self-actualized and integrated campus community. In this scope, the social changes are identified by Stephens et al. (2008) regarding three different levels: (a) strategic; (b) tactical and (c) operational. The first refers to the definition and development of a strategic societal vision and long-term goals, the second to coalitions and cooperation among stakeholders, and the third to the implementation of changes through the curricula, research, campus operations and societal teaching for specific challenges.

3 Method

3.1 Research Questions

The study's aims were achieved through a qualitative research design. As an instrument of data collection, semi-structured interviews were used. The interviews were designed to measure the stakeholders' understanding and concerns about several activities and practices for SD in HEIs: (a) teaching the concepts of SD, (b) encouragement of research on SD issues, (c) green and environmentally friendly

Table 1 Interview guide

1. Do you consider that HEIs should teach the concepts of sustainable development to undergraduates and/or graduates (master's, doctoral) of its various faculties/schools? If yes: a. Why? b. How should this be formalized/implemented?
2. Do you consider that HEIs should encourage research on sustainable development issues? a. How can this be implemented or encouraged?
3. Do you consider that HEIs should implement efforts to make the campuses greener, e.g., environmentally friendly? a. How could this be implemented or encouraged? b. Should these decisions be centralized or decentralized?
4. Do you consider that HEIs should work with local authorities and civil society to promote more sustainable communities? a. In your institution's context in what way could this be implemented? b. Who should take this initiative?
5. Do you consider that HEIs must commit to results and actions through international structures? a. What are the benefits that might arise from this involvement?
6. In addition to the above, what other practices or measures could be implemented by Portuguese HEIs in order to promote sustainable development and/or become sustainable HEIs?

campuses, (d) cooperation between HEIs, local authorities and civil society to promote more sustainable communities, and (e) committing to results and actions through international structures. The interview guide is in Table 1.

3.2 Sample and Procedures

In Portugal there are 34 public HEIs (of which 20 are polytechnics and 14 universities). For this study's purposes, four HEIs were selected (the University of Aveiro, the University of Coimbra, the Polytechnic Institute of Leiria, and the Polytechnic Institute of Santarém). We opted for a convenience sample due to: (a) easier access to the required stakeholders for intervening, and (b) geographic proximity. In each HEI, we interviewed five stakeholders (one leader, one faculty member, one staff member, one student, and one external stakeholder), involving a total of 20 individuals. As Bengtsson (2016) pointed out, "in qualitative studies, it is common that data are based on 1 to 30 informants (Fridlund and Hildingh 2000)".

All participants were invited to participate in the study through personal contacts and email messages. Each respondent was interviewed once, through a face-to-face interview. All interviews were audio-recorded after obtaining written consents.

A content analysis methodology was used for the interviews. The data was analysed by implementing the four main stages identified by Bengtsson (2016): decontextualisation, recontextualisation, categorisation, and compilation. As suggested in the literature, each stage was repeatedly performed to maintain the quality and trustworthiness of the analysis.

4 Findings and Discussion

The following sections present the analyses of the data and are organized according to the questions asked in the interview process.

4.1 Teaching the Concepts of SD

Regarding the teaching of SD in HEIs' curricula, all respondents agree about its importance (N = 20). Some of the interviewers also referred the need of teaching this subject in the context of families, in the lower levels of education, and throughout life. As a faculty member said: "You have to be involved in everything. Moreover, it has to begin at home with the parents when the children are born and afterwards in pre-school, primary school and so on" (F_1).

In what concerns the best way to teach SD concepts, one staff member mentioned "We should teach and acquire a base knowledge of what SD is, how the first foundations for participatory citizenship and responsibilities should be. However, these questions could be diluted in different subjects, not only in a specific topic about SD" (Stf_4). In this context, some respondents referred to SD as a topic that should be introduced in curricula in a transversal way. One staff member said "A university does not only have a formal curriculum, and it does not only have the mission of giving formal education. It should also educate citizens and adults. It is the university's civic spirit. In a less formal sense, the word sustainability has always to be there. Not always in a specific technical way, or in a particular technical area, but in a transversal way" (Stf_2).

Other stakeholders, namely external stakeholders and leaders, also agree about the introduction of SD in courses and disciplines in a transversal way. An external stakeholder said: "I think that this should be transversal to all courses. It is this culture that has to be transmitted from kindergarten to higher education, where obviously it needs to be adapted to each domain, but that is transversal to all the university's domains" (Es_2). For a leader, "Sometimes we might not be able to justify changing a certain curricular course specifically to teach SD. However, in other cases, we can justify it. It all depends on the courses. Nevertheless, the concept should be transversal to all curricular units, all the courses, all education levels" (L_4).

Students and faculty members defend that SD should be taught through concrete actions. For a student, practice is the best way to achieve SD goals: "I think that the best way to implement these new ideas (…) is to put them into practice" (Sdt_4). A faculty member defends this same view: "Each course should include practical actions that could involve the students' participation" (F_4).

The common idea to all respondents is the importance of introducing SD in all courses and subjects in a transversal way, not only theoretically, but also through practical actions on campus.

4.2 Encouragement of Research on SD Issues

This section addresses the importance of research on SD topics. As with education, all respondents agree on the promotion of SD issues (N = 20). However, for some respondents, research should be done in all study areas, while for others there are subjects where it is more pertinent to investigate the topic than others. For instance, social sciences, engineering, and environmental areas are the ones more often mentioned. Other respondents mention that, taking into account the new framework of Horizon 2020 (European Commission 2015), the research on SD is critical and almost mandatory.

The main stakeholders agree on the need to do research in a strategic way and involving partnerships within the community, namely with companies. A faculty member: "HEIs should promote the investigation of SD issues, namely through synergies with the business community, and also promote partnerships with universities, NGOs and the business community" (F_4). For a staff member: "HEIs should, without a doubt, take care to encourage research on SD issues, and we do not need leaders to do it, because all financed projects have, at the moment, that component. For example, Horizonte 2020 has what it is called the "Cross-cutting issues", the so-called transversal themes, and SD is transversal. It fits everything" (Stf_3).

Despite the importance given to interdisciplinarity in recent times, there are constraints related to the change of mentality. Many of these constraints are associated with some professors who do not conceive this relationship, particularly when it comes to expanding the role of SD in society. Some professors express difficulties in understanding the need for promoting SD in all courses and training areas. Therefore, attitudes can condition such joint actions on behalf of SD and on behalf of the creation of HEIs that are sustainable and more open to society.

4.3 Green and Environmentally Friendly Campuses

When asked about the necessity for green and environmentally friendly campuses, all respondents considered that HEIs must have this concern (N = 20). The interviewees reported different practices and initiatives that SHEIs could implement. However, the practices listed and considered as significant by stakeholders, in the majority of cases, were not sufficiently developed. Stakeholders believe that the encouragement for sustainable campuses should come from above and be centralized in all schools, as in these examples:

- "There must be a strategy coming from the central services and the responsibility to implement it should be given to the organic units", a staff member said (Stf_4).
- "Yes, I think that the responsibility and the coordination of initiatives should come from the central services, but each department should be given the

autonomy to implement them and to motivate all stakeholders", said a student (Sdt_1).

Respondents agree with the initiative, mentioning the cost savings that this could bring. An external stakeholder, for example, says that "with the development of our society it is fundamental to adopt SD practices to sustain our planet, and this will be very important in the medium and long term where there is a need to have these worries. Moreover, I can say that the majority of these worries are compatible with economic development. "If I save energy, reduce waste production and water waste, I am lowering costs of my business" (Es_3). "The interaction with the natural environment is not a cost, it is an investment", said a faculty member (F_4).

There seems to be a tendency for believing that the adoption of green and environmentally friendly campuses result in cost savings. However, the lack of action regarding these initiatives is equally noted, and it is justified by the lack of financial and human resources.

4.4 Cooperation Between HEIs, Local Authorities and Civil Society to Promote More Sustainable Communities

The respondents agree about the need of cooperation between HEIs, local authorities, and civil society regarding SD. When questioned about who should take the initiative, most interviewees stated that any of those parties can take the first step (N = 13). For a faculty member, "We all have to take the initiative as soon as we see the opportunity. Also, when we see an opportunity or a problem that needs to be solved, we can't wait for others." (F_1). For a staff member: "All can take the initiative. The initiative can come from stakeholders or from institutions, to raise awareness, to encourage, to show a more efficient solution in a sustainable point of view." (Stf_4).

However, two interviewees (N = 2) reported that the initiative should come from HEIs, and one other believes that it should start in local and/or civil authorities. One leader mentions, "I think that universities should have the initiative as much as possible" (L_2).

4.5 Commitment to Results and Actions Through International Structures

Regarding the commitment of HEIs through international structures, all sample (N = 20) agrees about its importance. However, the respondents also referred that this commitment should be translated into day-to-day practices and not only into signed documents.

The various stakeholders mentioned the advantages of joining these structures. They can benefit from the network, as well as from the positive image they share and from the benchmarking of best practices.

As stated by an external stakeholder "I think that the interchange of experiences, ideas and concepts brings us closer to our goals" (Es_1). Moreover, for a leader, "I think that we can have access to good practices in international terms. We learn a lot with benchmarking, so all this sharing between HEIs is always very important. Because many times, it is with the knowledge of other realities that we can progress in our institution" (L_3).

As argued by Leal Filho et al. (2015) the exchange of experience at an international level is very important. The international organizations and rules "can be used as anchors eliciting action by constituencies" (Leal Filho et al. 2015, p. 125). Moreover, as proposed by Kamal and Asmuss (2013), benchmarking can be a tool for assessing and tracking sustainability in HEIs, and also a way for HEIs to learn how to implement it.

5 Conclusion

We first conclude that SD is recognized as being very important to HEIs and society, but it still has not yet entered HEIs' system and activities, as other studies already pointed out (Aleixo et al. 2016; Kościelniak 2014). The interviewees agreed about teaching the concept of SD, encouraging SD issues research, green and environmental friendly campuses, cooperation between HEIs and local authorities and civil society, and their commitment to results and actions. Despite all stakeholders being unanimous in accepting the importance of the ESD, in the opinion of the interviewed stakeholders, there are no formal and strategical declarations encouraging its implementation. In practice, there does not seem to exist many initiatives in HEIs, except for research and community outreach through partnerships and development services to companies and institutions. This evidence might be explained by financial necessity, and by the emphasis on funded projects related to the societal issue. The introduction of the SD concept in the curriculum and the development of initiatives on campuses could allow further integration of the concept in the regular activities of the Portuguese HEIs.

Faced with the new UN-DESD (2014–2025) it becomes essential to identify HEIs' strategies regarding SD. It is essential to introduce SD in HEIs, in all activities, through a "top down" process, starting with planned activities from the governing body, and then involving all stakeholders.

This research contributes to a better understanding of what some Portuguese HEIs are doing in what concerns SD education. It has no pretension to represent the institutional view of the HEIs considered in the sample regarding the theme, and even less the Portuguese panorama about it.

The paper has two main limitations. Firstly, the study can suffer from social desirability bias because the interviewees might have felt impelled to answer what they consider to be the "right answer" (that is, what is socially expected), instead of what they effectively think. This problem can occur with higher probability with leaders and faculty members. Future studies might ask about what is already being

done in HEIs concerning SD issues, and ask for evidence. Secondly, the convenience sample does not permit the generalization of results to all the Portuguese Higher Education system. Future studies should consider all Portuguese HEIs, or a representative sample of it, as well as information that could be analysed in a more quantitative way. The results of the present study should be seen as an input for future, and more holistic studies.

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The Importance of Incentives and Grants for Green Buildings

Erin A. Hopkins

Abstract

The aim of this manuscript is to reconsider the building lifecycle cost of Leadership in Energy and Environmental Design (LEED) buildings certified within the higher education sector. It adds to the work put forth in a previous study published by the author and focuses on the importance of incentives and grants as this type of building cost reduction can be extremely beneficial. In the previously published manuscript, the cost of green was examined from a full building lifecycle, but without the inclusion of incentives/grants. In this manuscript, 15 institutions of higher education (IHEs) were surveyed with the findings focused on the upfront green premium after incentives/grants and down the line energy savings. The net present value (NPV), internal rate of return (IRR) and discounted payback period were calculated to determine the financial feasibility of LEED certified buildings within the higher education sector after incentives/grants. These findings were then compared to the above-mentioned prior study which did not take into account upfront incentives and grants. The findings of this study indicate that incentives and grants are instrumental in decreasing upfront green premiums and increasing the financial feasibility for the full building lifecycle.

Keywords

Sustainability · Financial incentives · Green buildings · Cost benefit analysis

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1 Introduction

Although a more recent phenomenon, interest in campus sustainable development continues to grow. Developments such as the Talloires Declaration designed by the Association of University Leaders for a Sustainable Future, the American College and University Presidents Climate Commitment (ACUPCC), The Higher Education Sustainability Act (HESA), the International Journal of Sustainability in Higher Education (IJSHE), and the Association for the Advancement of Sustainability in Higher Education (AASHE) are testaments to this growing interest. LEED, which is an internationally recognized green building program which benchmarks high-performance green buildings, is also being undertaken by more IHEs to address campus sustainability. This can be seen when reviewing the increase in LEED registrations and certifications in the higher education sector. In 2004, there were less than 200 registered or certified buildings, growing to 1300 in 2009, and to 5432 in 2013 (Dougherty 2010; Van Mourik 2013).

Higher education institutions are in a particularly advantageous position to capitalize on the overall benefits of LEED certification as they are long-term landholders and can capitalize on the potential down the line cost savings (Ried 2008). Since LEED certification can have positive environmental and fiscal outcomes, it is important to compare the number of LEED certified and registered campus buildings with the number of universities in the United States. With over 7300 Title IV postsecondary institutions in the United States and only 5432 registered and certified LEED certified buildings, it is clear that many colleges and universities are not participating (National Center for Education Statistics n.d.) in sustainability initiatives; particularly in light of the possibility that multiple higher education LEED projects may be on one campus. The impact of a universal participation in campus LEED certification could be significant from both an environmental and financial perspective. Because of this potential significance, it is essential to understand if LEED registration and certification makes sense economically for the higher education sector and if grants and incentives assist with financial feasibility.

The first item to consider when examining the costs and benefits of a LEED certified building is the upfront cost to build to this requirement. One common barrier to adoption of green development policy in the higher education sector is the perceived increased upfront costs to build green versus conventional buildings (Cupido et al. 2010; Kats 2006; Richardson and Lynes 2007). This green premium perception has been tested by performing studies using actual building data, but the results are mixed. Upfront green building premiums are a reality for a variety of building types within multiple sectors (Hopkins 2015; Kats et al. 2010; Kats 2006; Kats et al. 2003). However, many building projects are achieving LEED certification within budget and within comparable cost ranges as non-LEED projects (Matthiessen and Morris 2004, 2007). Furthermore, it is possible to have a green building with no upfront green premium (Houghton et al. 2009).

Once the green building is in operation, it is important to adopt a full building lifecycle perspective to account for the effects of green buildings on operating costs; namely energy costs. One goal of green buildings, to reduce energy operating costs, is being achieved in numerous developments (Hopkins 2015; Kats et al. 2010; Kats 2006; Kats et al. 2003). However, some green buildings have energy savings less than their non-LEED conventional peers (Newsham et al. 2009; Stegall and Dzomback 2004). Worse, it is possible that no energy performance benefits are realized with a green building (Scofield 2002).

The extant literature is sparse when seeking research results on the costs and benefits of green building throughout the building lifecycle within the higher education sector. Also, the possibility of incentives and grants to help defray any identifiable upfront costs to build green has not been addressed. A study could not be found that looked at the full building lifecycle taking into account the green premium before and after grants/incentives. Although buildings have been reviewed for their green premium taking into account incentives/grants, the difference in green premium for buildings before and after incentives/grants is not assessed (Kats et al. 2010). And grants/incentives can be significant in decreasing the upfront green premium.

This study fills the gap in the literature by discovering the effects of grants and incentives on the upfront green premium financial barrier and its effects throughout the building lifecycle by performing a lifecycle cost benefit analysis. The prior study published by the author looks at actual initial costs of LEED-certified campus buildings versus conventional campus buildings and discovers that the median actual upfront green premium is $5.41/sf. This study builds on this previous study by providing a comprehensive cost-benefit analysis which analyzes the costs and benefits of green building across IHEs and the effects of grants and incentives on any upfront costs to build green.

2 Data and Methodology

The data were obtained through the creation and administration of an online survey instrument which was taken from Appendix A of Kats et al. (2010) and slightly revised. The two online survey questions of interest for this study were the green premium after incentives/grants and annual energy savings questions. Participants in this survey were identified by utilizing the "Higher Ed LEED registered and certified projects" database which displays all LEED-certified campus buildings in the United States. The database was found on the Center for Green Schools' website, a division of USGBC and last updated in July 2013 (http://www.centerforgreenschools.org/main-nav/higher-edu/buildings.aspx). Once the building projects were identified, the online survey instrument was sent via email to

employees who were in a director of facilities or similar role within the university where a LEED-certified project was located. The surveys were anonymous to encourage the sharing of sensitive financial information.

In order to determine if grants and incentives assist the financial feasibility analysis of LEED-certified campus buildings, three quantitative methods were employed to analyze the results of 15 online surveys. First, the online survey question regarding the green premium after incentives/grants was analyzed by calculating the average, median, and mode green premium per square foot of the sample. The most suitable measure was used to measure the average green premium of the sample after incentives/grants; taking into account outliers and the possibility of removal or trimming. These results were then compared to the previous study published by the author to examine any effects of incentives/grants.

The second quantitative method employed on the sample of LEED-certified campus buildings was a net cost-benefit analysis to determine if the down the line energy saving benefits outweigh any initial upfront costs of LEED-certified campus buildings after incentives/grants. One consideration for the net cost-benefit analysis is the building lifecycle time period. The time period for this study was selected by reviewing prior studies and then modifying the time period to account for higher education sector idiosyncrasies. A conservative twenty year time period was used by Kats et al. (2010) which included building types within multiple sectors. One critique of applying the same time period for all sectors is the lack of consideration for different uses, purposes, and goals of the building owners. However, as this study strictly focuses on the higher education sector, one timeframe seemed appropriate. Also, when compared to the private sector, IHEs operate buildings over a longer time period as they typically are the only building owner during the building lifecycle. According to Castaldi, the general life expectancy of a school building is approximately 50 years (as cited in Chan and Richardson 2005, p. 7). Also, twenty to forty years have been modeled as the project life for a case study of LEED-certified silver residence hall at Carnegie Mellon University (Weber and Kalidas 2004). Thus, the building lifecycle time period selected for this study was twenty-five years which seems to be conservative so that benefits were not overstated.

Another consideration for the net-cost benefit analysis is the discount rate. A 7 % discount rate was used by Kats et al. (2010) with the justification that "this rate is equal to or higher than the rate at which states, the federal government, and many corporations have historically borrowed money, and thus provides a reasonable basis for calculating the current value of future benefits" (Kats et al. 2010, p. 4). A lower discount rate was used for this study as it focused strictly on the higher education sector. 3.5 % seemed reasonable for the discount rate because private investment was not crowded out and the timeframe was not intragenerational (Moore et al. 2004).

The green premium dollar per square foot after incentives/grants was then inputted into year zero of the net cost-benefit analysis. The net energy savings, using ASHRAE 90.1 2007 as a baseline, were inputted throughout the 25 year building lifecycle timeframe. NPV, which consists of adding all discount cash flows together, was employed to measure project performance for each survey. The IRR was also calculated to further present the findings. These findings were then compared to the previous study results published by the author to illustrate any impacts of incentives/grants on LEED-certified campus buildings.

The third quantitative method utilized for this study, the discounted payback period, was calculated to uncover the payback period for LEED-certified campus buildings. The discounted payback period takes into account the time value of money by discounting the cash inflows of the project by using a discount rate; which is 3.5 % in this case. It is important to note that the discounted payback period was not used in isolation, but merely another calculation tool employed to analyze the data. These results were then compared to the results of the prior study results published by the author to demonstrate any influence of incentives/grants on LEED-certified campus buildings.

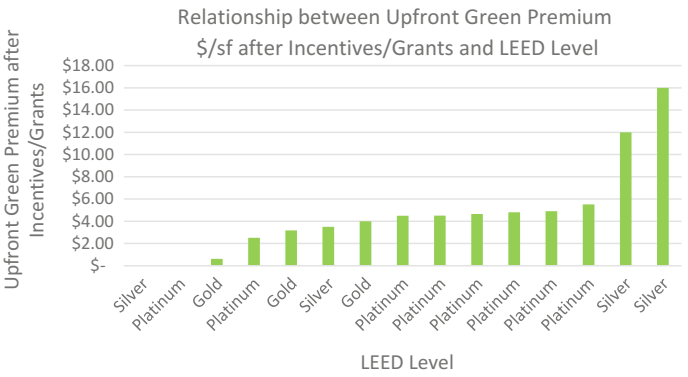
3 Results

A. **Upfront Green Premium**

The average function was employed in order to ascertain the upfront green premium for LEED-certified campus buildings after incentives/grants. Information was gathered on the green premium $/sf figures after incentives/grants from 15 online surveys. Responses ranged from $0.00/sf to $16.00/sf. In this case, the median of $4.49/sf was used to better represent the population as there were outliers and the average function would have been skewed by these outliers. The distribution is positively skewed as the mean exceeds the median. This is because there are high green premium/sf outliers.

The relationship between LEED level and green premium $/sf after incentives/grants was reviewed. As Exhibit 1 illustrates, there is no relationship between LEED level and green premium/sf after incentives/grants. The lowest green premium $/sf after incentives/grants was a LEED level platinum building and the highest green premium $/sf after incentives/grants was a LEED level silver building.

Exhibit 1
Relationship between LEED Level and Upfront Green Premium $/sf after Incentives/Grants

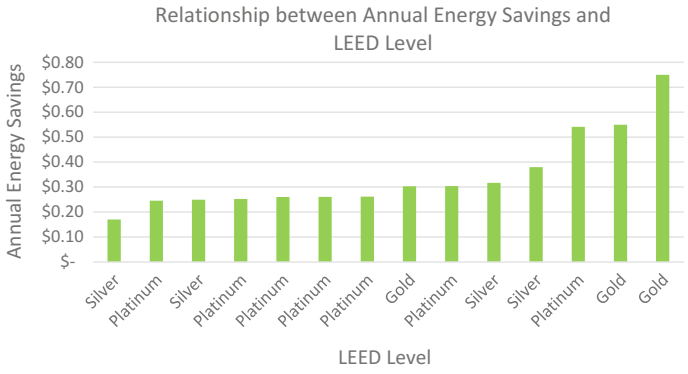


B. **Annual Energy Savings**

Information was gathered on the energy savings per year per square foot from the same 15 data-collection sheets. Responses ranged from $0.17/sf to $42.37/sf. In this case, since there was an outlier, the median of $.30/sf was used to better represent the population as there was an outlier and the average function would have been skewed by this outlier. The distribution is positively skewed as the mean exceeds the median. This is because there is a very high annual energy savings per square foot outlier.

The relationship between LEED level and energy savings per square foot per year was reviewed after removing the outlier of $42.37/sf. As Exhibit 2 illustrates, there is no relationship between LEED level and energy savings per square foot per year. The lowest annual energy savings $/sf were LEED level silver buildings and the highest annual energy savings $/sf was a LEED level gold building.

Exhibit 2
Relationship between LEED Level and Energy Savings $/sf/Year



C. Net Cost-Benefit Analysis

In order to address lifecycle energy benefits versus upfront costs of LEED-certified campus buildings after incentives/grants, a net cost-benefit analysis was performed. Calculating project performance criteria was done using NPV, IRR, and the discounted payback period for each survey with a discount rate of 3.5 % and a building lifecycle of 25 years. The NPV, IRR and discounted payback period for each of the 15 surveys are shown in Exhibit 3. NPVs ranged from −$11.89 to $698.32. IRRs ranged from −6.23 % to 122.95 %. The discounted payback period ranged from 0 years to 21.20 years. There were 7 surveys where the discounted payback period was not calculated as it exceeded the building lifecycle cutoff of 25 years.

Exhibit 3
Net Cost-Benefit Analysis Calculations

NPV	IRR	Discounted Payback Period
(11.89)	-6.23%	n/a
(5.74)	-1.72%	n/a
(1.47)	0.84%	n/a
(0.61)	2.31%	n/a
(0.50)	2.50%	n/a
(0.49)	2.50%	n/a
(0.18)	3.13%	n/a
0.51	4.52%	21.20
0.99	5.67%	18.02
1.72	7.61%	14.20
2.80	n/a	0.00
5.88	16.95%	6.58
6.41	21.40%	5.15
11.75	122.95%	0.84
698.32	n/a	0.00

4 Discussion

When reviewing previous literature, results showed an upfront green premium of $0–$9/sf. In regards to annual energy savings, results ranged from $.10 to $2/sf. The results for this study for the green premium ranged from $0.00/sf to $16.00/sf. There was an extremely high outlier of $42.37/sf in this study regarding annual energy savings. The respondent may have answered in a different measurement versus dollar per square foot and that is why the median was used in this case. Once this outlier was removed, the annual energy savings for this study ranged from $.17/sf to $.75/sf. When comparing the existing results to the current results without the outlier, they seem to be somewhat in line.

These current findings, when compared to the previous study published by the author, illustrate the important influences of upfront incentives and grants. In regards to the upfront green premium median, it is clear that incentives/grants have a significant impact contributing to a 17 % decrease in the upfront green premium. Furthermore, 63 % of surveys prior to incentives/grants exceeded the 25 year buildings lifecycle before incentives/grants versus only 47 % of surveys after incentives/grants. These results promulgate the importance of incentives/grants in order to facilitate green building within the higher education sector. It should be noted that the sample is not precisely the same for both studies being compared, but respondents who provided information regarding the upfront green premium before and after incentives/grants were included in both studies if energy savings for that respondent was available.

Just as in the prior study by the author which did not take into account upfront incentives and grants, there was also not a relationship between green premiums after incentives/grants and LEED certification level. Both the lowest green premium $/sf and highest green premium $/sf was a LEED level silver building. This could be due to different building projects obtaining different LEED points in order to achieve their particular LEED certification level. For example, one building project may have expended many more dollars to build to obtain 1 LEED point for brownfield development versus development density and community connectivity for 5 LEED points. The municipality and location of the IHE within that municipality may determine if an IHE would even qualify for the development density and community connectivity. For example, it is unlikely a building would qualify if it is in a setting such as a rural community with strict zoning density restrictions.

Again, as in the prior study by the author which did not consider incentives/grants, there was not a relationship between annual energy savings and LEED certification level. The lowest annual energy savings $/sf were LEED level silver buildings and the highest annual energy savings $/sf was a LEED level gold building. Again, this could be due to different building projects obtaining different LEED points in order to achieve their particular LEED certification level. For example, one building project may have decided to obtain 2 LEED points for introducing green power while another project may have opted to obtain 2 LEED points for materials reuse. This focus on introducing green power versus materials

reuse could potentially cause an increase in energy savings for one project versus another.

For the surveys where NPV was greater than 0, LEED-certified campus buildings were profitable. For the surveys where IRR was greater than the discount rate of 3.50 %, LEED-certified campus buildings were profitable. In regards to the discounted payback period, results less than the building lifecycle of 25 years made a campus building project profitable. More than half of the surveys had positive NPVs, IRRs greater than 3.5 %, and discounted payback periods of less than 25 years. These results show that the majority of campus buildings in this study did make sense financially. This is in contrast to the prior cost-benefit study done by the author which did not take into account incentives/grants. In that study, the majority of building projects did not make sense financially.

5 Limitations, Recommendations, and Conclusions

It is important to note that alternatives, such as using funds on other projects than LEED-certified campus buildings, were not measured which is a limitation of this study. Also, the results of this study cannot be extrapolated due to the small sample size. Another limitation of this current study is participation was not random as permission was needed from the IHE to obtain the data of interest. There were voluntary study participants sharing certain types of data which can create a potential bias in the selection of buildings. For example, IHEs only experiencing positive financial results may choose to participate. This study is also limited as it did not examine specific incentives and grants utilized by IHEs. As colleges and universities operate within variable landscapes, the incentives and grants opportunities may be vastly different. This study also did not look at green building requirements at the IHE. If a higher education institution has a green building requirement in place, they may be in a better position to organize and apply for grants and incentives.

Future research is recommended to review the specific grants and incentives utilized by IHEs to build sustainably. This can uncover trends and help identify the most widely used. It would also be interesting to conduct a qualitative study to find out how they found a specific grant or incentive and the lessons learned from going through the process to obtain the specific grant or incentive. Also, information on available green building incentives and grants should be disseminated to campuses so IHEs have the knowledge on which incentives and/or grants are available to help decrease the upfront green premium. This dissemination can be helpful in increasing utilization. Training on how to apply for and fill out the paperwork for these grants and incentives can also further foster implementation.

The purpose of this current study was to discover the impacts of incentives/grants on the upfront green premium and full building lifecycle when building to LEED certification standards. This study suggests that grants and incentives are instrumental in decreasing upfront green premiums and, therefore,

increasing the financial feasibility of the full building lifecycle within the higher education sector. This study furthers the research by providing the first comprehensive net cost-benefit analysis taking into account incentives/grants within the higher education sector.

The implications of this work are two-fold. First, this study should assist policy makers at higher education institutions considering implementation of a LEED-certified building by increasing their awareness of the benefits of incentives/grants to decrease the upfront green premium. Also, this study can be helpful to state and federal policymakers whom have the ability to provide IHEs incentives, such as grants, for upfront costs to build LEED-certified buildings. Secondly, this study fills the gap in the extant literature by providing a comprehensive cost benefit analysis taking into account incentives/grants for a sample of LEED-certified campus buildings nationwide.

In conclusion, interest in adopting sustainable development at colleges and universities is continuing to increase. One way to turn interest into adoption of sustainable development is the implementation of incentives and grants as they can decrease the upfront green premium and the full building lifecycle cost. As many higher education institutions do not have green building practices in place, a better system needs to be adopted to diffuse information on available green building grants and incentives. This can assist IHEs to realize green buildings and the correlating beneficial environmental and fiscal outcomes.

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Campus Living Lab Knowledgebase: A Tool for Designing the Future

Bojan Baletic, Rene Lisac and Roberto Vdovic

Abstract

Today university campuses and their new forms represent the cutting edge spatial and functional structures for conducting high quality educational, scientific-research and professional activities. Furthermore, holistic and interdisciplinary potential of processes conducted on universities and their campuses represent a living laboratory for development of urban areas and society in general: a polygon for inventing, implementing and evaluating new trends and potentials for future scenarios and sustainable development. The concept of the interactive university campuses knowledgebase represents a new programming and planning tool aimed at efficiently linking worldwide universities, encouraging interaction on the campus planning topics, and facilitating the comparison and improvement of planning strategies and activities. By examining universities in Europe and worldwide—their campuses, social, cultural and urban context and planning activities—it will be possible to compare different planning methods and campus activities. With continuous input base becomes a living tool and planning method that lives and develops itself fast and efficiently, inspiring future planning of campuses and urban areas based on global and contemporary experience.

Keywords

Knowledgebase · University campuses · Future designing and planning · Sustainability

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1 Introduction

Global processes in our environment, society as well as economics are leading to saturation and depletion of capacities to be in long term sustainable. Elements of crises are emerging in vulnerability of the environment, lack of social capital and resilience, as well as economic instability (Lisac 2012, p. 7–8). Thus, over the last decades sustainability has become an unavoidable issue in planning, especially in urban areas. Sustainable efforts are emerging worldwide, showing different approaches and giving their first results. Yet clear and integral vision of truly sustainable future is still missing, as well as direct and reliable pathways how to get there. Together with sustainability and urban planning declarations, best practices around the world represent important guideposts to lead the way. Availability of global knowledge can mislead us to universal models and central systems that tend to collapse, while in sustainability local and diverse solutions are way to go, assuring resilience to global changes (Dunster 2009). Collecting valuable experiences from worldwide examples of sustainable strategies and planning, with deep understanding of their motifs, methods and results can be of great help for developing unique local strategies but based on global knowledge and experience.

Today university campuses and their new forms represent the cutting edge spatial and functional structures for conducting high quality educational, scientific-research and professional activities. Furthermore, holistic and interdisciplinary potential of processes conducted on universities and their campuses represent a living laboratory for development of urban areas and society in general: a polygon for inventing, implementing and evaluating new trends and potentials for sustainable development. Acting as small cities in their urban structure and desired social complexity, planning experiences from university campuses are valuable for future development of cities (Baletic et al. 2015).

Therefore, this paper introduces the concept of the interactive university campuses knowledgebase. It represents a new programming and planning tool aimed at efficiently linking worldwide universities, encouraging interaction on the campus planning topics, and facilitating the comparison and improvement of planning strategies and activities. By examining universities in Europe and worldwide—their campuses, social, cultural and urban context and planning activities—it will be possible to compare different planning methods and campus activities. With continuous input the knowledgebase becomes an adaptable tool and planning method that lives and develops itself fast and efficiently, inspiring future planning of campuses and urban areas based on global and contemporary experience.

2 Sustainability and University Campuses

At the second half of 20th century, together with global acknowledgment of sustainable development, worldwide university leaders recognize the important role of universities in the process. Through several conventions and declarations in early

90, from "Talloires Declaration" (Association of University Leaders for Sustainable Future) in 1990, "Halifax Declaration" (International Association of Universities, United Nations University and Association of Universities and Colleges of Canada) in 1991, to "Swansea Declaration" (Commonwealth Universities, Swansea) and "Copernicus Charter" (Association of European Universities) in 1993, they commit themselves to implement sustainability principles in university activities. In other words universities are dedicated to follow a number of guidelines to integrate sustainable development into all parts of their institution. The Principles for Responsible Management Education (PRME 2005) is a UN Global Compact sponsored initiative with the mission to inspire and champion responsible management education, research and thought leadership globally. Higher education institutions become signatories to the six Principles for Responsible Management Education. University potential for sustainable development and society evolution in general can be observed through its three main objectives: scientific research, educational activities and professional work.

All three main university activities meet at university campus, a cutting edge spatial and functional structures for conducting high quality educational, scientific-research and professional activities, which, when intelligently combined, form a living laboratory for new and sustainable society. How? Interdisciplinary research teams are developing and testing inventions and models in the spirit of holistic approach. New technologies and social solutions are implemented and evaluated on site. Students, new generations of professionals, are raised in the context of new trends and sustainability, take part in processes of implementation. Creative and interdisciplinary environment combined with concentration of university infrastructure and knowledge open opportunities for start-ups and spin-offs, new economic activities. Campus connects with local communities, disseminates experiences in scientific community and public, cooperates with government in policy making, and so on. But not only campuses may act as small "cradles" for future society, all this university activity play an important and influential role for the urbanity of the surrounding city. University cities often contain healthier, richer and more diverse city life then for example industry or even tourism based cities.

Accepting this importance of universities, International organization ISCN (International Sustainable Campus Network) was formed as a global forum for research, information and best practices exchange on sustainable campuses. Trough their continuous activities they give support to universities and corporations in integration of sustainability in their campuses and activities. Between 2008 and 2010 ISCN working group has been developing a comprehensive and integral document "ISCN Guidelines", an effort to summarize all possible instructions for planning and managing sustainable campus (ISCN-GULF 2010). This inspirational guidebook for universities, developed in juncture of sustainability research and worldwide experiences in practice, became a focus of research at University of Zagreb, Faculty for Architecture and eventually a basis for a knowledgebase concept.

3 Certification Systems and the Knowledgebase Concept

Besides international declarations, charters and ISCN Guidelines, what are the existing tools for developing sustainable campuses and universities? For architecture and urban planning there are several existing certification models that evaluate overall sustainability of new as well as renovation projects. LEED, BREAM, CASBEE, MINEERGIE and similar systems recognize and evaluate sustainable practices in construction as an incentive to their continuous efficiency and cautiousness to the environment (Lisac 2012, p. 20–21).

The LEED integral certification system for urban projects and buildings was presented in 2007 by several organizations led by U.S. Green Building Council (USGBC), ten years after first version of certification for only buildings. Although developed in the USA, it became international through training of technicians and auditors worldwide. All LEED certification system uses the checklist methodology. A point system is related to a list of requirements, checks whether the project complies with the requirements to get different certification standards. Final certification of the evaluation object is obtained from the compliance of all prerequisites and the direct sum of credit points of all categories, awarding with LEED Certificate, Silver, Gold and Platinum certification (UEAB 2012, p. 15–16; USGBC 2016).

The BREEAM certification system for planning was developed by the organization BRE Global (Building Research Establishment) from the UK and it was presented as a pilot in 2008. BREEAM system also uses checklist methodology to evaluate an object (design or construction) based on pre-established requirements related to various aspects, such as design, construction or metabolism during the lifespan of urban development. The result of the evaluation is determined by the percentage of total credits earned and weighted with values set for each region implementing the evaluation system, awarding Pass, Good, Very Good, Excellent and Outstanding BREEAM certification level (UEAB 2012, p. 21–22; BREEAM 2016).

CASBEE for Urban Development was launched in 2007 by the Institute for Building Environment and Energy Conservation—IBEC with local industry and academic representatives in Japan. System was established as a tool for planning, to assist in the evaluation and planning of strategies for energy saving in the urban scale and to stimulate awareness on environmental aspects. Aiming to be simple as possible, applicable to a wide variety of subjects and cases and to consider the issues specific to Japan and Asia, it also uses checklist methodology to consider all stages of the life cycle of the built environment. Final certification is obtained from the BEE indicator value, derived from achieved quality and resulted environmental load ratio (Q/L), certifying from 1 to 5 stars levels (UEAB 2012, p. 29–30; IBEC 2016).

Certification or guides are an example of the initiatives that intend to collaborate in the development of activities in the building and urban planning sector, aimed at the achievement of sustainability objectives. They intend to foster the "green" competitiveness in the market to raise the quality of the products and services by introducing new criteria and values in productive activities (UEAB 2012, p. 11–12). Still to achieve better understanding of connections between the sustainability categories that are subject of evaluation and quality enhancement, as well as necessary integration of social sustainability criteria more comprehensive tools have been developed.

"Ecosystemic urbanism certification" is an example of such methodological guide, brought by Directorate-General for Land and Urban Policies, Department of Housing and Urban Interventions—Ministry of Development, Government of Spain in 2012, to evaluate more objectively sustainability of new urban development as well as existing urban environment transformation (UEAB 2012). First advantage that this systemic guide shows is as mentioned before inclusion of social sustainability criteria in the list of categories that are subject to evaluation. Secondly this certification has developed a set of elaborated guidelines including examples of urban solutions as very specific recommendations with their influences to sustainability. As third advantage to checklist methodology of LEED, BREAM and CASBEE systems, Ecosystemic urbanism certification recognizes importance of connections between separate criteria, and integral planning that in one design measure intelligently includes solutions for as many criteria as possible.

This short overview of some existing certification systems show continuous evolution of methodology, evaluation categories, their detail level as well as understanding of how to approach development of sustainable environment issues. Their aim is to evaluate and enable benchmarking between projects, to enhance desired values and raise their economic competitiveness. To achieve that goal, quantitative unifying system that levels different projects with one or a set of numerical data is necessary. On the other hand knowledgebase concept is aiming to promote diversity of the solutions, offer understanding of causes of differences that lie in surrounding conditions, and most of all to give inspiration for new solutions that may come even from unexpected and in some way marginal examples. Furthermore, our path in sustainable development direction is continuously evolving and we need open systems that can simultaneously evolve its criteria and develop together with our understanding of sustainability and quality of examples in practice.

4 Criteria for Sustainable Campuses and Database Development

Between year 2010 and 2012 a comprehensive research was carried out on University of Zagreb, Faculty for Architecture to understand the nature of campus sustainability. Proceeding to the knowledgebase development, research focus has

been set on defining clear and structured set of criteria, by which simple and transparent systematization of separated campus activities is possible. Started with analysis of ISCN Guidelines document, combined with theoretical insights on sustainability principles and campus structure as well as operations, research resulted with integral understanding of its relations and mutual influence. The table of sustainable campus criteria illustrates how each planning principle influences sustainability in its segments (Fig. 1). Each colored box denotes where certain

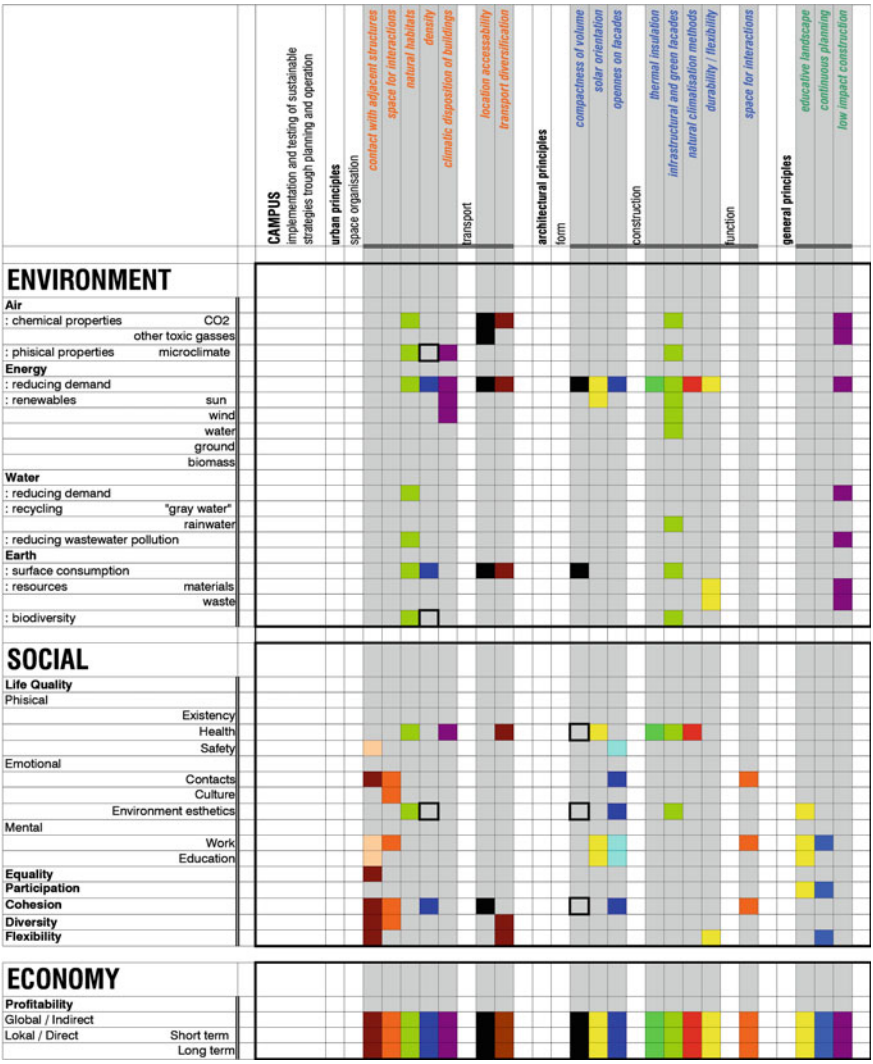

Fig. 1 Table of influence between planning principles and sustainability demands. *Source* Lisac (2012)

interaction between campus planning and sustainability exists. Likewise, this system explains how each sustainable campus guideline, as well as activity and measure in practice, can be described by criteria from the fields of sustainability (environment, society, economics) together with criteria from campus structure and operations. In other words, sustainable campus activity meets certain sustainability demand in a particular segment of a campus (Lisac 2012, p. 84–86).

Detected criteria became a framework for a future knowledgebase, a period from year 2012 to 2014 was dedicated to develop knowledgebase structure and together with criteria test it on several campus planning case studies. In collaboration with International Sustainable Campus Network (ISCN), University of Luxembourg (UNILU), Ecole Polytechnique Fédérale de Lausanne (EPFL) and Australian National University (ANU) first case studies together with Harvard Allston and Zagreb Borongaj campuses were collected. They were analyzed, divided into separate planning and operation measures as first entries into the knowledgebase beta version—examples of particular sustainable activity conducted by university. The main goal in the case studies testing was to answer and resolve some critical issues like how much in detail and on how many levels should criteria be divided to ensure logical connections between measures that match same criteria, how many criteria should be connected to a measure to enable efficient functioning of a knowledgebase, which set of information should one entry of sustainable campus measure contain?

As a result, four fields of criteria were formed: (1) Environmental criteria and (2) Social processes criteria from the sustainability issues, together with (3) Architecture and Urban Planning criteria and (4) Academic Activity criteria from campus structure issues. Each field is further subdivided into thematic areas. Air, Energy, Water, Waste and Land Use are environmental areas, while Social Well-being, Participation & Involvement, Social Quality, Fostering Local Economy and Academic Life cover social areas. In campus structure, Building, Landscape, Transport and Urban represent Architecture and Urban Planning areas while Management, Education, Research and Outreach cover Academic Activity areas (Baletic and Lisac 2010), (Fig. 2).

5 Knowledgebase Structure

The smallest unit or entry for the knowledgebase is separate university planning activity on campus—a sustainable campus planning measure. Associating corresponding criteria to the activity allows selective separation of worldwide or on campus measures that deal with certain sustainability phenomenon or campus segment. For example, it is possible to review and compare how water management is dealt with on different campuses or what activities on campus relate with water; what measures campuses undertake to enhance social cohesion or support sustainable transportation, what sustainability aspects influence open spaces design, with witch different patterns and forms can these measures result with, and so on.

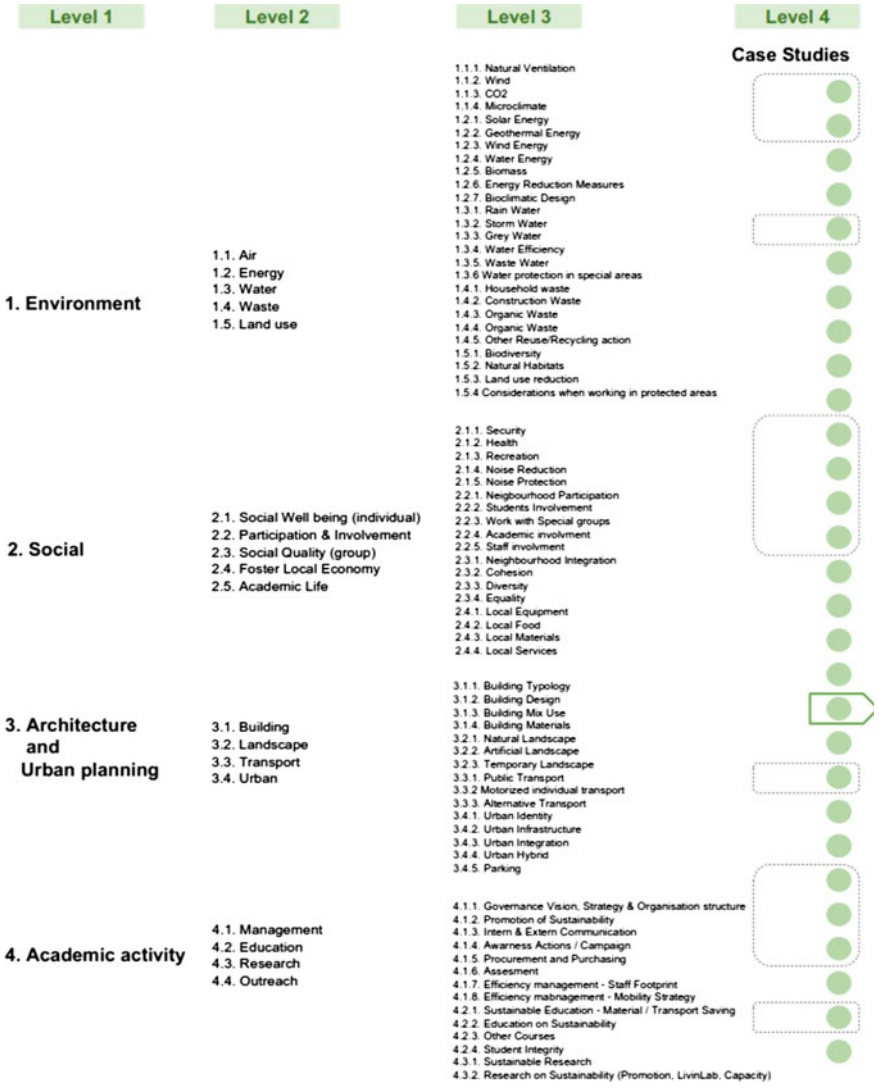

Fig. 2 Knowledgebase criteria, table overview showing their structure with 4 level depth. *Source* Baletic (2015)

Structured like this, knowledgebase contains integral networked knowledge that simultaneously enables focused and thematic insights for comparison, research and inspiration (Fig. 3).

Other important issues in the knowledgebase development process were how to structure information in all measures, so they can be comparable between each other. Analyzing dozens of collected worldwide measures, eight main categories were chosen. Depending on the stage of an activity (planning, construction,

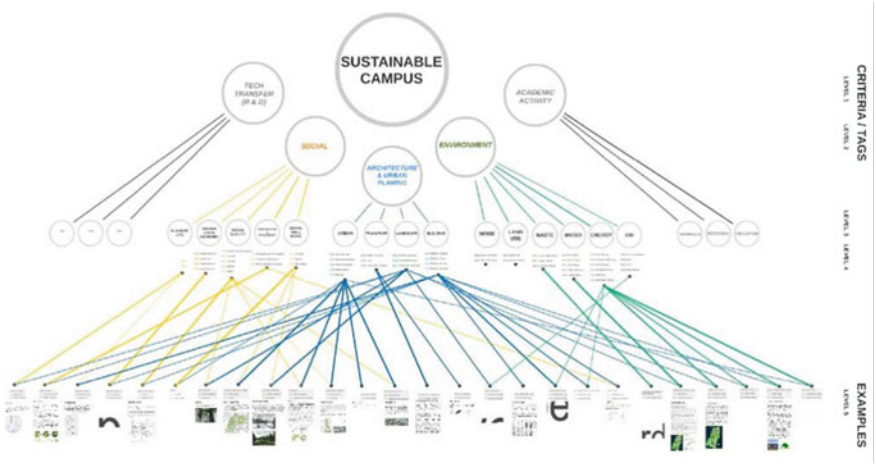

Fig. 3 Knowledgebase structure, diagram overview showing criteria—measures connections. *Source* Baletic (2015)

maintenance), universities can describe their measures in as many categories as possible from: (1) **Measure goal and description** (title, goal, short description), (2) **Measure details** (methods of achieving the goal, systems used or processes carried out, subjects involved and time required), (3) **Measure challenges** (specific problems and challenges dealt with in the process), (4) **Measure results/status** (specific results of the measure, continuous monitoring results), (5) **Finance** (cost data, financial analysis of cost efficiency, pay-backs from measure), (6) **Graphics** (descriptive graphic material of the measure, schemes, illustrations, photos), (7) **Annex** (additional information of importance) and (8) **Links** (google map/earth pin, web site for more information), (Baletic and Lisac 2010).

Each sustainable campus planning measure is a separate entry in the knowledgebase; still a sum of measures from one university represents its sustainability case study, inseparable to its academic, social, national and environmental contexts. So, all university measures in the knowledgebase are connected to several chapters, including: University and campus description (general info, history, campus master plan and architecture, relation to the city), campus numerical data (no. of faculties, companies, institutions, students, employees, residents, campus area, floor space, etc.), campus sustainability strategy, institutional context and governance (degree of autonomy, decision-making process on infrastructure matters), (Baletic and Lisac 2010). Schematic illustration of database structure (Fig. 4) shows how database is filled with case studies (from bottom) and how can the same data be approached by users from three different directions: searching through certain university activity, trough worldwide location of activity or sustainable campus criteria.

To illustrate clearly how measures are connected with knowledgebase criteria, example from University of Zagreb, plan for sustainable campus Borongaj is presented in the following chapter.

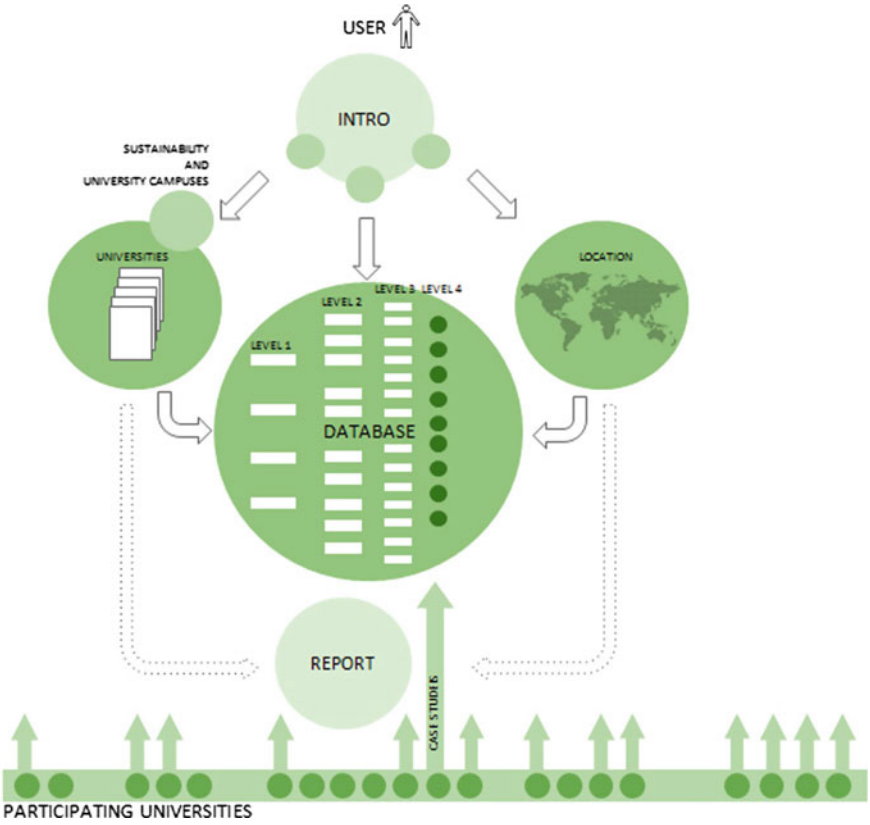

Fig. 4 Complete knowledgebase structure, case studies input and three directions how to approach data: searching through certain university activity, through worldwide location of activity or sustainable campus criteria. *Source* Baletic (2015)

6 Measure Example, Campus Borongaj

Borongaj Campus is a new development at University of Zagreb, an extension of university locations, at the eastern part of the city. Aiming to solve current space deficiencies and issues of the faculties and lack of student accommodation, new campus will provide contemporary research, education and development synergies—new academic experiences in sustainable built and natural environment. First strategic and spatial solution for campus was obtained through open architecture and urban planning competition in 2011, designed by professor and architect Hrvoje Njiric (2011). Through numerous planning as well as management measures like bioclimatic design, sustainable and car free internal transport, wind corridors and urban greenery, building energy efficient systems and design, planning of spaces for social interaction on all levels, empowering social diversity and cohesion on campus

and so on, comprehensive plan for Borongaj covers majority of important sustainable campus criteria. Unlike checklist approach just to fulfill criteria one by one, all elements of Borongaj campus design naturally reflect noumerous and different sustainability principles, from environmental to social ones. In other words, creative and intelligent way how sustainable measures are connected and manifested in urban and architectural design, potentially announces a new level and understanding of sustainable planning (Lisac 2012, p. 138–139). This makes Borongaj campus plan a very interesting and important case study for the knowledgebase.

To illustrate how campus design can integrate several different criteria and how a knowledgebase entry looks like, measure from the Borongaj plan named "Urban Farming" is presented here. Socially and environmentally conscious student activity of urban farming is introduced into university campus that is in the development phase. Plots for future buildings are occupied immediately for agricultural activity, in time they become glasshouses for more intensive production, till they turn into campus building—an energy efficient concept of building within glasshouse envelope (Njiric 2011). This measure in the same time fosters student involvement, defines character of artificial landscape and enhances biodiversity on campus, as well as involved and continuous sustainable development of buildings.

1. **TITLE**

   Urban Farming

2. **DESCRIPTION**

   Urban farming: empty clearings for the future faculty lots and free stripes cut through the forest serve as test-beds for experimental urban occupation.

3. **OBJECTIVES**

   We propose to diversify flora and fauna, empower people, manage whole systems and maximize long-term benefits.

4. **STAKEHOLDERS**

   University (student associations, staff, neighbors), city of Zagreb

5. **DURATION/start-end**
6. **CONTEXT**

   Use of lot reservations for the future

7. **REALISATION STEPS**

   Time-biased landscaping: (1) Soil preparation (2) Pathway construction (3) Formation of voids—stripes and clearings.

   Phase 0: In order to achieve the desired image of identity and completeness from the very start, the initial stage of the project (without constructing any

of the faculties) envisages: the shaping of the park + temporary commercial glasshouses (at the clearings for the future faculties).

8. **BUDGET**

   Unknown at the moment

9. **RESULTS**

   Produce, teamwork, recreation, neighborhood, involvement,…

10. **CONTACT**

    Bojan Baletic, bojan.baletic@arhitekt.hr

\+ **LOCATION DATA**
\+ **MAP**
\+ **ILLUSTRATIONS**

1: Campus Borongaj Master Plan (Fig. 5)
2: Campus Borongaj Urban Gardening initiative (Fig. 6).

The **Campus Living Lab Knowledgebase** project is aimed to be developed as a multimedia application for the iPad and the web. If we assume that 20 institutions can provide in average 50 interesting examples of sustainability practice or plans the knowledgebase would house some 1000 examples—sustainable measures. Systematic structuring through linking case study measures with sustainable campus criteria together with illustrative and informative nature of different patterns on campus enables easy thematic searching through this complex and numerous set of information contained in knowledgebase, depending of the point of interest. Expected users for the knowledgebase application are University Policy Makers, Campus Facility, Sustainability Managers, Planners, Architects, Sustainability Professionals, Public. Confronting with several elaborated worldwide examples of specific sustainable practice that show different approach inspire different professionals and expands their perspective.

Currently, data base is in the development phase. First case studies from four universities have been acquired and as a part of testing case study measures have been filled in the database. First demo version, financed by Croatian science foundation, will be presented in September 2016. Future full development of the knowledgebase, financing through EU funds as well as participation with case studies, is expected in the framework of UNICA international organization network. UNICA is an institutional network of 46 universities from 35 capital cities of Europe, combining over 150,000 staff and 1,800,000 students.

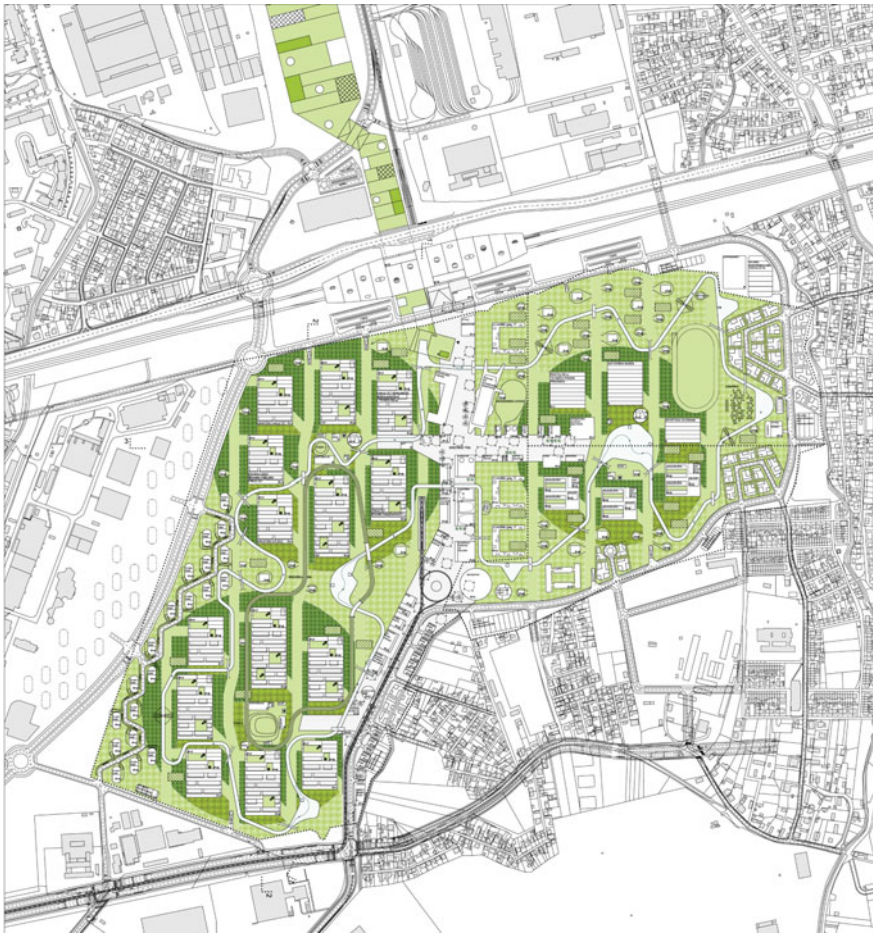

Fig. 5 Campus Borongaj master plan. *Source* Njiric (2011)

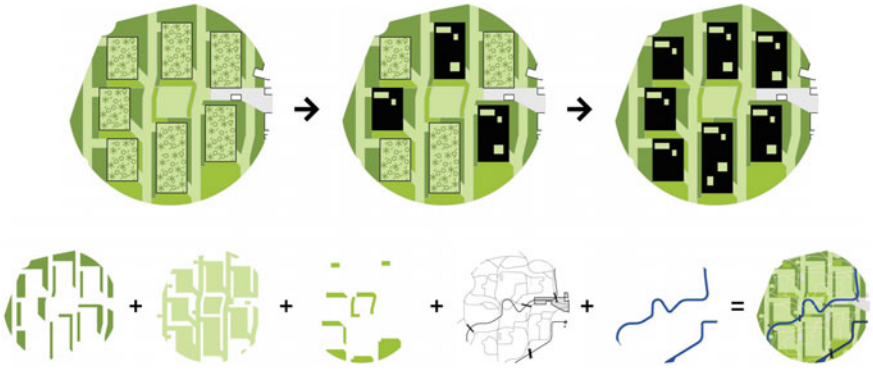

Fig. 6 Campus Borongaj urban gardening initiative strategic scheme. *Upper* images show development of building plots through time, while *bottom* images show components of the artificial landscape. *Source* Njiric (2011)

7 Conclusion

Universities and their campuses play an important role in sustainable development of cities and society in general. As a source of creativity, knowledge and interdisciplinary interactions, placed in a city like structure prone to continuous development, they become a living lab for improvement in all possible societal scenarios. In the context of complex environment of numerous and interlinked sustainability principles and guidelines, Campus Living Lab Knowledgebase represents a cutting edge tool to accelerate evolution of our sustainable future vision and planning or designing our built environment. Instead of forcing implementation of fixed set of directives and universal solutions, it was recognized that worldwide universities and campuses, coming from different social, ecological and economic context, need an open system to inspire for diverse and locally adapted solutions. We were interested in a system that confronts the user with the complexity of the problem, that questions his category system, and offer him along with the clear the unexpected lines of inquiry to his problem. It needs to inspire and support the "out of the box" thinking.

In the Croatian context, spatial transformation of Zagreb University is in progress. Planning of campus Borongaj, consolidation of other University zones in the city and sustainable renovation of existing buildings opens new areas for research and testing of new planning models, processes and technologies. Knowledgebase examples can inspire Croatian planners, City and University of Zagreb leaders to develop and accept more advanced sustainable measures, locally adapted but corroborated by global experience.

Long term scenario of knowledgebase use means of continuous accumulation of new worldwide experiences. New campus activities, inspired by the knowledgebase, advanced and tested in practice, become new base entries leading to continuous evolution of methods and criteria—a sustainable planning and future scenarios paradigm shift. Knowledgebase becomes a method and a planning tool that follows cutting edge trends, develops itself fast and efficiently presenting global experience but preserving local particularities.

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Author Biographies

Prof. Bojan Baletic, Ph.D. M.Arch is a full professor at the University of Zagreb, Faculty of Architecture. From 2006 to 2014 he served as vice rector for master planning and inter-institutional cooperation at the University of Zagreb. He is the author of the University master plan and was responsible for the development of the new campus areas. He was the editor of the "University and the City" book edition at the University of Zagreb. In 2011 he was a working group coordinator in the International Sustainable Campus Network. He serves as a member of the City of Zagreb Partnership Council. He is a member of the Croatian Academy of Engineering and a member of a number of professional associations.

At the Faculty of Architecture he teaches the Digital Design course. He served twice as the vice dean and was responsible for the curricula reform. From 2005 he was a member of the workgroup for architectural education at the Architectural Council of Europe. He was also a member of the workgroup for education and a member of the workgroup for international relations at the Croatian Chamber of Architects. In 1989 he established the CAD Forum conference in Zagreb and a year later the MediaScape international conference that is still active. Bojan Baletic is also the author of architectural projects and multimedia presentations. He has headed or participated in a number of national and international interdisciplinary research projects. He has published over seventy scientific and professional articles and has been invited to give lectures in Croatia and abroad. In 2005 he received from the University recognition for the promotion of international cooperation in the scientific, artistic and educational field.

Assistant Prof. Rene Lisac, Ph.D. M.Arch is working as a research fellow—assistant at the Cabinet for computer application in architecture, Department for Architectural Design at the Faculty of Architecture, University of Zagreb since 2004. He teaches courses "Introduction to computer application", "Computer Application in Architecture I" and "Computer Application in Architecture II". He also worked as a research assistant on the scientific research project "The living space in the digital age" (2004–2007) and is currently working on the project "The Digital House typology" (from 2007 till today), both being under the leadership of prof. Dr. Sc. Bojan Baletic. In the spring of 2007 he enrolls the doctoral study at the Faculty of Architecture, University of Zagreb. In July 2012 he defends his doctoral dissertation with the title "Guidelines system for sustainable campus planning", under the mentorship of prof. Dr. Sc. Baletic.

Rene authored several research articles and participated in domestic and international conferences. He also attended various summer schools and professional congresses. Rene published and continues to publish his professional papers in Croatia as well as abroad. He is the designer behind several built projects, and the author of several complete conservation studies, organized workshops and exhibits. As a contestant, Rene participated in a number of urban and

architectural competitions with success, winning 4 awards and five runner ups. He is also an active member of the Croatian Architects' Association and the Zagreb Architects' Association, works as executive board member from 2013–2015, as president form 2015. In the Zagreb Architects' Association, he is one of the authors of the interdisciplinary project "City Acupuncture". Since 2011, the project has been funded by the European programme "Culture 2007–2013", for which Rene Lisac is the programme coordinator. Since January 2015. He is coordinating City Acupuncture project activities in the framework of interdisciplinary and participative project "Zagreb for Me" in collaboration with the City of Zagreb and Faculty of Architecture, University of Zagreb, aiming on revitalizing 17 public spaces in Zagreb.

Roberto Vdovic Ph.D. candidate Msc. March is working as a research fellow—assistant at the Department for Architectural Design at the Faculty of Arhitecture, University of Zagreb since 1993. He teaches courses "Introduction to CAD", "Computer aided architectural design—3D modeling" and "Computer aided architectural design—3D visualization and presentation". He also worked as a research assistant on the scientific research project "The living space in the digital age" (2004–2007) and is currently working on the project "The Digital House typology" (from 2007 till today), both being under the leadership of prof. Bojan Baletic, Ph.D. In the spring of 2005 he enrolls the doctoral study at the Faculty of Architecture, University of Zagreb his doctoral dissertation with the title "Visual Impact Assessment", under the mentorship of prof. Baletic, Ph.D.

Roberto authored several research articles and participated in domestic and international conferences. He also attended various professional congresses. Roberto published and continues to publish her professional papers in Croatia as well as abroad. His continuous interest in state-of-the-art technology and cutting edge implementation results with developing his own visualization and multimedia projects from 1990–2000, and recently developing 3D printing devices and explore digital fabrication implementation in architectural structures. Hi is founder and president of FabLab, as a part of international FabLab association and project leader for partner institution of Make-IT Horizon 2020 project.

Urban Sustainability Profiling: A Case Study from Far North Queensland, Australia

Colin J. Macgregor

Abstract

Cities and towns are places for human survival and well-being. They are also places where the greatest sustainability challenges of the century are expected to emerge. In Australia, urban development is largely the responsibility of accredited planners who are inclined to prioritize bureaucratic and political requirements over local scientific knowledge in decision-making. Sustainable development (SD) emphasizes local scientific knowledge because it draws attention to the social and environmental fabric of communities that is known to support economic performance. One of the first steps in any urban SD initiative is to 'take stock' (profile) the town's ecologic, social, economic and political capital and comprehensive urban sustainability profiling can support effective planning decision-making and SD. This paper reports on research underlying an urban sustainability profile for the town of Malanda in Far North Queensland, Australia. The research was conducted by a team of students from James Cook University as part of their sustainability studies. The research required collection of primary and secondary data (qualitative and quantitative) and a credible and useful urban profile emerged. The research process also provided an effective problem-oriented, place-based learning (POPBL) experience for the students.

Keywords

Urban sustainability profiles · Problem-Oriented Place-Based learning

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1 Introduction: Urban Profiling and Sustainable Development

> The future will be predominantly urban, and the most immediate environmental concerns of most people will be urban ones (WCED 1987).

Cities and towns have become the dominant form of human settlement. Today, 54 % of the world's population lives in urban areas, and this is expected to increase to 66 % by 2050 (UN 2014). Humans are increasingly choosing to live in cities and towns because of the economic and social development opportunities they offer; they are central places for economic growth, innovation, and employment (Cohen 2006). In this respect, cities and towns may be regarded as one of the greatest achievements of human civilization; however, environmental, social and economic challenges are evident in all urban places even in developed nations. For example, it has been estimated that cities account for some 75 % of the world's energy use (WWF 2012) and they are responsible for 75–80 % of global greenhouse gas (GHG) emissions (Satterthwaite 2008). Sustainable development of cities and towns implies consideration of a broad range of factors, which may be said to fall into four domains: ecological, economic, political and cultural.

Those responsible for the development of cities and towns (typically, urban planners) have a strong professional orientation. Most professional planners in Australia are accredited by the Planning Institute of Australia (PIA) upon completion of a PIA accredited bachelors or masters degree. Planners are therefore highly educated and they tend to take a traditional approach to planning practice, which is based on rules of thumb, tradition, experience, bureaucratic requirements and political processes (Krizek et al. 2009). Many in the planning profession perceive urban research, such as that concerned with sustainable urban development, as either marginally relevant or not directly applicable (Krizek et al. 2009). However, commentators such as Corburn (2005) and Krizek et al. (2009) emphasize there is increasing pressure and to take account of local and scientific knowledge in planning decision-making, which is also critical to ensure sustainable urban development. But, where should planners and urban researchers begin? Urban profiling is a technique used by urban researchers and others concerned with urban development to determine those aspects of urban life that may require attention—either management or development planning. This paper reports findings from the application of urban sustainability profiling assessment technique carried out for a small town (Malanda) in Far North Queensland, Australia. The assessment was mostly carried out by students enrolled in James Cook University's (JCU) *Bachelor of Sustainability* to both inform the Malanda community about opportunities for sustainable development in Malanda, and to provide the students with an effective problem-oriented, place-based learning (POPBL) experience, which is the underlying pedagogy of the degree.

2 Problem-Oriented, Place-Based Learning

POPBL is well regarded as the most effective approach to learning for sustainability (e.g. Domask 2007; Lehmann et al. 2008; Fang 2013). Macgregor (2015) identified three main components of the POPBL approach: *cognitive learning* (learning organized around problems and carried out in projects); *contents learning* (emphasizes interdisciplinary learning and exemplary practice where theory and practice come together); and, *collaborative learning* (emphasizes collective identification of problems and ownership of projects and the learning processes). POPBL also emphasizes adaptive management where students are encouraged to continually reflect on the effectiveness of their research process and where appropriate adjust the research methods employed. Urban sustainability profiling is regarded as a valuable POPBL experience because: (a) urban sustainability problems are often 'wicked' in nature i.e. they are difficult to define, have many interdependencies and are socially complex, and sustainability assessment involves consideration of all these; (b) data collection involves researchers (students) actually spending time in the urban locality (fieldwork); (c) data collection requires students to work in teams i.e. students are required to work together to collect and manage data; and finally, (d) data analysis, synthesis and reporting requires students engage in critical systems thinking, which is fundamental to sustainable development (Hjorth and Bagheri 2006).

The urban sustainability profiling case study was developed for second year students undertaking the subject *EV2011 The Case for Sustainability.* Profiling fitted with the learning outcomes for the subject, which included:

- critically appraise the role and relevance of sustainability and sustainable development in local, regional and global society;
- demonstrate a broad understanding of problem-oriented sustainability approaches, including stakeholder analysis, values clarification, interdisciplinary collaboration, and systems and futures thinking;
- retrieve relevant and appropriate information from a range of sources;
- plan and conduct reliable, evidence-based desktop and fieldwork sustainability investigations, by selecting and applying appropriate methods;
- organise, analyse and interpret sustainability data using mathematical, statistical, technological and/or interpretivist skills, and convey ideas, arguments and conclusions clearly and coherently using suitable written and oral media.

3 Urban Sustainability Profiling Frameworks

Urban profiling has been used by urban geographers and others for many years but most of these have been concerned with particular features of urban life e.g. the provision of services. The emergence of sustainability and sustainable development

requires a much more holistic and systemic examination that at least considers the 'triple-bottom-line' (environment, society, economy). Two notable urban sustainability profiling frameworks are summarized below, the latter of which forms that basis for Malanda's assessment.

The European Union (EU) SusSET Project (Sustainable Small Expanding Towns) involved 12 towns from Scotland, Sweden, Poland and Greece (three case study towns from each country). These towns worked for almost three years exploring and sharing their ideas and experiences around local sustainability. The results are contained in a 'toolkit' which was shared with other EU towns but is now generally available (see: http://www.pagodagraphics.com/susset/welcome.html). The heart of the SusSET model revolves around 18 criteria spread across the conventional triple-bottom-line domains of environment, economy and society (Table 1).

The case study towns in the SusSET project had populations between 5000 and 35,000 (INTERREG IIIC, n.d.). The 18 themes (criteria for assessment) may be regarded as sufficiently comprehensive for towns of this size; however, Paul James (2015) in his book *Urban Sustainability in Theory and Practice: Circles of Sustainability*, argues that "Positive sustainable urban development needs [to] take seriously the integral importance of economic, ecological, political and cultural factors. In particular, questions of culture need to be taken more seriously and directly". The *Circles of Sustainability* (CoS) approach, which may be reviewed at: http://www.circlesofsustainability.org/, considers four 'domains' of urban sustainability i.e. ecology, culture, politics and economics (Table 2).

There are seven criteria within each domain. By responding to questions for each criterion it is possible to generate a simple graphic representation of the sustainability profile for the urban locality under consideration. James (2015) suggests four

Table 1 Urban themes associated with sustainable small expanding towns

Domain	Criterion
Society	• Identity & Culture • Equal Opportunity & Inclusion • Community Dialogue & Engagement • Partnership/local governance • Community Safety & facilities • Healthy Living & Community Well-Being
Environment	• Long Term Planning • Housing • Natural heritage • Built heritage • Environment quality • Waste, Water & Energy Consumption
Economy	• Transportation & Infrastructure Investment • Jobs & Employment • Tourism • Marketing & Promotion • Networks & Connections • Town centre management

Adapted from INTERREG IIIC (n.d.)

Table 2 Urban themes associated with circles of sustainability

Domain	Criterion
Ecology	• Materials & Energy • Water & Air • Flora & fauna • Habitat & food • Place & Space • Constructions & Settlements • Emissions & Waste
Economy	• Production & Resourcing • Exchange & Transfer • Accounting & Regulation • Consumption & Use • Labour & Welfare • Technology & Infrastructure • Wealth & Distribution
Politics	• Organisation & Governance • Law & Justice • Communication & Movement • Representation & Negotiation • Security & Accord • Dialogue & Reconciliation • Ethics & Accountability
Culture	• Engagement & Identity • Recreation & Creativity • Memory & Projection • Belief & Meaning • Gender & Generations • Enquiry & Learning • Health & Wellbeing

Adapted from James (2015)

approaches to data collection: (1) Rapid Assessment Profile; (2) Aggregate Assessment Profile; (3) Annotated Assessment Profile; and (4) two options for a Comprehensive Assessment Profile. The approach adopted will depend on context, but clearly the availability of time and resources will also affect the choice of approach. The Rapid Assessment could in theory be carried out in just a few hours; on the other hand, a Comprehensive Assessment could take as long as a few months to complete depending upon the scale of the urban centre. Whatever assessment approach is adopted, mean judgment scores for all 28 criteria must be calculated based on a nine-point sustainability scale (Fig. 1).

A mean score of 0–0.9 indicates the need for critical or urgent change, while a mean score of between 8 and 9 implies vibrant long-term sustainability. It is an adaptation of James' (2015) *Circles of Sustainability* approach that was adopted for Malanda's assessment.

0 to 0.9	1 to 1.9	2to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 9
Critical	Bad	Highly Unsatisfactory	Unsatisfactory	Basic	Satisfactory	Highly Satisfactory	Good	Vibrant

Fig. 1 The scale of urban sustainability. *Adapted from* James (2015)

4 Study Location: Malanda, Far North Queensland

The case studies featured by James (2015) are nearly all large city-scale (typically above 3 million people) but the approach is certainly not constrained to cities with large populations; all urban localities may be assessed using the methodology. The township of Malanda was chosen as the case study for students of *EV2011* partly because, being a relatively small town, the profiling would be manageable within the constraints imposed by an undergraduate subject. Malanda is also within easy reach of JCU's Cairns campus so travel to and from the town is relatively easy.

With a population of approx. 1700 people, Malanda is located on the southern part of the Atherton Tablelands about 80 km south-southwest of Cairns in Far North Queensland, Australia. The area surrounding Malanda has traditionally been dairy farming and while much of the surrounding lands are still used for this purpose, tourism is a very important part of the Atherton Tablelands economy and Malanda is benefitting from this. The town may also be regarded as a fairly typical Australian country town in that it provides essential community and commercial services to its residents and those living in the surrounding hinterland. It is notable that much of the residential population is retired and elderly.

5 Assessment Methods

For James (2015), urban sustainability profiling is centred on four basic questions:

- *How sustainable is ecological resilience in the urban area?* This question refers to the extent of people's impact upon the environment and their involvement with nature.
- *How sustainable is the economic prosperity of the urban area?* Rather than just being concerned with wealth or material possessions, this question also refers to the extent to which the urban community engages in activities relevant to their economic wellbeing and the extent to which the local economy is capable of adapting to changes beyond the locale.
- *How sustainable is political engagement of people in the urban area?* This question seeks to provide an understanding of the extent to which members of the community participate and collaborate in local political processes that affect themselves and others.
- *How sustainable is the cultural vitality of the urban area?* This refers to the extent to which the local community is able to maintain and develop their beliefs, celebrate their practices and rituals, and cultivate diverse systems of meaning.

Clearly the quality of an assessment depends upon the expertise of the researchers and on this note it is important to acknowledge the constraints and limitations implied by involving second year undergraduate students in this assessment.

- The students of *EV2011* were involved in building their research capacity so they did not have all the skills needed to fully respond to the questions above.
- There was very limited time available to undertake the research; in particular, there was only one full day available to collect data in the field however, field data were supplemented with secondary data from published/online sources.
- Many of the research questions imply examination of people's values, attitudes and behaviour. Research involving human subjects has ethics implications and JCU employs an Ethics Committee to determine any ethical issues. Time constraints meant it was not possible to obtain ethics approval for the assessment so students were unable to survey or interview Malanda residents or other stakeholders.

Table 3 summarises the general questions associated with the seven criteria within each domain.

The general questions contained in Table 1 form the basis of a Rapid Assessment Profile (see above) but in the case of Malanda it was possible to achieve a more Comprehensive Assessment by obtaining a combination of field and secondary data based on more detailed 'particular' questions. Most of the particular questions were derived directly from James (2015) but in some cases minor adjustments were made to ensure they were contextually relevant. For the benefit of managing student data collection, field collection methods and secondary data sources (e.g. suitable documentary sources and websites) were provided to students e.g. as was the case with Ecology: Water & Air (Table 4).

Table 4 reveals two measures associated with each particular question. For example, question (c), which is concerned with air quality, has a measure based on primary data collected from the field i.e. unpleasant smells or odours; and, a measure based on secondary air quality data provided by a local site recognized by the National Pollutant Inventory (NPI) website (http://www.npi.gov.au/npidata/action/load/map-search). A pseudo quantitative score (/9) was determined for each measure based on a subjective interpretation of the sustainability standard expected. In the case of air quality, a score of 9/9 emerged for both measures because the air in and around Malanda had no obvious smells and the latest NPI data revealed that of the nine substances of concern all were below their designated threshold levels e.g. emissions of Carbon monoxide in the year 2014/15 at Malanda were 4100 kg (the threshold is 10,000 kg/year). A mean score for each particular question was calculated by adding the scores revealed by primary and secondary measures. It should be acknowledged that all field observations and scores, e.g. for the presence of odours, were derived from just one day's observations and other days in the year may not be odour free. Finally, particular question scores were summed and an Overall Mean Score calculated, e.g. 6.8/9 (Table 4).

Table 3 Profiling domains, criteria and general questions

Domain	Criterion	General questions
Ecology	• Materials & Energy	• How sustainable is energy production for the urban area?
	• Water & Air	• How sustainable are the levels of air quality and water quality in the urban environment?
	• Flora & Fauna	• To what extent is biodiversity sustainable across the urban region?
	• Habitat & Settlements	• How well does the urban area relate ecologically to the landscape on which it is built?
	• Built form & Transport	• Does the form of the urban area and its transport system support sustainable living?
	• Embodiment & Sustenance	• How sustainable is the urban area in supporting the physical health of people?
	• Emission & Waste	• How sustainable is the way the urban area deals with emissions and waste?
Economy	• Production & Resourcing	• How sustainable are the broad patterns of production and resource access in the urban area?
	• Exchange & Transfer	• How sustainable is the current movement of money, goods and services into and through the urban area?
	• Accounting & Regulation	• How robust are the various accounting and regulatory frameworks in the urban area?*
	• Consumption & Use	• How sustainable are the current consumption patterns of the urban area?
	• Labour & Welfare	• How sustainable are the conditions of work across the urban area?
	• Technology & Infrastructure	• To what extent is basic infrastructure in the urban area appropriate and supportive of a cross-section of needs?
	• Wealth & Distribution	• Is the wealth of the urban area sustainable; and, is it distributed in a way that benefits all?
Politics	• Organisation & Governance	• How well does the current system of governance function to maximise benefits for all?
	• Law & Justice	• How well does the dominant legal system work?
	• Communication & Critique	• How sustainable is social communication access in the urban area?
	• Representation & Negotiation	• How well are citizens of the urban area represented politically?
	• Security & Accord	• How secure and peaceful is the urban area?
	• Dialogue & Reconciliation	• Is meaningful dialogue possible between groups with significant political difference in the urban area?
	• Ethics & Accountability	• How ethical is social life in the urban area?*
Culture	• Identity & Engagement	• Does the urban area have a positive cultural identity that brings people together despite individual differences?
	• Creativity & Recreation	• How sustainable are creative pursuits in the urban area—including sporting activities and creative leisure activities?
	• Memory & Projection	• How well does the urban area deal with its history in relation to projecting visions of alternative futures?
	• Belief & Meaning	• Do residents of the urban area have a strong sense of purpose and meaning?

(continued)

Table 3 (continued)

Domain	Criterion	General questions
	• Gender & Generations	• To what extent is there gender and generational well-being across different groups?
	• Enquiry & Learning	• How sustainable is formal and informal learning in the urban region?
	• Health & Wellbeing	• What is the general level of well-being across different groups of residents?

*These two questions could not be considered in *EV2011* due to logistical constraints on data collection

Adapted from James (2015)

Table 4 General and Particular Questions associated with Ecology (Water & Air)

General question: how sustainable are the levels of air quality and water quality in the urban environment?		
Particular questions (James 2015)	Suggested data sources	Mean scores
(a) Bodies of water in the urban area and broader region?	• Count of lakes, ponds, reservoirs, rivers, irrigation in urban region; evidence of water sensitive urban design (WSUD) in the urban area	
	• Satellite imagery e.g. *Google Earth*	7
(b) Water quality of surface water e.g. rivers, drainage channels, lakes and ponds?	• Observed clarity/colour i.e. turbidity, algae; waste discharge pipes; fish or other aquatic life; sewerage treatment; erosion	
	• Published state/local government water quality data (turbidity, dissolved oxygen, N, P etc.)	8
(c) The continuous presence of good quality air in the urban region?	• Unpleasant smells or odours in any urban area e.g. sewerage treatment, landfills, industrial areas; factory emission flues/stacks	
	• Air quality data from the National Pollutant (NPI) Inventory website	9
(d) The liveability of the urban region's climate and CBD microclimate?	• The extent of street shading (trees, eves, walkway shelters etc.)	
	• Temp range data from Bureau Of Meteorology (BOM) Climate Data Online	7
(e) Rainwater collection/use in the urban area?	• Number of houses with rainwater tanks	
	• Houses with rainwater tanks (*Qld Globe* imagery); rainfall data from BOM Climate Data Online (proxy indicator)	4
(f) The development of climate-change adaptation strategies for the urban area?	• Infrastructure installed e.g. sea walls, erosion prevention	
	• Local government websites for evidence of adaptation strategies/projects	6
Overall mean score (sum of mean scores /9)		6.8

6 Malanda Urban Sustainability Profile Assessment—Principle Findings

There are 28 criteria in all so potentially there are up to 168 particular questions involved in a full profile. In the case of Malanda it was not possible to assess two criteria (Accounting & Regulation and Ethics & Accountability) and it was sometimes not possible to consider a full set of six particular questions for each of the 26 remaining criteria e.g. four criteria were informed by four particular questions (the Politics domain proved to be the most challenging to obtain data). Despite data constraints, Malanda's profile was informed by responses to 134 particular questions producing a comprehensive assessment.

Malanda's overall mean sustainability score was 5.6/9 indicating the town had attained a 'Satisfactory' score on the sustainability scale (Table 5). Being the mid-point on the scale, this suggests Malanda's sustainability allows for a 'basic equilibrium' (James 2013) over the next 30 years (one generation), which is regarded by the Bruntland Commission's (1987) definition of sustainable development as that which meets the needs of people now, without compromising the needs of the next generation. Of the four domains Malanda scores highest on the Culture domain (6.4—'Highly Satisfactory') and worst on Ecology (5.2—Satisfactory) implying the town is neither performing especially well or badly in any of the four domains. Variances across the four domains and 28 criteria are displayed in Table 5 and graphically in Fig. 2.

Space does not permit explanations for all 28 criteria in Table 5 and Fig. 2 so the following considers the highest and lowest scoring criteria in the four domains. In Ecology, a score of 6.8 (Highly Satisfactory) emerged for Water & Air. This is mainly due to the fact that, as already noted, Malanda has good air quality (a country location with very little industry) and water in local rivers is clear and unpolluted. It is notable that the score for Water & Air would have been even higher had a greater proportion of houses in Malanda installed rainwater tanks. The Flora & Fauna criterion is much lower—3.4 (Unsatisfactory). The main reason for this is the presence of exotic weeds in remnant vegetation, parks and reserves, and the general lack of trees and other vegetation along roadsides. This has obvious aesthetic implications but it also implies lack of habitat for fauna e.g. native birds and bees etc., which were not observed.

In Economy, the highest scoring criterion is Technology & Infrastructure (6.0—Highly Satisfactory). Variables here included education infrastructure such as schools and libraries but also residential Internet access. Australian Bureau of Statistics census data (ABS 2011) indicate that most residents of Malanda have Internet access in their homes but the local council (Tablelands Regional Council) also provides a well-serviced library and primary school, and there is also a state secondary school. All these are regarded as being of a standard above what may be expected in a town of Malanda's size. The lowest scoring economic criterion is Labour & Welfare (3.7—Unsatisfactory). This score was partly informed by employment data and on this Malanda has a reason to be concerned. The range of

Table 5 Results from Malanda urban sustainability profiling, 2015

Domain	Criterion	Total mean scores	Mean domain scores
Ecology	• Materials & Energy	6.4	5.2
	• Water & Air	6.8	
	• Flora & Fauna	3.4	
	• Habitat & Settlements	5.0	
	• Built form & Transport	4.2	
	• Embodiment & Sustenance	5.3	
	• Emission & Waste	5.2	
Economy	• Production & Resourcing	5.2	5.3
	• Exchange & Transfer	5.5	
	• Accounting & Regulation	5.3*	
	• Consumption & Use	5.8	
	• Labour & Welfare	3.7	
	• Technology & Infrastructure	6.0	
	• Wealth & Distribution	5.8	
Politics	• Organisation & Governance	4.0	5.4
	• Law & Justice	5.8	
	• Communication & Critique	6.0	
	• Representation & Negotiation	5.2	
	• Security & Accord	5.3	
	• Dialogue & Reconciliation	6.3	
	• Ethics & Accountability	5.4*	
Culture	• Identity & Engagement	4.8	6.4
	• Creativity & Recreation	6.4	
	• Memory & Projection	7.1	
	• Belief & Meaning	7.2	
	• Gender & Generations	5.5	
	• Enquiry & Learning	6.8	
	• Health & Wellbeing	6.8	
Overall mean sustainability score /9			5.6

*These two scores are derived from the mean domain score

employment opportunities is quite limited, unemployment is higher than neighbouring larger towns, and job vacancies (as advertised in local newspapers etc.) appeared very low.

As indicated above, obtaining data to inform the Politics domain proved challenging without interviewing relevant stakeholders. Nevertheless, worthwhile data were obtained which provided useful insights. The highest scoring criterion here was Dialogue & Reconciliation (6.3—Highly Satisfactory). This was informed by data supporting recognition of Traditional Owners' values e.g. use of Indigenous place names, museums displaying local past events/stories, multicultural events and festivals. All these appear to feature quite strongly in Malanda. The weakest score

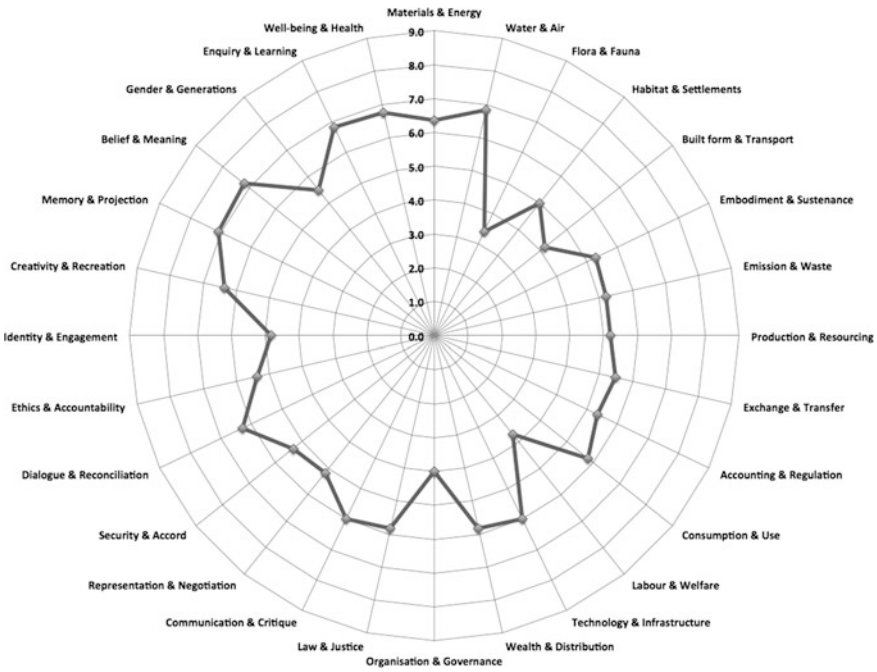

Fig. 2 Malanda's mean urban sustainability scores, 2015

in this domain was Organisation and Governance (4.0—Basic). This was mainly informed by the range of government services provided in Malanda, which was minimal. The largest town in the district (Atherton) is just 18 km to the north and a good range of local government services are provided there. However, since Malanda has a generally older population, some of these residents could find accessing government services in Atherton challenging because the region is not serviced well by public transport.

Finally, the high and low criteria in the Culture domain are Belief & Meaning (7.2—Good) and Identity and Engagement (4.8—Basic). Belief & Meaning was informed by the range of spiritual activities, places and events in the town. For example, Malanda has five functioning church buildings, which is quite a lot for a town of just 1700 people. There is evidence of other spiritual and culturally related activities available in the town as well, many of which are advertised in local newspapers and on community notice boards. Identity and Engagement was partly informed by secondary data such as those provided by the ABS census e.g. country of birth, ethnicity and language spoken at home. These data revealed a culturally homogenous town with little diversity. This criterion also considered public meeting places and while there are quite a few public places for people to meet and converse there was no evidence of people actually using these places on the day of the assessment.

7 Discussion and Implications

The value of urban sustainability profile assessments, such as the one featured here, will be obvious. Any intention to produce scoping documents or strategic sustainable development plans for urban localities first requires an inventory of where the town is with respect to sustainability. Findings from such assessments provide indications about specific areas that may require special attention, either in terms of management or planning. Low scoring criteria may become targets for investment and attention, while those that score high, may be managed to ensure they continue to perform well. Even if strategic planning is not on the agenda, simply obtaining a picture of where a town or city is with respect to sustainability will help inform local initiatives, and regular assessments (e.g. every five years) should reveal trends about sustainable development or otherwise.

In the case of Malanda there are some notable implications from the findings of this study. First, it is important to acknowledge Malanda's successes. The community evidently regards the town favourably; the population has remained fairly stable over the last three census periods (15 years) and many elderly people are choosing Malanda as a place to retire. The extent of tourist visitations also confirms that Malanda is regarded as an attractive country town. It has many endearing features e.g. the oldest theatre in Queensland (the 'Majestic'), the Malanda Falls Regional Park (MFRP) and Visitor Centre on the edge of town, easy access walking trails and outdoor recreational facilities, excellent aged care facilities, and there are many historic buildings with both aesthetic and heritage value. It is no surprise then that most tourists who visit the Atherton Tablelands include Malanda in their itinerary. In economic terms tourism is an area that the town may be able to capitalize further on.

There is however some areas revealed by the assessment that are of concern. Allocating the 28 criteria into priority categories (levels) based on natural breaks in the scores reveals the criteria of most concern (Table 6).

The highest priority (Level 1) contains six criteria. Level 2 contains 14 criteria and Level 3 (criteria of least concern) contains eight criteria. Those with responsibility for Malanda's management and future development (e.g. Tablelands Regional Council) may wish to regard the Level 1 criteria as indicators for management/planning priorities. The remaining discussion is confined to consideration of Level 1 priority criteria.

As mentioned above, one of the most important ecological issues is the presence of environmental weeds in and around Malanda. These include Michelia/Golden champaca (*Michelia champaca*), Asparagus fern (*Asparagus plumosus*), Wild tobacco (*Solanum Mauitianum*) and Guinea grass (*Panicum maximum*). Weeds detract form the visual appeal of natural areas and they impact on environmental integrity and biodiversity (it is notable that Michelia is present in the MFRP). The condition of riparian areas is another issue. While there has been some impressive efforts by local people to rehabilitate riparian areas, e.g. along parts of the Johnstone River, there are sections of this river and associated streams where improvements

Table 6 Priority criteria for planning and management for Malanda, 2015

Criteria (domain)	Total mean scores	Priority level
• Flora & Fauna (Ecology)	3.4	1
• Habitat & Settlements (Ecology)	5.0	1
• Built form & Transport (Ecology)	4.2	1
• Labour & Welfare (Economy)	3.7	1
• Organisation & Governance (Politics)	4.0	1
• Identity & Engagement (Culture)	4.8	1
• Embodiment & Sustenance (Ecology)	5.3	2
• Emission & Waste (Ecology)	5.2	2
• Production & Resourcing (Economy)	5.2	2
• Exchange & Transfer (Economy)	5.5	2
• Accounting & Regulation (Economy)	5.3	2
• Consumption & Use (Economy)	5.8	2
• Technology & Infrastructure (Economy)	6.0	2
• Wealth & Distribution (Economy)	5.8	2
• Law & Justice (Politics)	5.8	2
• Communication & Critique (Politics)	6.0	2
• Representation & Negotiation (Politics)	5.2	2
• Security & Accord (Politics)	5.3	2
• Ethics & Accountability (Politics)	5.4	2
• Gender & Generations (Culture)	5.5	2
• Materials & Energy (Ecology)	6.4	3
• Water & Air (Ecology)	6.8	3
• Dialogue & Reconciliation (Politics)	6.3	3
• Creativity & Recreation (Culture)	6.4	3
• Memory & Projection (Culture)	7.1	3
• Belief & Meaning (Culture)	7.2	3
• Enquiry & Learning (Culture)	6.8	3
• Health & Wellbeing (Culture)	6.8	3

could be made. If further rehabilitation were feasible (e.g. weed removal and replanting with native species) this would improve biodiversity, connectivity and visual value. It is also notable that the MFRP and riparian areas around Malanda are important habitats for Lumholtz's Tree-kangaroo (*Dendrolagus lumholtzi*) and the Tapping Green Eyed Frog (*Litoria genimaculata*), both of which are classified as Rare under Queensland's Nature Conservation (Wildlife) Act (1994). While these are all issues of concern it is encouraging to know that there are local community groups working hard to manage these e.g. the *Malanda & Upper Johnstone Landcare Group Inc*., the *Trees for the Evelyn and Atherton Tablelands Inc.*, and the *Tree-Kangaroo and Mammal Group Inc*.

The standard and availability of public transport may also be regarded as another important issue of concern in Malanda. With few public transport options available (no train service and a limited bus services) residents are dependent on private motor vehicles, which is a significant sustainability issue. Providing cost-effective reliable public transport is always challenging in rural towns with smaller populations but the case for improving these in Malanda is strong given the comparatively older residential population. On this last point, older residents would also benefit from improving the availability of disabled parking and wheelchair access to shops and public buildings. And, if more dedicated walking/cycling tracks were provided this too might help lower car dependency.

Lack of employment opportunities is a common concern in small Australian country towns, especially in regional/remote areas (Collits 2000). One of the implications is declining populations, and while Malanda's population has remained fairly stable it is likely that this is because the town has been attracting retirees. Unemployment in the town is not especially high—7.3 % compared with Queensland's 6.1 % (ABS 2011); however, opportunities for employment within Malanda are limited. The biggest industry in the town is dairy products but most employment is in retail and health (aged) care, both of which are relatively lowly paid. That said, Malanda is not an expensive town in which to live and housing may be regarded as affordable. The median house price for Malanda is $280,000, compared with neighbouring Atherton at $317,500 and Cairns at $410,000 (REA Group 2015; Keegan 2016). However, there is no major supermarket in Malanda so grocery prices are generally higher when compared with Atherton and Cairns. The Malanda branch of *Tableland LETS* (Local Exchange Trading System) is very active and the main drop-off/collection centre is located in the town. *Tableland LETS* (T-LETS) provides a wide range of local food and commercial services which members pay for in *Bartles*, the local exchange currency of T-LETS. The contributions LETS schemes can make to community sustainability has been acknowledged for many years (e.g. Davis and Davis 1987; Lang 1994); importantly, by using *Bartles* instead of conventional Australian dollars members are able slightly lower the cost of living in the locality. However, when it comes to employment, many residents commute to nearby Atherton or Mareeba for work, while others undertake the 80 km commute to Cairns where they can access a broader range of higher paid jobs. There is a fairly active regional Chamber of Commerce (*Atherton Tableland Chamber of Commerce*) that does what it can to encourage commercial and business development but attracting new enterprises to small country towns is always challenging.

The other major employer in Australian country towns is local government (LG). As discussed above, Malanda contains very few LG services; there is the local primary school and library but other LG services e.g. road maintenance, waste management, parks maintenance, planning, licensing etc. are provided from offices in the largest Tablelands central place of Atherton. If the Tablelands Regional Council could decentralize and provide at least some of these services from an office in Malanda then it would support local employment and improve the accessibility of the services to locals.

Lastly, despite having some historic architectural buildings, Malanda did not score especially high on the Identity and Engagement criterion (associated with the Culture domain). There are two notable tourist attractions; the Malanda Dairy, which has a café/restaurant that contains a display showing off Malanda's dairy and timber history. This café is probably one of the most visited sites by tourists, the other being Malanda Falls Visitor Centre. However, these cater to tourists and there is little else in the town that supports residents' cultural identity or sense of place/community, another widely regarded important element of local sustainability (e.g. Uzzell et al. 2002).

8 Conclusions

James (2015) demonstrated the value of the *Circles for Sustainability* urban sustainability profiling approach when it was applied to large-scale city contexts e.g. cities with population more than 250,000. However, the approach remained untried and tested in small town contexts. The findings presented in this case study (Malanda, Far North Queensland, Australia) indicate the approach is equally as effective for small towns as it is for large cities. However, further research into the application of the approach is warranted to further refine the methods, especially for small towns.

Nevertheless, an informed and effective profile for Malanda emerged in this case, even though the vast majority of the researchers were inexperienced in both field and secondary data collection and analysis. The results from this assessment are consistent with what is known about Malanda from various publications and informal conversations with local people and other stakeholders.

It must be acknowledged that this particular study was constrained by university ethics bureaucracy, which precluded any form of consultation with local residents or other stakeholders e.g. local government representatives. Many of the assessed criteria would certainly have been better informed by the inclusion of survey and/or interview data. This is especially the case for many of the particular questions within the Politics and Culture domains. Those considering using the methods described here, particularly those who may be contracted to undertake such work on a commercial basis in support of an urban strategic plan for example, will want to ensure their assessment includes as strong community engagement component.

Despite the limitations, this study provided strong indications of priority areas in Malanda that need attention in order to support and progress sustainable development. It is clear that local government has an important role; for example, by decentralizing its services for more local delivery. However, Malanda is fortunate in that there are many active community, religious and even sporting groups that are all supporting social capital as well as providing economic, social and environmental services that government (local or state) are increasingly drawing back from. In the end, it may be concluded that Malanda's future seems secure but perhaps its main role will largely be a supportive one—mainly as a place of rest and retirement

for elderly people. But, there is potential for Malanda to expand its economic base e.g. to become an even stronger draw-card for tourists. There appear to be two or three areas of potential: ecotourism and cultural (indigenous) tourism, perhaps provided from the relatively new (and apparently under-utilised) Malanda Falls Visitor Centre, and food tourism, which could take advantage of some of the Tableland's boutique agricultural activities such as organic produce (dairy, meat, fruits and vegetables).

Finally, many authors who have commented on problem-oriented, place-based learning (POPBL) have noted that one of the most effective learning experiences students can obtain is when they are directly involved in a genuine research process. The end of semester student feedback survey for *EV2011* demonstrated this study was an effective POPBL experience—many students commented that the fieldwork component of this research project was the best feature of the subject adding weight to the value of POPBL pedagogy.

The research reported here may be of interest to urban researchers, local government and urban planners with an interest in encouraging sustainable development. It may also be of interest to university educators, not just those involved with sustainability, but perhaps also others delivering courses in other disciplines such as human geography and planning.

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Author Biography

Doctor Colin Macgregor originally joined James Cook University (JCU) in 1995 as an Associate Lecturer, which is when began studying for his PhD in Sustainable Development. He took up a position with the Bureau of Rural Sciences (BRS) (Commonwealth Government) in 2000 where his research involved adoption of sustainable land management practices. He completed his PhD in 2002 and moved to Scotland to take up a three-year Post-doctoral research position at the University of St Andrews. He then established St Andrews' undergraduate degree program in Sustainable Development before returning to Australia in 2006 as a Lecturer of Environmental Social Science at the University of Western Australia. Finally, Dr. Macgregor returned to JCU as a Senior Lecturer in 2012 to establish and coordinate JCU's Bachelor of Sustainability. Dr. Macgregor thanks students of JCU's subject *EV2011 The Case for Sustainability* for responding so positively to the sustainability challenge, and in particular he acknowledges the support he received from the Malanda community in supporting this research.

Promoting Sustainability in Institutions of Higher Education—The Perspective of University Teachers

Violeta Orlovic Lovren

Abstract

Despite common agreement on the importance of integrating sustainability into universities, the level of progress made in that process varies greatly in different countries and academic institutions. At the University of Belgrade, efforts are being made to integrate sustainability issues into the curriculum of certain studies, while slow progress is seen within other areas of sustainability. Because of the importance of teachers in promoting and integrating sustainability in universities, the focus of this paper is on their perspective and the challenges they face in performing this complex role in the academic and wider community. This paper contains the results of a survey of teachers, performed at selected faculties of the University of Belgrade. The aim was to gain insight into the teachers' own assessment of the role they play and the barriers they perceive in promoting sustainability, within the specific context of their respective academic institutions. The teachers' perceptions and needs expressed in this research offer a foundation for further discussion of the existing situation and the potential for improvement, using lessons learnt from international experience, together with knowledge of the unique local context.

Keywords

Sustainability · Teachers · Perspectives · Barriers · University

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1 Introduction

The growing influence of the movement to integrate sustainable development within universities, raises a number of questions regarding higher education's potential to lead this change within society. Universities are widely perceived as "…important agents in advancing more sustainable practices in different culture and context" (Ricacaboni and Trovarelli 2015, p. 298). The recently adopted 2030 Agenda for Sustainable Development shows that tasks of great importance are being assigned to all educational institutions, including academic ones, to"… 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" (http://goo.gl/pcYvB3). The "Post 2015" framework, therefore, officially reconfirms the global ambition to strive for holistic, integrated, interdisciplinary education and calls on institutions and education providers to actively contribute to the global process of "transforming our World". These trends have huge implications on teachers as potential role models.

The most relevant documents for universities in Europe, such as the Bologna Declaration, promote principles of quality and collaboration, compatible to the concept of sustainability (Orlovic-Lovren et al. 2016). However, through its objectives, universities are also directed to enhance student employability and efficiency by increasing their competitiveness and mobility (Bologna 1999), obviously targeting the economic rather than holistic development goals of individuals and societies. The implementation of this competence-based process varies among countries and universities, just as the modes and achievements in incorporating sustainability into academic institutions vary.

The potential of the university to serve as a "social agent of change" depends on many factors—related not only to the institution of higher education, but to its wider societal context, processes and developments in the local and regional community (Riccaboni and Trovarelli 2015). Expected to contribute to the development of critical thinking and the sustainable leadership of students as citizens of the future, institutions of higher education are simultaneously trying to meet the demands of a "increasingly neoliberal" context, which "…threatens the ability of academics to contribute critical dialogue and significantly change the wider setting" (Doring, according to White 2015, p. 677).

Other challenges related to "traditional culture" or to the structure of academic institutions have also been identified in the literature as potential threats to their transformative potentials. One of these challenges certainly lies in the traditional role of universities as "scientific producers" of knowledge, which is not easily shared with the community, nor widely. Barriers to their own transformation and the ability to impact the transformative processes of students and communities are also evident in the fragmented, compartmentalized structure of universities, which challenges the implementation of the new paradigm—sustainability—through all aspects of the university, thus leading to a "structural trap" (Savelyeva 2012, p. 229). In an effort to bridge that gap, researchers emphasize the role of teaching,

which should connect the separated elements of the university structure and its functions (providing for economy, development of values, and enhanced intellectual merit) with aspects of sustainability within the university context (campus greening, education for sustainability, sustainability science) (Ibid.) In order to be capable of affecting change in society, it is necessary for the university to reflect on its own readiness for change and accept newly defined or reformulated objectives and tasks.

Evaluating the institutional potential of the university in order to accelerate change towards sustainability requires reflection on teaching approaches, and, naturally, upon the role of teachers. If universities are to play the role of being leading examples and facilitators of transformation towards sustainability, then teachers should be the "facilitators and enablers of learning" rather than "dispensers of information and knowledge" (UNESCO 2012, p. 10.)

The concept of sustainability brings additional demands to teachers in their already complex role. No matter what the social context or the institutional setting is, teachers today are encouraged globally to "…rethink old assumptions, ask the big questions, and readjust their own narratives about what it means to educate, to learn, and to know—with the challenges of sustainability in mind" (Boring 2014, p. XIII). In other words, they should re-evaluate their own teaching philosophy, their personal values or the "standard or criterion for guiding action" (Rokeach, according to Zinn 2004), in relation to the direction suggested by global recommendations, and in some cases by institutional policy, as well.

Because of the multidimensional nature of sustainability in universities, as well as the responsibility of teachers, our focus is not only on their highly important role in curriculum development and "greening". Rather, it is concentrated on their role as a "leading example" in promoting the values of sustainability through all their dimensions, while performing activities within both academic institutions and the surrounding communities.

2 University Teachers as Role Models in Achieving Sustainability

Whilst there are mutual interrelations between social and institutional contexts which affect the roles of teachers, there also exist dynamic interactions between teachers' contributions and the transformative potentials of universities, "inside and outside its walls". As it has been noted, "even if an educational institution dictates or regulates certain aspects of the teaching process, the individual educator may support, modify, reject, or conform to such mandates, based on personal beliefs and interpretations" (Zinn 2004, pp. 41–42). The question is whether sustainability values are incorporated into or compatible with a teacher's personal beliefs? And if so, are those values reflected in the teacher's methods, research and all the other activities conducted with students, colleagues and the community?

Teachers' 'operational behavior' in every aspect of their role affects and is affected by all the relationships they make. Numerous research data and analysis shows that, for instance, interdisciplinary research is facilitated by trust built between academics; active engagement with the university community and the co-production of knowledge with students increase the chances and potentials for sustainability learning and action (Freire 2000; White 2015). Personal engagement and an example given by the teacher facilitates active learning and stimulates critical thinking—as reported by students; analyzing those relations, Brookfield sends a strong message that "there is something essentially false about you asking a learner to do something that you haven't done first" (Brookfield 2013, p. 38).

Following the integrated approach as one of the key sustainability principles, teachers are also expected to ensure connections between theory and practice, "… injecting real life situations to students" (Yuan 2015, p. 129), not only through content or methods used, but also through the involvement of practitioners in the teaching, mentoring and research process.

Interconnections between teachers' performances in all their roles and institutional potentials require mutual synergy and their full participation in designing and conducting steps towards sustainability. Not only is it true that "…the roles of an academic cannot be fully resolved until a paradigm shift in higher education institutions is achieved" (White 2015, p. 675), but the transformation is not possible without teachers' contributions.

Recent experiences in several countries suggests that one of the successful mechanisms for achieving progress in incorporating sustainability in universities is developing networks of academics, students, staff, and representatives of local communities, expanding their scope further towards the national and/or international level, and their activities from teaching to research and greening the infrastructure in and around their institutions. Some examples of that kind may be found in Italy—the Network Sienna Sustainability (Riccaboni and Tovarelli 2015) or in the UK—the TUSA (Transition: University of St Andrews), representing a "grassroots initiative that aims to promote and enable sustainability in the university and wider communities" (White 2015, p. 679).The majority of those are either initiated or actively conducted by teachers, based on and followed by intensive reflection, the questioning of their methods and sharing of experiences with other participants. As shown in many such examples, the collaborative creation of vision and cooperation in its implementation are among the key conditions for success.

Starting from the claim that teachers' personal philosophies, including the elements of sustainability, might best be reflected through their activities in practice, related but not constrained to the teaching process, in our research we asked university teachers to provide their estimations regarding the roles they perform and the obstacles they experience in the specific context of academic institutions and the community at the University of Belgrade in Serbia.

3 The Research Context

The University of Belgrade is a state university consisting of 31 faculties, divided into four groups: the social sciences and humanities, medicine, science and technology. The University of Belgrade is the oldest and largest state university in the country. According to a recent ranking of world universities (the Shanghai list), it is among the 400 best universities in the world (http://www.bg.ac.rs/).

As mentioned before, the University accepted the Bologna declaration and in accordance to that, started the reorganization and diversification of study programs at different levels of study (undergraduate, master's, doctoral). It opened the door to the development of new programs and improving curricula, but also to changing the traditional institutional framework, which is a slow but significant process (Orlovic-Lovren et al. 2016). In most cases, the process was initiated by teachers, and is not being systematically supported yet, neither by strategic policy at a particular institution nor at the University level (Orlovic-Lovren 2015).

These sporadic changes, occurring more often in curricula than in other aspects of sustainability, should be considered in light of the current capacities of the academic institutions in Serbia, having in mind the fragility caused by recent dramatic social developments—the effects of conflicts, NATO intervention, prolonged economic and political transition. At the same time, in a country which is making efforts to accept European and sustainability values, the university shares several of the challenges of other universities mentioned earlier. Operating between the, sometimes contradictory, demands originating from the neo-liberals and the concept of sustainability, it is obviously going through a multidimensional transition process.

While there have recently been a few analyses conducted regarding the integration of sustainability into the curricula by faculties belonging to the University of Belgrade (Loncar 2011; Orlovic-Lovren 2015), to our knowledge there have been no comprehensive reviews of the situation regarding other dimensions of sustainability. In addition, there is a lack of analyses made from the teachers' perspectives on this particular issue. Those were some of the main motives to initiate this research.

4 Methodology

In the development of the research design, we combined qualitative and quantitative research methods, including an analysis of the literature and the survey. We started from the multidimensional concept of sustainability in a university, as well as from the complex role of teachers in facilitating transformative learning in and out of academic institutions. Following the claim that teachers should be an example to their students if they want to contribute to the transformative changes within the mutual learning process, we focused on the integration of sustainability principles within teachers' performances in their teaching, researcher or activist roles:

- *Teaching and mentoring*: infusion of sustainability issues into subjects; involving practitioners as guest teachers and mentors; involving students in the community (as volunteers);
- Research: collaboration with students in scientific and applied projects; collaboration with practitioners in action research in the community;
- *Activism*: teachers as public advocates, as activists in CSO, as practitioners of sustainability behavior.

Using the survey method, we collected teachers' self—estimations of performance, as well as perceptions of obstacles faced within that process. Beyond that, teachers were asked to assess the level of integration of sustainability, as well as barriers to that in their academic institutions.

The research was performed via an online questionnaire, distributed to teachers holding assistant professor, associate professor or full professor titles, and employed by faculties from the four scientific groups of the University of Belgrade. The survey was conducted during the end of 2015 and the beginning of 2016.

5 Results and Discussion

5.1 Limitations of the Study

One of limitations in this exploratory study is the small sample size. Due to the small number of respondents (105), we cannot consider this sample as representative of the university as a whole.

Another limitation relates to the distribution of respondents (as shown in Table 1). While the intention was to have equal representation of the four academic fields, this was not possible. Around 40 % of respondents in our survey are from the field of humanities and social sciences, which may influence the findings of the study. First, a different number of faculties within the groups contributed. The humanities and social sciences make the second largest group within the University. Second, in spite of the efforts made to obtain more responses from the sciences and mathematics, this was not possible within the timeframe of the research. Though it was specified within the invitation to the responders that dealing with sustainable

Table 1 The structure of the sample

Scientific groups	Number of faculties that participated	Number of respondents	Percentage
Faculties of humanities and social sciences	8 out of 10	43	40.95
Faculties of medical sciences	3 out of 4	21	20
Faculties of sciences and mathematics	3 out of 6	11	10.47
Faculties of technology and engineering sciences	7 out of 11	30	28.57
Total:	21 out of 31	105	100

development education was not a crucial precondition to participate, some teachers from the faculties of sciences were reluctant to provide responses, justifying that with the notion that it is "not the area of their scientific interest."

A future study with a larger sample size will help to validate and to better understand the results of this survey.

5.2 The Sample

Invitations for teachers to participate in the online survey were distributed to all the faculties belonging to the University of Belgrade and to all scientific groups. Responses were received from 21 of the 31 academic institutions. In that sense, we did comprise a majority of the academic institutions operating within the University of Belgrade.

A smaller percentage of male (40.6 %) as opposed to female responders (59.4 %) can also be seen in light of the fact that a majority responded from the humanities and social sciences, where traditionally more female teachers are employed (Fig. 1).

The structure of our sample regarding the years of teaching experience follows the expected distribution: the smallest number of the most experienced, followed by "newcomers", while the highest proportion have worked between 11 and 30 years as university teachers. Generally, this indicates that the majority have taught for more than 10 years and have enough experience to estimate their roles and situation at their faculties, as well as their interactions with students, colleagues and the community. Also, most of them belong to a group of teachers with 11–20 years of experience, which may be considered as a highly potential period in terms of their professional development and chances to improve or innovate their teaching practice, within the sustainability framework.

5.3 The Role of Teachers

Data that will be presented were collected and analyzed based on teachers' self—estimation, within the framework of their roles (teaching, research, and activism) in

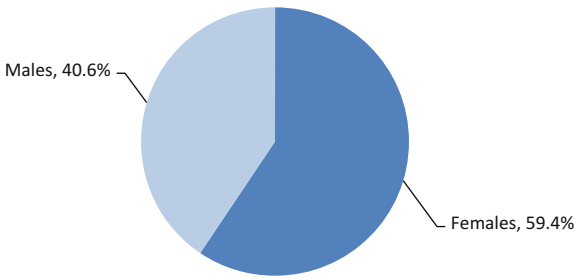

Fig. 1 Respondents by gender

contributing to sustainability at their academic institutions and respective communities. The three level scale has been used and data processed by calculating frequency and percentage.

5.3.1 Teachers as "Theoretical Practitioners"

As shown in Fig. 2, only 16 % of teachers build the curricula of their subjects with sustainability as the key concept. Nearly 40 % introduce related issues in their teaching content, while the majority of respondents did not include it at all. Among those using it as the key concept, there are more teachers from the technical, engineering, medical and science fields, while a few of them from the social sciences mainly come from the field of sociology at the Faculty of Philosophy.

The group of questions related to teachers' role in "injecting" practice into teaching and mentoring, covered their activities in engaging fellow practitioners as guest teachers or mentors to their students. We were also interested to find out about the opposite direction of such interactions: the existence and frequency of organized students' activities in the community, initiated through cooperation between teachers and practitioners (Fig. 3).

By comparing those three elements, we can see that the most usual activity is guest teaching by practitioners, while co-mentoring occurs on a regular basis only in 14 % of cases and 34 % of teachers surveyed have never invited co-mentors to collaborate in facilitating students work on projects/final works.

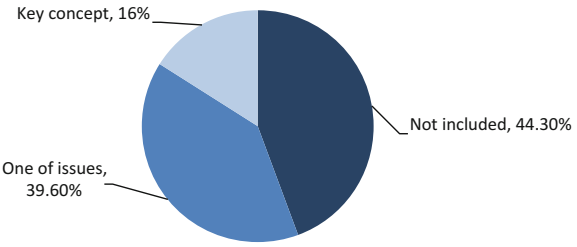

Fig. 2 Infusion of sustainability in subjects

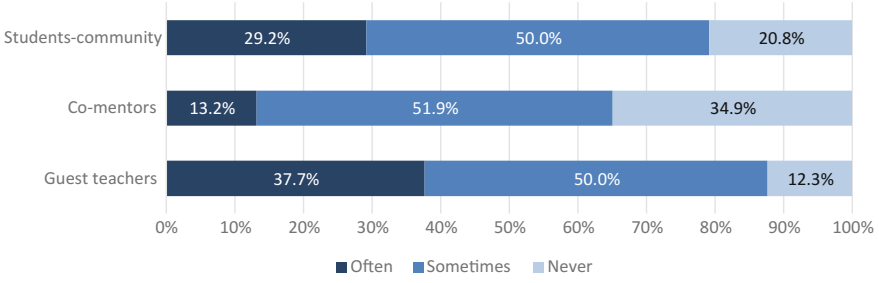

Fig. 3 Introducing practice in teaching and mentoring of students

At the same time, 21 % of teachers do not encourage students' collaboration with the community at all, while 29 % engage in that process on a regular basis.

In this area, as in the majority of other segments in this study, teachers mainly report that they perform activities contributing to sustainability of university occasionally, selecting the answer "sometimes", which may hide diversity of meanings and very different frequency, within the large scale between "never" and "regularly". The methodology and the scope of this research did not allow us to perform more a detailed analysis of this segment of teachers' behavior.

5.3.2 Teachers as Collaborative Researchers

Reviewing teachers' collaborative practices from the point of view of sustainability, we observed their activities in involving students, other researchers and practitioners in their research activities (Fig. 4).

While nearly 20 % of teachers often take research steps in the community with fellow practitioners or within applied projects with students, it is evident from the results above, that the involvement of students in scientific research is a more developed practice, exercised on a regular (30 %) or occasional basis (59 %). At the same time, nearly 40 % of teachers never undertake action research within their communities.

5.3.3 Teachers as Activists

In order to see how teachers personally play the role of activists, we asked them—are they—and how often—involved in activities related to the promotion of sustainability, through public advocacy and participation in efforts or events organized by civic organizations (CSO). They were also asked to estimate how much they practice "sustainable behavior" in their everyday life (energy saving, recycling, etc.). The findings presented below show that their personal activism is much higher than their collective engagement in the community (Fig. 5).

Based on this briefly presented data, it appears that all the activities chosen to illustrate teachers' contribution to the implementation of sustainability principles (an integrated approach, collaboration, participation) are constituent parts of their usual practice. However, it is evident (here and in the segments analyzed above),

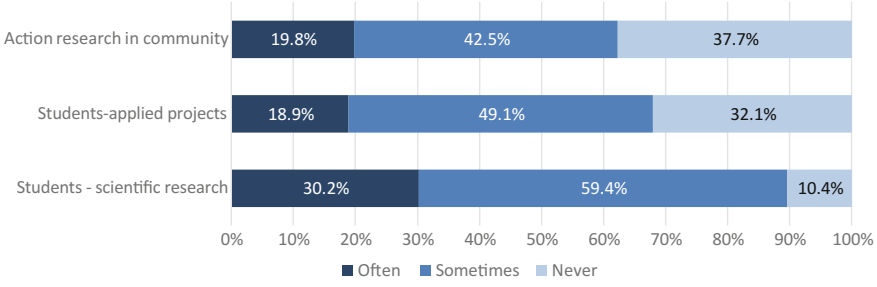

Fig. 4 Collaborative research activities of teachers

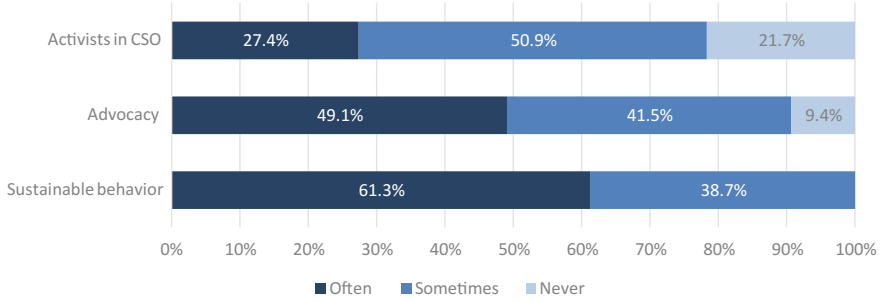

Fig. 5 Teachers' activism

that the majority of those take place occasionally and are not performed by all teachers. Only one of the elements—teachers' "sustainable behavior" (recycling, energy saving, protection from pollution, etc.) is practiced by all the surveyed teachers: 62.4 % claim that they regularly perform such behavior in their private and working environment, while 37.6 % of them do so occasionally. While this draws a very positive picture, we need to remember that it is based on teachers' personal estimations and that responses might also reflect their wish to look better in terms of their individual contributions to the quality of the environment and sustainability. It might also mean that they follow a better "sustainability model" when individual, rather than collective, activities are concerned. That possibility may be supported by the general tendencies shown in this research, that teachers' activity in all the examined segments declines when moving from the institutions towards the surrounding community.

If we recall that personal actions are guided by individual values (Zinn 2004) then we can also ask whether the tendency to pay more attention to individual than to collective activities, has to do with teachers' beliefs that their role is to contribute individually and within the institution as much as they can, while leaving that "comfort zone" is not something they are ready—or even interested in doing. Knowing how much personal and social values are interconnected, we were also interested to find out what teachers see the main obstacles to be and how they perceive the impact of those obstacles (high, medium, low) in conducting the activities we analyzed (Fig. 6).

Based on these results, it can be concluded that almost the same percentage of teachers find that both the lack of time and opportunities for their commitments create high barriers and that they do not really create an obstacle. At the same time, they see other actors, except for communities, as less responsible for the barriers: the interests of students or practitioners are perceived as a weaker barrier than the lack of readiness for cooperation by the community. However, the impact of obstacles coming from the institution is almost as strong as the one related to teachers' "lack of time and opportunities".

While there is a tendency for teachers to take the main responsibility for this process, it is obviously interrelated with the context of the institution and the

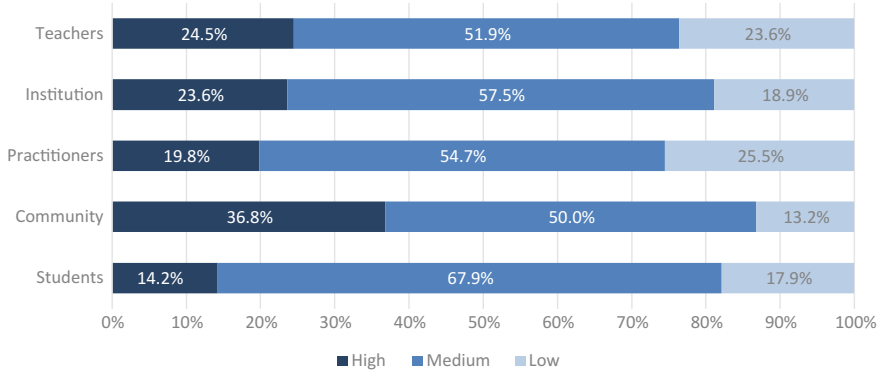

Fig. 6 Contribution of different actors to the obstacles in performing teachers' activities

support provided by other colleagues. Does this mean that there is not enough of an enabling environment for the implementation of sustainability principles, and if it does, what are the reasons for it? Is it more a result of the fragile societal context under the burden of prolonged transition and crisis? Or is it a result of the "package" that came together with the good parts of the Bologna process, forcing teachers to calculate their, as well as students', achievement scores and perform administrative tasks, thus "stealing" their time and energy from performing the activities analyzed here? Or is there something in their readiness to deal with sustainability, within or beside the curricula?

Also, if teachers perceive the community as not very interested in cooperation, does that reflect the real situation, or is that perception affected by institutional policy and practice where collaboration with the community is concerned? Some of the possible answers might be initially received by looking at the institutional context for the integration of sustainability, as perceived by the teachers that participated in our survey.

5.4 Integration of Sustainability at an Institutional Level

In this segment of the survey, teachers evaluated the level of integration of sustainability in all its dimensions within their respective institutions. They were allowed to choose between three answers, reflecting different stages of development: the first one describing fully integrated sustainability, at both a strategic and an operational level; the second one referring to faculties where sustainability is partially integrated (through curricula, infrastructure, energy efficiency, etc.) and the third one indicating that the concept is not applied at either a strategic or an operational level. The summary of their estimations is presented in the chart below (Fig. 7).

As can be seen, only 3.8 % of respondents find that sustainability has been integrated in all its dimensions at their faculties, on both a strategic and an

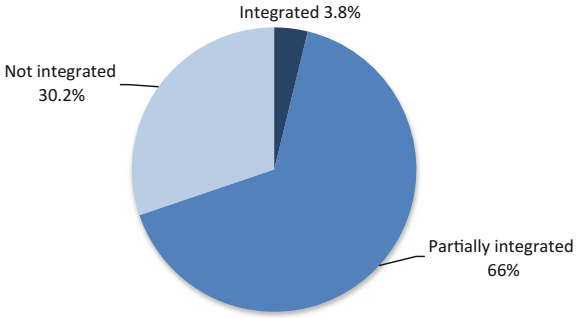

Fig. 7 The level of integration of sustainability in faculties

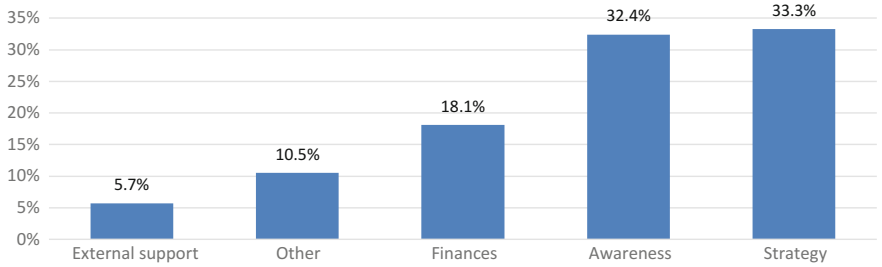

Fig. 8 Main barriers for integration of sustainability into institutional policy and operation

operational level. A third of the teachers do not see any elements of sustainability in their institutional context.

What contributes to such a situation? We analyzed that again, using their perceptions of barriers (Fig. 8).

Judging by the data presented, the strongest barrier to the integration of sustainability perceived by a majority of teachers is the lack of strategic orientation of the faculty; this is closely followed by the lack of awareness and willingness of employees, and then by the lack of finances. More than 10 % of respondents chose the option "other", without providing any specific reasons. Only 5.7 % of teachers think that the strongest barrier is the lack of external support (community, authorities, etc.).

As expected, these answers shed more light on the previously analyzed tendencies. First, it confirms that an institutional vision plays a significant role in enabling teachers to implement sustainability within their work. It also provides very important information on the existing gaps: the lack of awareness of staff and teachers, described by teachers in this research, marks one of the important and necessary directions of advancement for the future by improving the awareness and motivation to contribute to the integration of sustainability. While the financial aspect is recognized as important, external support is, surprisingly, not perceived as a strong barrier.

6 Conclusions

Based on the perceptions of 105 teachers, from 21 out of the 31 faculties, expressed within a survey conducted via online questionnaire, it can be concluded that there is an obvious need to improve the conditions and further increase awareness of all actors, in order to accelerate the integration of sustainability at the University of Belgrade.

While performing their teaching, research and activist roles, teachers generally contribute to the implementation of sustainability principles, such as the integration of theory and practice (cooperation with practitioners, stimulation of students' community work), collaboration in research (with students, practitioners) and activism ("sustainable behavior", advocacy, voluntary engagement). However, the majority perform these activities occasionally, while nearly half of them do not include sustainability in their teaching content at all. The other tendency is that the active participation of teachers declines in almost all activities/roles as they "leave" the university walls: fewer teachers participate in action research in a community than in scientific research at the faculty; their percentage is also smaller in the activities of community organizations than in the activities related to advocacy or their own "sustainable behavior". As a result, fewer students are involved in applied research projects than in the scientific projects performed within the faculty.

Apart from the obstacles coming from a perceived lack of community interest in cooperating in this process, teachers see the main barriers for the implementation of sustainability concepts in the faculties, in their own lack of time and opportunity for all needed activities, but also in the lack of institutional strategy and awareness of employees.

Looking at the data collected, we are aware of the limitations of this study; first of all, it has a relatively small sample size and the other issue is that, due to the methods of research, it was not possible to examine certain relevant questions in depth (such as the teachers' understanding of the role of community, their definition of sustainability at the university, etc.). Still, keeping in mind that this survey is, to our knowledge, the first of its kind at the University of Belgrade, we find its results to be a good foundation for future research and policy considerations.

First, it reconfirms the importance of vision, institutional strategy and the involvement of all actors for the successful integration of sustainability. If less than 4 % of teachers report that sustainability is fully integrated at their institutions, then we can assume that fragmentation exists at all levels of the university, from curricula to campus infrastructure and policy, weakening the potential of faculties for transformation. If such a "paradigm shift" (White 2015) is crucial for the development of the teachers' full transformative potentials, then it is not difficult to see that there is a lot to do along the way towards sustainability. Organized training and awareness raising on the concept of sustainability at higher education institutions for the teachers and staff at the University of Belgrade may be the first useful step towards better understanding of the concept, the stakeholders and their role in developing future collaboration, rather than competition.

Appendix: Survey Questions

1. Gender:

   (1) Male
   (2) Female

2. The title of the Faculty:
3. Number of years of teaching experience:
4. Within the subjects you teach, sustainable development is included:

   (a) As one of the issues
   (b) As the key concept
   (c) Not included at all

5. Please estimate the degree in which the following activities are incorporated into your practice (1) never; (2) sometimes; (3) on a regular basis

   5.1:

   (a) Involving students in scientific projects
   (b) Involving students in applied projects in the local community
   (c) Stimulating volunteering of students in local institutions/organizations

   5.2:

   (a) Involving guest-lecturers in the teaching
   (b) Involving co-mentors from the practice
   (c) Joint action research with practitioners from the local community

   5.3:

   (a) You actively participate in public advocacy for environmental, humanitarian issues of interest for your local community
   (b) You volunteer in local organization/actions of interest for your community
   (c) You personally contribute to energy saving, recycling…and other forms of sustainable behavior in your work and private life

6. Please mark the intensity of barriers/difficulties you face in performing the activities listed above (1) low; (2) medium; (3) high

   (a) Students are not interested/prepared for the engagement
   (b) Low interest of local community representatives
   (c) Lack of interest of local practitioners
   (d) Lack of support in the institution
   (e) Lack of time and effort that should be invested

7. Please select the answer that most closely describes the situation at your academic institution:

   1. Faculty has a developed strategy and is intensively working on incorporation of sustainability in all aspects of its operation, including curricula changing
   2. There are fragmented elements of sustainability incorporated in some aspects of faculty operation
   3. Sustainability has not been seriously taken into consideration, neither at strategic nor at the operational level

8. Please select one of barriers listed below for integrating sustainability into policy and operation at your academic institution, or add a barrier not listed:

   1. Lack of finances
   2. Lack of strategic orientation/institutional policy
   3. Lack of willingness and awareness of employees
   4. Lack of external support
   5. Other, please state:

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Author Biography

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ShowHow: A Flexible, Structured Approach to Commit University Stakeholders to Sustainable Development

Leendert Verhoef, Luuk Graamans, Dean Gioutsos, Ad van Wijk, Jo Geraedts and Chris Hellinga

Abstract

This paper presents an alternative approach and preliminary results to developing a sustainable campus by connecting research, education and real estate management. It is coined 'ShowHow': the deployment and display of the knowhow of all stakeholders in a university. The approach is built upon five pillars: (1) *Projects*: the initiation of a variety of projects; (2) *Intensive real estate involvement*: the introduction of sustainability and innovation to all levels of real estate strategy and decision-making processes; (3) *Programmatic themes*: the development of multi-faculty, overarching programmatic themes; (4) *Stakeholder integration*: The involvement of and intense liaison and co-creation with

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real estate, facility management, professors, and students, and (5) *Outreach*: the provision of impetus for regional/national sustainability systems with campus projects. The results are encouraging: In a short period of time, one year, more than 20 projects have been developed, the board of the Real Estate department adopted sustainable development as a key value, three programmatic lines are under construction, personal connections between students, operational and scientific staff were established, and 2020 goals for greening the energy supply will be met in 2017. Additionally, the University also performs a catalyst role for regional sustainable heating transformations. New PhD positions could be established. This approach seems very promising, generating enthusiasm throughout the university. It has elements, typical for technical universities, but the formula may be replicated at other universities in general, by deploying non-technical knowhow, and by including existing local sustainability themes and opportunities.

Keywords
Innovation · Sustainability · Circularity · Real estate management · Campus operations · Student participation

1 Introduction

Universities across the world fulfill a variety of functions in their operation. First and foremost, these reside in scientific and applied research, and education. Simultaneously, they satisfy a range of quite different other complementary functions, from identity formation to stimulating the values that engineers should carry forward into their professional working lives.

An increasingly important challenge for engineers is to acquire (technological) leadership skills and experience in the pursuit of a sustainable society and circular economy. To fulfill these roles, and as an overarching responsibility, universities should set an example for society. Universities can take the first steps towards fulfilling this responsibility, by developing and implementing plans for sustainable campuses.

Delft University of Technology (TU Delft), like other technical universities, addresses fundamental and technical issues through its research and education. Moreover, TU Delft prides itself in fostering students with a pragmatic, critical, and problem-solving oriented attitude.

The campus is like a small city, and is in many aspects representative of the vast challenges faced in society. Moreover, the campus physically connects research, education, staff and students. Hence, it is an ideal environment to define precise, clear targets for sustainable development. Simultaneously, visionary input and practical implementation can be integrated, with a keen eye for innovation.

Many universities have committed to energy reduction goals. TU Delft is committed to 50 % CO_2 emission reductions, 40 % primary energy savings and 25 % sustainable energy generation in 2020, from a 2012 base line. This is no trivial task, considering that university campuses are advanced building and laboratory complexes, housing critical, and often energy-intensive research equipment, and engaging in primary processes where energy consumption is a small part of total expenditure. Additionally, campus management needs to take into account a vision on the future strategic developments of the University (den Heijer 2011).

In many universities, students have taken the lead in change towards sustainability, by opening the dialogue and/or establishing 'Green Offices.' Sometimes this occurred concurrently with pioneering real estate departments. Scientific funding proposals increasingly require practical relevance, and an interdisciplinary approach. In accordance, the TU Delft Green Office initiates and stimulates practice-oriented projects with a strong sustainability perspective and scientific challenges, thus providing new impulses for TU Delft primary processes.

A campus is an interesting playground for researchers, innovative external stakeholders, real estate developers and managers, which can influence the mindset of the future leaders. It can provide a more practical approach for scientists, along with innovative thinking of the real estate developers and direct contact to more innovative suppliers and designers.

The goal of this paper is to present an alternative approach to developing a sustainable campus, by connecting the often isolated spheres of research, education, campus operation and real estate management, and present preliminary results of this approach. The underlying methodology adopted at TU Delft—which is continually being refined—is focused on, with its replication potential for other Universities in mind. The approach has been coined 'ShowHow': the deployment and display of the knowhow of *all* stakeholders in a University.

2 Approach

2.1 Analysis of Other Initiatives

In creating the ShowHow approach, a body of knowledge and approaches towards sustainable universities has been reviewed. A few findings:

In the best practices developed by ISCN members, limited attention is currently being paid to projects utilizing the expertise of the research institute *itself* (ISCN 2014).

The Green Offices are a growing movement throughout the Netherlands, Germany and further across Europe, in which groups of students take the initiative in making their own universities sustainable (RootAbility 2016). These are effective, but face challenges in continuity and serious stakeholder engagement and project realization, depending on the level of resources available, both human and financial, and how the organization is embedded within the University institution.

Other initiatives that have taken place in the past 5 years at TU Delft (The Green Village, Delft Energy Initiative) have shown that visionary, staff-led student-supported systems lead to improved staff contact and involvement, science involvement/connection and stronger results.

From these experiences, a program for sustainability at a technical university campus needs to utilize and employ its own technical knowledge, expertise and innovations and should cover a wide range of activities both managerial as well as research oriented.

2.2 'ShowHow'

The philosophy of the TU Delft Green Office is that a nearby, visible, and innovative implementation of sustainability and circularity is stimulating, and strongly contributes to the greater mission of the university. When engaging in the selection process of projects or technologies to implement at a University campus, one can identify and prioritize areas where home-grown knowhow (generated by the University's own scientists) is used or knowhow of other parties (see Fig. 1). The TU Delft Green Office focuses primarily on those technologies that strongly resonate in staff and department expertise—its own knowhow—and secondarily on external technologies that deliver significant positive impacts on sustainability. Deploying and stimulating TU Delft knowhow outside of the University is mostly called valorization, and outside the Green Office scope.

The approach presented in this paper is in operation for almost one year, and has been developed through research and practice in a *technical* University environment, and therefore the replication potential of the approach may have an implicit bias towards *technology-based* universities.

Where Applied? / Whose KnowHow?	University Campus	Other locations
Own Researchers	ShowHow	Valorization
External Parties	Innovative Partners	Other

Fig. 1 Applying own knowhow on campus sustainability: ShowHow

2.3 The Five Pillars

The approach is built on five pillars as illustrated below, in Fig. 2. These five pillars are a combination of hands-on activities, strategic interventions, thematic programming, networking, and deploying off-campus opportunities.

1. **Pillar 1**: *Projects.* Practical and opportunistic: launch a variety of projects. Develop a portfolio of projects small and large, covering a wide range of circularity topics. Initiate projects that can be executed in limited time by students and (very) large projects requiring significant time investment of specialized staff.
2. **Pillar 2**: *Intensive real estate involvement*. Introduce sustainability and innovation to all levels of the real estate and facility management group's strategic and decision-making processes. Real estate departments are organized to manage large projects, driven financially. A separate strategy is needed to include circularity/sustainability into their processes, for instance in the design, tender and procurement procedures.
3. **Pillar 3**: *Programmatic themes.* Build cross- and multi-disciplinary, faculty-overarching programmatic themes. Since most real estate projects are of limited or temporal value to researchers, overarching, longer lasting research themes should be developed to engage and maintain their interest or to facilitate visionary professors.
4. **Pillar 4**: *Stakeholder integration*. Intensely liaise and co-create with real estate, facility management, professors, employees and students. Because of large differences in culture, language, interest and skills of the stakeholder groups: real estate staff, research staff, and students, no single person can be liaising with all different ones. Therefore a triple-liaison system was set up in the Green

Fig. 2 Five pillars under green office approach. *Source* the authors

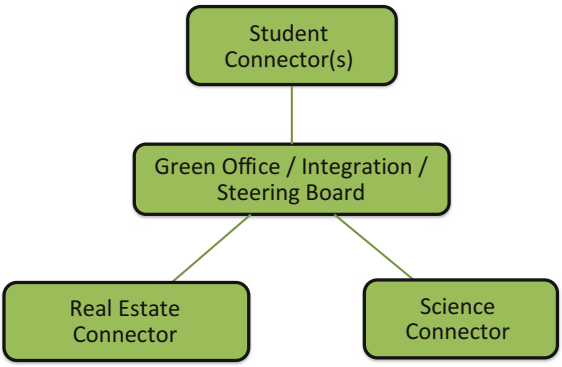

Fig. 3 Triple Liaison approach green office. *Source* the authors

Office, where students, science connectors, and real estate/circularity strategists can interact, see Fig. 3. The Green Office yields the backbone to bridge the gap between facilitating university departments, scientific staff and students.

5. **Pillar 5**: *Outreach*, the university as a catalyst in regional/national sustainability systems. A campus is a large office/laboratory park, with significant streams of energy, materials, and food flowing both in and out. These connections with the outer world can be utilized and developed to stimulate solutions for larger circularity and energy sustainability systems. It is aimed to provide impetus for regional sustainability developments with campus projects.

Pillars 2 and 4 can be seen in many real estate (campus) sustainability programs. Pillars 1, 3, and 5 are more particular and unique to the ShowHow approach.

2.4 Green Office Organization: Students, Staff, and Steering Board

The movement for a dedicated sustainability department at TU Delft, initiated by students in 2013, ultimately led to the formal establishment and resources for the Green Office by the Executive Board starting Jan 2016. It is a formal department in the university organization consisting of University four staff members and five student assistants with a three- member board consisting of:

1. The director of the Real Estate & Facility Management Department (Anja Stokkers)
2. A distinguished professor in the field of sustainability (currently prof. dr. Kornelis Blok, chair Energy System Analysis)
3. The TU Delft Sustainability Program Manager (Chris Hellinga)

3 Results

So far the adoption of the '5 Pillar' approach at TU Delft is successful, with a growing integration of sustainability principles within the organizations responsible for campus projects, management and operations and pathways to merge sustainable campus developments with the prime responsibilities of a university: high-level research and education have appeared to emerge.

The university has received high sustainability rankings (34st overall and and 1st on Sustainable campus transportation on the UI-Greenmetric[1] 2015) and will meet its goals, set by the executive board in 2014 for 'greening' the campus energy use and supply, well before the original target year of 2020.

3.1 Pillar 1: Projects

Over 20 projects have been developed so far. Some find their roots in the real estate department, while the Green Office initiated others, with input from students, and scientists. To name a few:

- Solar PV on the roofs of many faculty buildings, generating more than 1 GWh/year (Fig. 4)
- Purchase of Dutch Wind electricity
- Energy Monitoring
- Real Estate Energy Saving
- Food Collection
- Coffee cup collection
- Student Farming
- Joint Venture Earth, a circularity demonstrating ship, sailing around the north pole

The Delft Energy Monitor (Fig. 5) (www.energymonitor.tudelft.nl) keeps track of energy production and consumption. It has led to a new monitoring project to explore opportunities for monitoring individual appliances (Moorman 2016).

3.2 Pillar 2: Introduction in Real Estate and Facility Management Decisions

At every University, campus development and facility management are complex matters with a plethora of strategies, visions and opinions. The goals of sustainability are clear, but the means to achieve this goal are often debated. The

[1]University of Indonesia Greenmetric ranking 2015, currently with over 400 universities participating, www.greenmetric.ui.ac.id.

Fig. 4 Installation of solar energy on campus buildings. *Source* TU Delft

Fig. 5 Delft University of technology energy monitor website. *Source* TU Delft

implementation of circularity in all campus development is the TU Delft strategy to streamline this debate.

Circularity at TU Delft focuses on Energy, Water, Material and Topsoil. These four aspects are key in minimizing the environmental footprint of the University campus.

- Energy: demand and production of the campus on daily, seasonal and annual basis.
- Water: demand and collection of the campus on daily, seasonal and annual basis.

Fig. 6 Draft circularity commandments. *Source* the authors

- Material: The material which used for the construction and is 'temporarily stored' in the building, during its functional lifespan.
- Topsoil: The natural land and its functionality, which will be subplanted by the new development.

Each project is designed to first reduce the demand for energy, secondly to re-use waste streams as much as possible and finally to meet the remaining demand by sustainable measures. The Green Office has developed Ten 'Commandments' of circularity to be integrated in all future projects, as shown in Fig. 6. An interdisciplinary advisory group is currently evaluating this approach.

Three examples of this pursuit in practice:

I. Future buildings are designed to be energy neutral. The new learning center, is the first and sets an example: a sustainable energy neutral building,[2] achieving BREEAM excellent. Set to be operational in 2017, it deploys know-how from the Architectural Engineering & Technology Department. The design features underground cold-heat storage system, LED illumination, a green roof, and 3D-printed sun blinds. Additionally, it is flexible to facilitate changing use demands.

[2]https://intranet.tudelft.nl/en/direct-links/news/latest-news/article/detail/realisatie-nieuw-onderwijsgebouw-pulse/.

II. Introduction of sustainability and innovation criteria in the purchase processes. A first significant result is the electricity contract for 2017–2018, which will be fully based on Dutch wind energy. This approach will be pursued stimulating innovation.
III. New campus real estate strategy. This strategy is currently being prepared and will involve the construction of new buildings rather than renovations, partly as a financial consideration, but also to realize energetically more attractive buildings, reduction of floor space and improvement of the sustainability of the campus. New questions arise as to the demolition waste handling and re-use, offering new challenges to staff.

Each building or development is unique and should be optimized with regard to its individual program and context. These 'commandments', however, illustrate the primary principles that have to be taken into account in the design for circularity for the future campus. The principles will be converted to a set of requirements and design strategies that enable the real estate department to develop all buildings as sustainable as possible.

3.3 Pillar 3: Programmatic Themes

Criteria for programmatic theme development are:

1. Leading to significant solutions for energy, mobility, materials, and/or facilities
2. Applicable/testable at the campus
3. Cross-or multidisciplinary, relevant because mono-disciplinary themes can be handled with/within one department and need no overarching programming

Demonstration projects can be a meaningful way to connect expert fields, while not interfering with the core expertise and research interests within the respective faculties. The TU Delft Green Office - in collaboration with Department of Industrial Design Engineering - asserts a proactive role, initiating project formulation and consortia formation. The spin-off of these demonstrators should be that powerful and promising project proposals can be submitted on the basis of a portfolio and an existing network.

Various themes have been developed, such as *Geothermal heat* for regional networks (see more details in section 'Pillar 5'), *Green Digital Manufacturing*, and *Advanced* Smart Lighting are emerging as strong cross-disciplinary connectors for stakeholders. A particular paradigm-changing program, the 'Car as a Power Plant' is also described.

a. *Green Digital Manufacturing (GDM)*

Digital Manufacturing (DM, the combination of Digital Design with the Internet of Things and 3D printing) is an example of a technological development that will

result in significant societal changes. A sustainable society requires minimalized, sustainable materials in a circular economy and reduced global fuel demand for the transport of goods. To highlight some environmental challenges around DM (Verhoef 2016):

- The location of the design becomes irrelevant
- Products can be made when they are needed
- Production and application sites are closer together
- Sustainable—locally available organic materials may come within reach
- There may be new options for a circular economy (material recycling)

Connecting DM to sustainability illustrates the role of universities: addressing technical questions, developing sustainable solutions and thinking through the social consequences.

At TU Delft, a number of activities and initiatives are going on in the field of 3D printing. Application areas range from small plastic components, reproduction of old paintings and surface treatments, car parts, up to building facades, bridges, and later even entire buildings. Researchers welcome a comprehensive and multidisciplinary approach/philosophy of this fourth industrial revolution in which common scientific factors and bottom-up approach are important steps. Lastly, but not least: DM is seldom approached integrally with sustainability as first priority.

How does green digital manufacturing answer to the three criteria?

1. This technology will have a major global impact on material and energy consumption. Policy questions will arise—and the TU Delft should be able to assist decision makers in answering these
2. Applicability and testability—in buildings, construction, products, and maintenance, and repair. The wide scope of the technology requires focus and ambitious demonstration projects
3. A strong multidisciplinary challenge, with interfaces in all university departments It is suspected that both fundamental science and applied technology are involved and GDM can be a good bridge between the faculties

b. *Smart lighting by Light Emitting Diodes (LED's)*

Lighting at TU Delft amounts for approximately 25 % of total electricity consumption. Most of the lights are TL-tubes. A large energy saving is possible with no doubts at all on the environmental profile by LED's. Changing all buildings on TU Campus to LED will cost around 2–3 million Euros. It will yield an annual saving on energy and maintenance of around 0.5–0.7 million Euros. Many university campuses already deploy LED's. The consensus is forming: "let's do it!"

When talking to *scientists* on LED-based illumination strategy, they are working on much more than *just* light: Sensing, wireless Internet, colour matching are just a

few ideas. Application areas are wide such as indoor-Google maps and crowd control for example. When talking with *real estate officers*, they see and understand the potential, but have questions and often doubts on the financial and technical feasibility of LED's. When talking with *suppliers* of LED systems and services, they immediately talk about smart lighting, services, and business cases.

LED implementation requires a vision and a future proof program, because it necessitates the connection of ICT with other TUD departments and activities and LED lights last 30,000 h - approaching a building's lifetime. It also needs a hands-on approach, because in many buildings, switching to LED is feasible already.

LED offers new opportunities to building management and is a testing ground for novel features to scientists, not only for lighting, but for other facilities as well. Projects can utilize features of LED's as a *light source,* its *smaller size/lighter weight*, its *reduced energy consumption and DC power requirement*, and the *digital-based electronics* for new ICT systems. Besides these, technological, behavioral and business aspects are of interest.

The applicability area is wide, but research interest is predominantly linked with the electronics and ICT departments, as well industrial design and architecture. Some areas in which electronics researchers are active are: Visible Light communication (10 × higher speed and much lower power consumption than WiFi) and distributed intelligence (individual lights deciding on their illumination levels).

The TU Delft approach is to stimulate application of LED's in all renovation and new-built projects, using a simple decision diagram based on clear questions. In new buildings, one or more of the extra features that LED's offer should be pioneered.

c. *Car as a Power Plant*

One program example of thematic multi-disciplinary programming is the Car as a Power Plant Program (van Wijk and Verhoef 2014). It does not originate from the TU Delft Green Office, but from The Green Village.[3]

The 'Car as a Power Plant' program is based on a strong paradigm-changing vision that: *Fuel cell vehicles can provide efficient and clean transportation, but also clean and efficient electricity production at times when renewable electricity production is not sufficient. And the 'waste' products of heat and water could be utilized as well. In such an integrated transport, energy and water system, hydrogen will become a key energy vector in storing and transporting energy*. It is exemplary and showing the success for the three criteria of programmatic themes:

1. Major impact? Fuel cell electric vehicles such as cars, buses and trucks can provide, when parked—which is more than 90 % of the time—electricity to houses, cities, industry or the electricity grid, producing useful 'waste' products:

[3]The Green Village is a platform for system innovation, located on the TU Delft premises *(*http://www.thegreenvillage.org*)*.

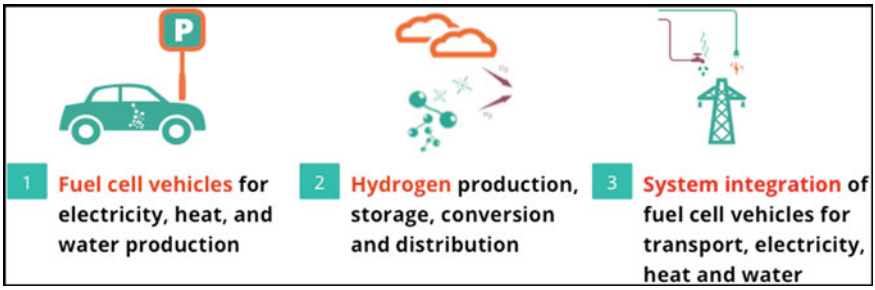

Fig. 7 Program lines car as power plant program. *Source* The Green Village

heat and water. A fuel cell car can power 10–100 European houses and can replace all power plant capacity.

2. Applicable/testable on the campus? The research and innovation program requires a special test bed facility with real life conditions. This test bed facility will be realized on the Green Village, in the heart of the TU Delft campus.
3. Cross-disciplinary. The newness of technology and paradigm change requires technological and systems research. The research and innovation program will encompass the entire energy and transport system, from demand to source with all conversion, storage, distribution, logistics, IT and integration challenges included in 3 program lines are (Fig. 7).

Most importantly, it is successful. Starting with the vision in 2011, now 15 researchers at the TU Delft, several research institutes, and over 40 companies and organizations are connected. Seven research and innovation projects are being executed.

3.4 Pillar 4: Liaising and Co-creation

Trust and dialogue has developed between departments and researchers. Innovative concepts underlying the sustainable TUD Learning Centre Building (under construction) were developed in close collaboration between scientists, the real estate department, the project architect, and external stakeholders.

3.5 Pillar 5: Outreach: University as a Catalyst in Regional/National Sustainability Systems

As an owner and operator of combined heat and power installations and several underground Heat and Cold storage systems, the facility management department is already trading energy with several third parties.

An example of how connecting to the region can provide new insights is the preparation of geothermal heating for the campus. A new smart district heating system is being developed. Part of this development is a deep (2.3 km) geothermal well. New scientific opportunities arise for the Geoscience Faculty. Developing it provides hands-on experience with regulations, financial, and societal aspects.

The foreseen geothermal well will deliver heat at a temperature of 70–75 °C, below the operating temperature of the existing high temperature heating network (100–130 °C). The transition requires campus-wide adjustments of the in-building heating systems and a new heating strategy, reducing the peak demands that supersede the thermal well power. Moreover, the geothermal well competes with the CHP system, which is also operating in the lower temperature range. To manage the complex transition at reasonable investments, next to the well development itself, two parallel projects are started to address (1) the building transitions and (2) an overarching new (model predictive) control approach.

This control approach requires minimizing peak demands, dealing with a new, cascaded building structure, and utilizing the various heating options (gas fired boilers for remaining peak demands, the CHP unit and the geothermal base load) in a cost effective and environmental friendly way. It is termed the Smart Thermal Grid project (Fig. 8), an intensive collaboration between scientists, the real estate department and external parties.

This innovative approach for district heating with practical experience, including organizational and financial aspects, provided a basis for input in the regional discussion the development of provincial heating network, connecting waste heat from the Rotterdam harbor area and new sustainable heat sources (such as geothermal wells) to the heat demand of a major part of the Province of South

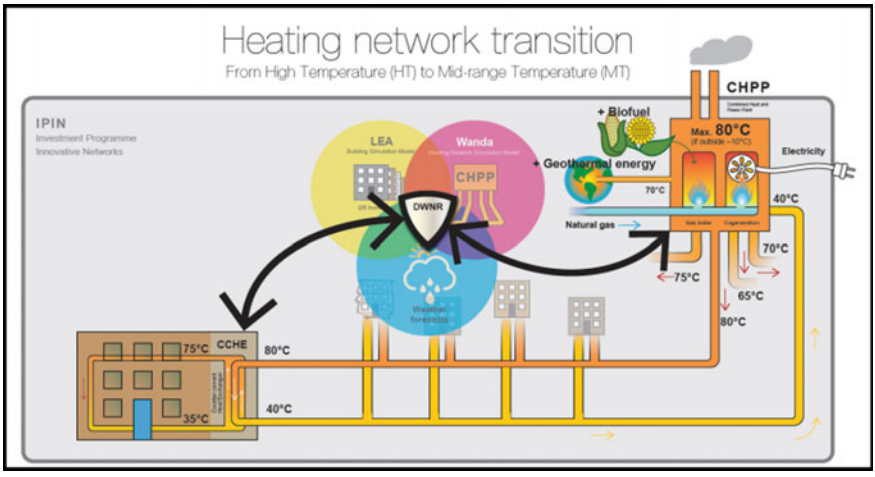

Fig. 8 Campus-wide sustainable heating: from high- to medium-temperature with geothermal heating. *Source* TU Delft

Holland, including Rotterdam, Delft, The Hague, other cities and the energy intensive greenhouse sector.

As a consequence of this engagement the span of the university input has broadened to more general questions surrounding the logics behind regional heating network: To develop a vision on future waste heat availability in the Rotterdam harbor industrial area. A challenge that requires a fundamental evaluation on future energy systems, with, for example waste heat flows accompanying future fuel production and back-up electricity facilities.

This case clearly shows how campus developments can provide an anchor in creating new collaborations and scientific challenges that have impacts well beyond the campus boundaries. Although presented as a Pillar 5 example, it is also based strongly on Pillar 4.

4 Discussion

This ShowHow approach has been in effect for less than a year but has already yielded valuable results. Its impact will become even more visible throughout the coming year. Some observations and considerations:

1. Challenges of the 'Five Pillar' Approach

The 'five pillars' approach seems to be a solid foundation to stimulate sustainability between all stakeholders. Pillars 1, 3, and 5 seem to be powerful ingredients in addition to the pillars 2 and 4. They give visibility, structure, and grip for all of the relevant stakeholders:

- *Pillar 1* has quickly led to visible projects, with increasing participation of the University community.
- *Pillar 3* has identified new and interesting themes and openings for scientific research and innovation, which have enabled the research of numerous new PhD's.
- *Pillar 5* is leading to a wide variety of opportunities, where a university can become a well embedded, catalyzing partner in creating new pathways for sustainability.

The main challenges of the approach lie in the balance between the responsibilities of the Real Estate department in optimally facilitating a demanding academic environment against scientists whose research often is not yet ready for market or perhaps even demonstration. Possible solutions are:

– To identify and involve departments/researchers whose activities are more near-market

– To deploy technologies developed in the past, which are only now becoming ready for market

2. Suggestions for Replication

The '5 Pillar' approach is applicable and replicable at other universities. In essence, it relies on utilizing *all* available resources at that University, with the aim of expediting the process towards sustainable Universities.

The initial success of the '5 Pillar' approach experienced at TU Delft seems to depend on the expertise and in-house knowledge that is created and fostered within it. The required resources for the approach are:

– Student communities
– A real estate department, willing and capable to engage in sustainability
– Scientists/researchers willing to implement their research
– People who are able to connect the various cultures
– Clear overview of local and regional (physical) possibilities and opportunities.

The first four can be developed or acquired anywhere. The fifth is campus-specific; at TU Delft, geothermal and regional heat demand forms an opportunity. Other campuses may have other opportunities such as a dense metropolitan area, an airfield, river water, or solar resources. These opportunities should be identified and explored by each university individually.

This highlights an opportunity for future research, in testing the effectiveness of such an approach at other technical as well as non-technical Universities, to shed light on *how* the '5-pillar' approach works within them.

3. Looking Ahead at the Approach, at the TU Delft Green Office

The real estate department can now rely on a 'sustainability back-office,' with scientific and student support. This has facilitated and strongly enhanced the focus on sustainability for new buildings, renovations and campus-wide developments.

Innovative concepts underlying the sustainable 'Pulse' Learning Centre Building (under construction) were developed in close collaboration between scientists, the real estate department, the project architect and external stakeholders. This is partly a result of the triple-liaison structure, with the Green Office as the proactive and motivated connector to all these stakeholder groups.

A less tangible but equally important result is the newly developed trust and dialogue between departments and researchers. This has allowed for a more centralized and collaborative strategy towards sustainability.

Consequently, the University will meet its goals, set by the executive board in 2014 for greening the campus energy use and supply, well before the original target year of 2020. Together with the high (inter)national rankings this places further impetus on improving performance and discussing the goals.

It is not yet possible to comment on the long-term effectiveness of the approach. Follow up assessment is required in order to gauge the long-term effectiveness and longevity of the approach.

5 Conclusion

The ShowHow approach has been presented, detailing a method for traversing the gap from a general recognition of the importance of sustainable development to a working practice that joins the university's various internal and external stakeholders on the path towards sustainable campuses and University environments.

The initial results of the adoption of the '5 Pillar' approach at TU Delft indicate the successful integration of sustainability principles within the organizations responsible for campus projects, management and operations. Pathways are being formed to merge sustainable campus developments with the prime responsibilities of a university: high-level research and education have appeared to emerge.

Replication of the initial success of the '5 Pillar' approach experienced at TU Delft, at other Universities, is dependent on the expertise and in-house knowledge that is created and fostered within it. This highlights a need for future research, in testing the effectiveness of the approach at other technical and non-technical Universities. Follow up assessment is also required in order to gauge the long-term effectiveness, merit and longevity of the approach in itself.

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University of São Paulo: Sustainability Masterplan for Policies, Plans, Goals and Actions

Marcelo de A. Romero and Roberta C. Kronka Mülfarth

Abstract

The University of Sao Paulo (USP) is the largest and one of the most prestigious universities in South America with an academic population of nearly 150,000 people (127,000 students, 17,000 staff members and 6000 teachers). The USP has 14 campuses around the state of Sao Paulo and an annual budget of US$250 million, totally funded by the State of Sao Paulo, Brazil. Almost twenty years ago, USP started to take action in the area of sustainability and in the reduction of its environmental impacts. Due to its immense size and the presence of diverse properties in rural and urban areas, it was necessary to define environmental policies for all campuses prior to decision-making and the establishment of indicators and targets. Since 2014, USP initiated a comprehensive Sustainability Management Plan. Coordinated by the Superintendence of Environmental Management of the university (SGA), this plan was designed with the following phases:

(1) Definition of Sustainability Issues Policy for the university (November 2015)
(2) Definition of Sustainability Issues and Plans (June 2016)
(3) Sustainability Masterplans with 11 thematic chapters for each campus (July 2017)
(4) Specific Sustainability Programs of each Faculty or Departments (December 2017)

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All these actions are ongoing and the deadline for their completion is December 2017. It is an ambitious plan, with almost 1000 people involved and working in the process. This work intends to present the methodologies developed to achieve the sustainability goals of the University of Sao Paulo and the results already achieved.

Keywords
Campus sustainability · Policies · Sustainability plan · Sustainability diagnosis

1 Introduction

As the fifth largest country in the world based on geographical area, Brazil has made great efforts in minimizing environmental damage by prescribing relevant legislation.

In 2010, given the increasingly visible environmental predicament, Brazilians regulators enacted the national policy for solid waste (NPSW) under the Law 12.305/2010. The goal of this extensive regulatory policy is to internalize costs and liabilities to manufacturers and consumers while establishing and promoting reverse logistics and material stewardship (Jabbour 2013).

The NPSW established guidelines for National, State, Regional and Municipal Solid Waste Plans. The specific goals of the Law include: providing incentives for recycling industries to help in the use of recycled raw materials; encouraging the use of clean technology in order to minimize environmental impacts; promoting a management hierarchy of reduce, reuse, recycle and ensuring that solid waste disposal is completed in an ecologically and environmentally responsible way; prioritizing green government procurement; and integrating reusable and recyclable materials in actions that involve liability life cycles (PNRS 2010).

Because of this new regulatory policy, USP organized in 2012 (USP 2015), a Working Group (WG) in order to adapt to the demands of NPSW. Although this process is not finalized, the structure of the USP solid waste policy followed the guidelines presented in NPSW:

- 1st phase: Definition of sustainability policies (in this phase the following should be defined: subject and applications, settings, principles, guidelines, preliminary provisions, management tools, administrative and financial tools, responsibilities and prohibition);
- 2nd phase: Definition of the Policy Management Plan (in this phase the goals and indicators should be defined);
- 3rd phase: Definition of actions (in this phase it should be defined actions by national legal entity registration[1]—NLER)

[1]NLER—National legal entity registration, translation of CNPJ—Cadastro Nacional de Pessoa Jurídica.

Along with the tasks of the Solid and Waste Work Group, the University of São Paulo created in 2012 (SGA 2016) the Superintendence of Environmental Management (SGA *Superintendencia de Gestao Ambiental*). The main purpose of SGA is to plan, deploy, maintain, and promote environmental sustainability on the 14 campuses and research areas of the University of São Paulo and also to incorporate the environmental dimension of sustainability across the board in all policies, plans and activities, in the areas of teaching, research, extension and management. Although environmental and sustainable actions at USP started in the 90s, it was only with the creation of SGA that many actions related to sustainability became part of an official program for the entire University. Up until this point, sustainability actions had been compartmentalized, occurring separately at some of the USP's campuses (Delitti and Cerri 2013).

From these assumptions, the SGA began to develop these actions based on three goals: (1) Towards Zero Carbon Emissions: (2) Our campuses as a lab for our cities and (3) Sustainable actions.

As a result of these actions, the first task of SGA, on its second mandate (2014) was to create "Environmental USP" based on the structure of Solid and Waste Policy of USP, guided by NPSW.

2 Sustainability Plans

Over the past decade, the issues of sustainability has come to the fore and the its principles are being incorporated by all actors in society reinforcing the need to promote deep structural changes in search of greater social equality, enhancement of cultural aspects, greater economic efficiency and less environmental impact on the equitable distribution of raw materials, ensuring the competitiveness of man and cities (Kronka Mülfarth 2006).

In this context, it is worth mentioning the role of universities, which in their primary function of knowledge construction, have a duty to strengthen their roles as an intermediary between local government and society, not only in promoting discussion, but also as an important agent towards these changes.

The natural teaching vocation, research and extension gives universities the potential to become a "laboratory" of looking not only for solutions to the demands, but also to effectively contribute in the construction of knowledge, with a fairer society.

In the case of public universities, especially in Brazil, this commitment to the incorporation of more "sustainable" variables should be seen as a duty, and this search for a better dialogue between society and governments must be seen as a daily exercise in all instances they are requested.

According to the Environmental Protection Agency EPA (2015), sustainability plans are those developed by an organization or government to achieve goals that foster environmental, community, and financial sustainability. These plans set goals

that are particular to the organization in question. The plan will also establish guidelines for achieving and measuring the impact of these objectives.

The creation process of a sustainability plan will provide a roadmap to guide the organization to work on sustainability efforts and can strengthen their partners and understanding of the efforts needed to, keep projects operating and improving. According to Johnson et al. (2004), sustainability plans can help identify what resources are necessary to sustain projects, encourage the development of partnerships, and support collaboration. Whatever the understanding of sustainability (different organizations' or governments' interpretation of sustainability will vary according to their priorities), sustainability plans are an important tool not only for diagnosis, but also to identify actions in pursuit of more sustainable benchmarks. Moreover, for universities, sustainability plans are important to not only organize actions, but also to establish goals.

To incorporate a new vision for a healthier and resilient future, many universities around the world have adopted principles that will guide projects and plans in teaching and research to achieve goals in *sustainability.*

In 2004, Harvard University (2015) adopted principles that will guide projects and plans in teaching and research to achieve goals in "health and wellness, conserving resources and improving the efficiency of campus operations". The Harvard Sustainability Plan recognizes that creating a sustainable campus strengthens the research and teaching mission. Faculty, students, facilities, and operational experts, along with the Harvard Office for Sustainability management, developed the Plan, and it is defined by the following topics:

- Emissions and energy: greenhouse gas emissions; energy reduction; renewable energy.
- Campus operations: new construction; building operations; transportation; climate preparedness and campus resilience; procurement.
- Nature and ecosystems: landscape operations; campus design; conservation and education.
- Health and well-being: personal well-being; food.
- Culture and learning: research and teaching; governance; external partnerships; communications; community action.

Each of these topics is organized according to three categories:

- Goal: reduction goals by a set timeframe.
- Standard: to facilitate, to ensure, and to allow flexibility with the implementation.
- Commitment: to improve the research on areas that had not enough information to achieve a specific numeric goal.

City University of London (2015) initiatives undertaken in 2013/14 build on the accreditation within the People and Planet University League. The University achieved IS014001 accreditation for its Environmental Management System, while

undertaking a range of actions as part of its commitment to embedding sustainability within its activities.

The following key aspects defined the University's environmental performance:

- Energy
- Water consumption
- Waste
- Construction and maintenance
- Transport and travel
- Purchasing and procurement
- Sustainable food
- Biodiversity
- Stakeholder engagement

The Strategic Plan for the University of Maryland (2008) was adopted in May 2008 with a focus on undergraduate education, graduate education, research, scholarship, the creative performing arts, partnerships, outreach, and engagement. Moreover, it was guided by the University's core principles, listed below:

- Build an inclusive community
- Embrace the power of technology
- Act with entrepreneurial spirit
- Partner with others, globally and locally
- Take responsibility for the future

After the adoption of the Strategic Plan and the Climate Action Plan, every year Maryland looks to continue to reduce its environmental footprint and enhance its positive social impacts. In 2012, The Office of Sustainability (OS)—("The University of Maryland Office of Sustainability supports and advances environmental performance, economic prosperity and social equality through a variety of initiatives"), published a progress report (it's a merge of the Campus Greenhouse Gas Inventory Report and Campus Sustainability Metrics Report) highlighting improvements and achievements to the campus community and identifying areas for improvement. The progress report consists of the following sections:

- Sustainability education: integration of sustainability concepts.
- Sustainable behaviors: campus community participation (recycling, composting, and others).
- Resource conservation: reduction of climate-related pollution and use of non-renewable natural resources.
- Sustainable transportation: incorporation of alternative transportation forms and reduction of climate-related pollution from fuel for air travel and vehicles.
- Green procurement: incorporation of environmental and social performance by campus department.
- Community involvement: engagement and services to off-campus communities.

Each of these six sections contains system indicators, to show the changes, and program indicators, specific programs that will influence the performance.

Politecnico di Milano (POLIMI) and *Universita degli Studi di Milano* (Unimi), promoted a project named "*Citta Studi Campus Sostennible*" with the proposal to transform the campus neighborhood into a model of life quality and a sustainable environment (POLIMI 2015).

The principle goals are "*to test innovations developed by scientific research; to promote life style transformation and more livable spaces; to become a positive example for the entire city; to cope with the international network of sustainable campus*".

The main idea to create a campus as a living lab is to promote a participating community and most importantly, to make "*Sustainability*" part of an awareness program. To help the development of the process the campus started with the implementation of a web platform that shares information, proposals, studies, and case studies of collaborative work.

Since 2011, after the website was launched, they started to organize technical meetings (thematic tables) whereby students, academics and technical staff "share ideas and proposals to improve our common good".

The project was structured initially according to four areas of interest. In 2012, an additional thematic table was created, 'City', followed by the 'Food and Health' table in 2013:

- People; *users, participation and identity*
- Energy; *energy efficiency and renewable energies*
- Environment; *environmental quality*
- Mobility; *transport terms accessibility and sustainable mobility*
- City; *transferring research from labs into urban life*
- Food and Health; *sustainable lifestyle and sociocultural topics*

> The themes are identified in order to cluster the received project proposals and initiate thematic working groups, which are called the Thematic Tables (POLIMI 2015).

The University of Melbourne (2015) has a commitment to addressing environmental issues through its documented Environmental Management System. The proposal is to become a "model" for other institutions.

In 1996, the University began to address its environmental impacts and in 1997, the Council had accepted the Environmental Management System (EMS) ISO 14001. However, the ISO 14001 was ceased and the University developed a new framework based on sustainability guidelines and education environments: "Resource Smart Tertiary Education" (RSTE).

The main activities and achievements established in 2011 (University of Melbourne 2015) were:

- *Waste reduction;*
- *Ten new 'Aqua Bubblers';*
- *Standardised 'Under-Desk'*
- *'Public Place' recycling stations*
- *Bicycle facilities*
- *Campus Sustainability Centre*
- *Sustainability commitment*
- *New sustainability website*

In addition to these university initiatives, it is important to note that there are also joint initiatives with the aim to not only strengthen the role of universities, but also to assist in the adoption of guidelines, goals and actions towards a more sustainable campus. The creation of university networks, has not only aided in this process, but act as an important forum for discussion on the implementation of more sustainable benchmarks.

The *ISCN—International Sustainable Campuses Network* (2016), founded in 2007, with more than 70 universities from more than 20 countries on 6 continents, is an example. The network idea is not only to help universities with the implementation of sustainability plans, but also to provide a global forum to support leading colleges, universities, and corporate campuses in the exchange of information, ideas, and best practices for achieving sustainable campus operations and integrating sustainability in research and teaching (ISCN 2014).

Another example is *WC2—World Cities World Class/University Network* (Stiasny and Gore 2013). The network has been developed with the goal of bringing together top universities located in the heart of major world cities in order to address cultural, environmental and political issues of common interest to world cities and their universities. By promoting closer interaction between universities, local government and business communities, WC2 will help to create a forum where universities can be more responsive to the needs of their stakeholders in the context of world cities. Each of the founding members bring together local expertise in issues of common interest to world cities such as:

- Transport
- Global health
- Global cultures
- Business
- Ecocampus

The Global Universities Partnership on Environment for Sustainability (GUPES) is one of the programmes of UNEP's Environmental Education and Training Unit (EETU). GUPES was the result of a consultative forum organized by UNEP and its partners, to deliberate on ways of escalating UNEP's engagement with universities. At present, over 680 universities and regional partners/focal points from five different continents are part of the growing GUPES network (UNEP 2013).

GUPES aims to promote the integration of environmental and sustainability concerns into teaching, research, community engagement, the management of universities (including greening of university infrastructure/facilities/operations), as well as to enhance student engagement and participation in sustainability activities both within and beyond universities (UNEP 2013).

For its distinct regional characteristics, mainly in the economic field, there are several universities in Latin America networks that are organized in order to enable actions in pursuit of more sustainable benchmarks.

ARIUSA is a network of environmental university networks created in Bogota in October 2007 by a group of University Networks for Environment and Sustainability (RUAS), gathered during the "IV International Congress University and Environment", organized by the Colombian Network Training environmental (RCFA). The purpose of ARIUSA is to promote and support the coordination of actions in the field of higher environmental education as well as academic and scientific cooperation between University Networks for Environment and Sustainability (Sáenz 2014).

The network RISU—*Red de Indicadores de Sostenibilidad en las Universidades* is an important example not only to promote the exchange of experience in establishing sustainability indicators of the participating universities, but also by periodically collecting data for universities to set their goals (Álamo 2015).

The RISU Project, "Defining indicators to assess the implementation of sustainability in Latin American Universities" was proposed by the Research Institute for Higher Education and Science (INAECU Institute) in close collaboration with Red de Indicadores de Sostenibilidad Universitaria (RISU) of ARIUSA and with financial support from the Centro de Estudios de América Latina at the University Autónoma de Madrid (UAM) and Santander Bank. The project is also endorsed by the Latin American Chapter of the Global University Partnership on Environment and Sustainability (GUPES-LA) from the United Nations Environment Programme (UNEP).

The following project phase consisted of reviewing the monitoring and evaluation experiences that were being developed and carried out in the region. The project identified some previous initiatives aimed at defining indicators in this area, developed by university networks in Costa Rica, Colombia, Chile and Brazil in addition to other publications and more elaborated proposals developed by other universities and networks in Latin American countries. An assessment tool was developed with a set of 114 indicators clustered in 11 thematic areas or dimensions for implementing sustainability in universities (Álamo 2015):

- Sustainability Policy (15 indicators)
- Awareness and Participation (12 indicators)
- Social and Environmental Responsibility (10 indicators)
- Teaching and Learning (13 indicators)
- Research and Knowledge Transfer (13 indicators)
- Urban Planning and Biodiversity (7 measures)
- Energy (10 indicators)

- Water (10 indicators)
- Transport (8 indicators)
- Waste (11 indicators)
- Responsible Procurement (5 indicators)

In total, 65 universities located in 10 Latin American countries (Argentina, Brazil, Colombia, Costa Rica, Chile, Guatemala, Mexico, Peru, Dominican Republic and Venezuela) have participated in the project on a voluntary basis. The countries with the highest representation in the study are Mexico with 15 universities, Brazil with 13 and Chile with 10. The number of universities in these three countries represents 50 % of the sample. It is important to note that these countries have the highest number of universities in comparison to the rest of the participating countries.

Regarding the Sustainability Policy in RISU Project, it is important to state that only 35 % of universities have a communication plan associated with their sustainability policies or strategies and also a small proportion of universities (30 %) have a sustainability committee or council with students, academics and support staff who can oversee and monitor the implementation of sustainability policies (Álamo, 2015).

3 USP's Sustainability Policy

Based on the background described previously, USP, being aware of the established importance of its Environmental Policy, decided to set up "Environmental USP", based on the structure proposed for the national policy for solid waste (NPSW).

USP decided to adopt the same structure and principles adopted in the NPSW. Consequently, the construction of Environmental USP was defined in four phases:

- Phase 01—Definition of Sustainable Policies
- Phase 02—Definition of Sustainability Issues Plans
- Phase 03—Sustainability Masterplans with 11 Thematic Chapters
- Phase 04—Sustainability Program of each school or department (Fig. 1)

4 Phase 01—Definition of Sustainable Policies

Thus, Environmental USP was divided in 11 + 01 sections, 11 thematic policies and 01 management policy of thematic policies, as following:

1. Administration
2. Greenhouse Gas Emissions
3. Energy

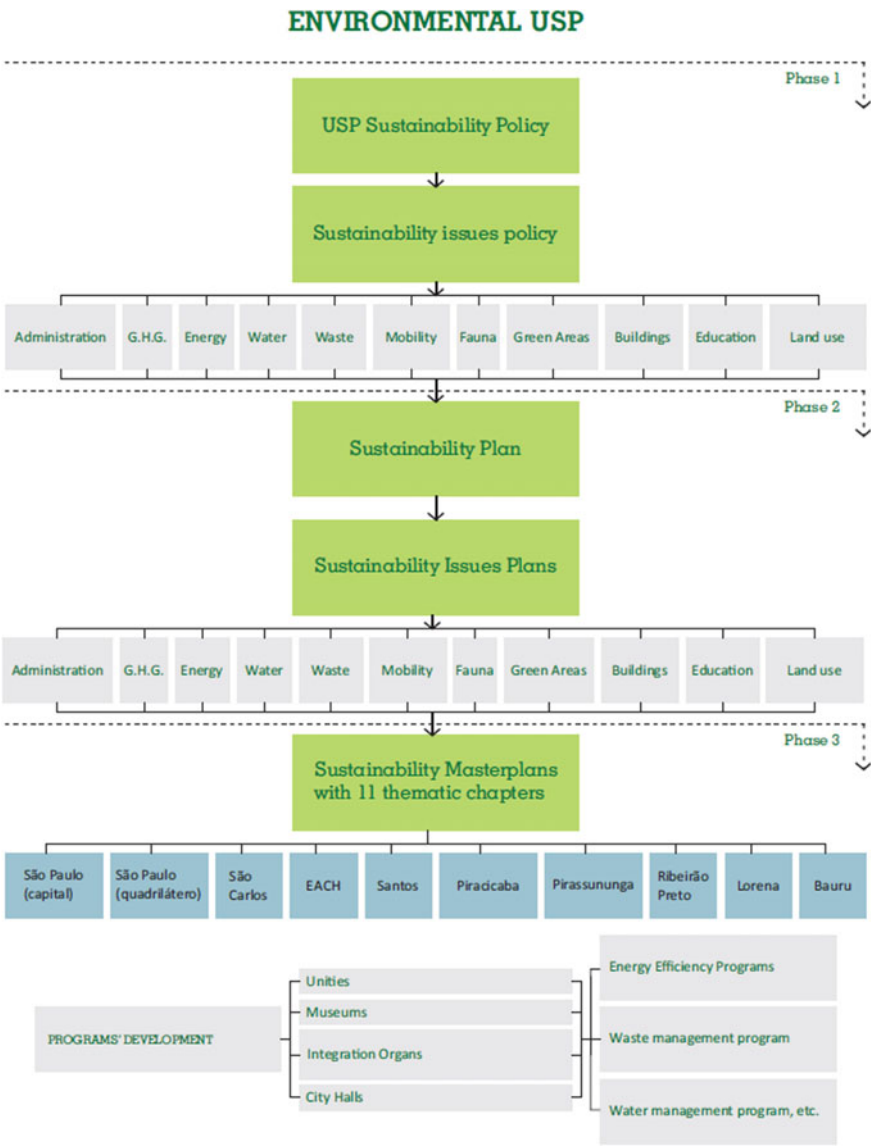

Fig. 1 USP sustainability chart

4. Water
5. Solid Waste
6. Mobility
7. Fauna
8. Green Areas
9. Sustainable Buildings

10. Environmental Education
11. Land use
12. Sustainability Policy

The last point, "Sustainability Policy", organizes the sustainability issues from an administration perspective in terms of USP administrative structure.

From this, subdivisions were established consisting of 12 working groups (WG) involving about 300 people, including faculties and technical staff who produced 12 documents with the following structure:

- Subject and Applications
- Preliminary Provisions
- Principles
- Guidelines
- Goals
- Preliminary Provisions
- Management tools
- Administrative and financial tools
- Responsibilities
- Prohibition

This phase was concluded in November 2015, and established the following policies at USP:

5 Administration Policy

The administration WG was created in order to reduce the environmental impacts of the administrative activities of the University, establishing definitions, criteria and goals that guide the work of the Coordination of General Administration (CODAGE) and all administrative bodies in order to match the commitments of the University of São Paulo with the environmental agenda.

The WG works for rationalization of goods and services consumption, expanding the use of clean technologies and reuse in order to save natural and economic resources.

Some of the means to achieve these objectives are:

- the application of the 3Rs, in other words, prioritization of environmental education in the management of solid waste so that people can reduce consumption, reuse and recycle materials;
- budged points institution promoting the implementation of this policy;
- reduce bureaucracy of administrative procedures;
- prioritizing the purchase of goods with longer life and lower maintenance costs; and

- electronic systems such as the purchases Electronic Exchange System (BEC) and the Corporate System Computerized environmental data from USP, and studies such as the Environmental Catalogue and technical studies of outsourced services (CADTERC) made by the Government of the State of São Paulo;

The governing principles of this policy are rationality and responsibility in the use of natural and economic resources, transparency, participation of the whole community, the development of an intersectional and interdisciplinary approach, considering the various dimensions affected by the administration of the University.

6 Greenhouse Emissions Policy

The WG reduction of GHG emissions was created in view of the need for the University to adapt legislation, such as the National Policy on Climate Change, and develop policies for the prevention and mitigation of greenhouse gas emissions.

The WG works in order to harmonize the activities of the University with the protection of the climate and environmental systems and public health. To this end, it encourages the use of renewable energy, the identification of the sources of greenhouse gas emissions and global warming and the adoption of clean technology standards and rational consumption.

Some of the means to achieve these objectives are:

- computerized corporate system;
- promotion of scientific and technological research;
- environmental impact assessment;
- environmental licensing;
- social and environmental formation of USP community;
- diagnosis and monitoring of emissions from the University using indicators;
- adopt measures to prevent, mitigate and adapt to climate change; and
- prioritization of products and services with less environmental impact.

The governing principles of this policy are, in order of importance, systemic and interdisciplinary vision, prevention and precaution, cooperation, access to information, awareness, and use of best available technologies and the principles of non-generation, reduction and treatment.

7 Energy Policy

The Energy WG was established to promote the study of energy use at USP, given that it is vital that its management must prioritize conservation and rational use, in addition to meeting the legal requirements, as provided in the National Energy

Policy in National Policy for Energy Efficiency and the relevant rules issued by the competent bodies.

The WG looked to promote the welfare of the population, through the adoption of sustainable standards, increasing public awareness, or by the development of programs that improve production processes and energy use. In addition, it is necessary to prioritize the purchase of durable goods that have a low environmental impact, preferably recycled or recyclable, and are efficient. Moreover, it is important that hired services be committed to the same principles that guide the University of São Paulo.

Some of the means to achieve these objectives are:

- carry out a full assessment of the energy situation at the University, including indicators and inventories;
- the Corporate System Computerized environmental information, enabling better control and monitoring;
- the promotion of scientific and technological research and educational processes;

The governing principles of this policy are systemic, social and environmental commitment, prevention and precaution, the rationalization of consumption to a sustainable level, interdisciplinary collaboration and cooperation, reuse and increase efficiency (PUERHE Recursos Energéticos 2016).

8 Water Policy

The Water WG was created in recognition of water scarcity issues and the consequent need for rationalization of its use, as well as preservation of water bodies. In addition, the University of São Paulo has a moral responsibility to exceed current legislation and public policies.

The WG works in order to ensure water quality and adequate quantity standards, to improve the quality of effluent produced and make use of the best available technologies in order to reduce the environmental impact of the University. Moreover, the WG is looking to build a shared management structure incorporating USP water to protect the health of the University and the environment.

Some of the means to achieve these objectives are:

- general diagnosis including the following quality indicators: discharge of effluents, consumption and water losses;
- certification of performance and environmental quality;
- control of the granting of right of use of water resources;
- technical training;

- prohibition of underground water use, surface water, reuse of water and the discharge of effluents into water bodies without proper approval from the competent bodies and without additional environmental impact assessments;
- environmental training programs; and
- sub metering and the apportionment of costs of water and sewage.

The governing principles of this policy are transparency, the right to participation, rationality and efficiency of water use, the compartmentalization of consumption measurement, care at the final destination of waste and prioritization of the use of water for human consumption aimed at protection of health and the environmental balance. It should consider the need to adapt water management and wastewater to local diversities (PUERHE Recursos Hídricos 2016).

9 Solid Waste Policy

The Solid Waste WG was created due to the requirement for a solid waste management group in accordance with the National Policy on Solid Waste (NPSW), in order to reduce the environmental impacts of the assets disposed of through human activities, including hazardous waste.

The WG works in order to ensure that solid waste management prioritizes non-generation, reduction, reuse, recycling and disposal of environmentally solid waste. The aim is to protect health and the environment by adopting sustainable patterns of consumption, including products whose production chain is sustainable, and environmental education.

Some of the means to achieve these objectives are:

- computerized corporate system;
- waste inventories;
- selective collect;
- promotion of scientific research;
- continuity of educational processes; and
- disposal that is environmentally appropriate (presenting the certificates required by law).

The governing principles of this policy are multidisciplinary, a systemic vision, prevention and precaution, transparency, access to information, cooperation, shared responsibility and reducing the social impact of the regular activities at the University.

10 Mobility Policy

The Mobility WG was created by the perceived need to improve mobility inside campuses and among the campuses so that they can carry out the mission of the university and its regular activities. The WG works in order to develop mobility policies that improve the lives of campus users, are a model for society, and comply with policies and legislation.

Some of the means to achieve these objectives are:

- to establish better integration between transport facilities and the surrounding areas;
- prioritizing non-motorized means of transport and collective public transport, discouraging the use of motorized individual transport;
- encouraging active mobility by ensuring there is adequate infrastructure to promote the use of transport considered most suitable by the University in terms of the health benefits, well-being and social interaction; and
- encouraging the development of studies on the mobility theme and encouraging the use of cleaner renewable energy sources that have less impact on the environment and public health;

Thus, it enables a reduction in the environmental and socioeconomic impact of displacement, providing improved comfort, safety and health of users and the public.

The governing principles of this policy are universal access, equity, security and efficiency.

11 Fauna Policy

The Fauna WG was created based on the realization that, as the campuses are home to wildlife species, which interact with humans, there is a need for a policy that guides the administration's actions. To minimize human-wildlife interaction risks, it is vital that there is a behavioral change in the management of the University and wildlife management.

The WG works in order to conserve wild and native wildlife, controlling the risks of human-wildlife interaction and combating invasive species. The goal is to guarantee a healthy and balanced environment, the management of wildlife where necessary, the prevention and control of risks and the formation of conscious citizens.

Some of the means to achieve these objectives are:

- computerized corporate system;
- social and environmental training programs for the USP community;
- diagnosis and survey of fauna and human-wildlife interactions;

- the environmental impact assessment;
- use zoning and land occupation of campuses;
- training and technical training; and
- ban on animal feed, as well as abandonment or capture.

The governing principles of this policy are the conservation of biodiversity, a systemic and interdisciplinary approach, social participation, access to information, cooperation, respect for diversity, responsible action, and fairness and proportionality.

12 Green Areas Policy

The Green Areas WG was created in view of the responsibility of the University for the protection of its ecological heritage. In addition, the USP is committed to institutional leadership and proactivity, as well as to enforcement. The preservation of green areas promotes conservation of water resources and biodiversity, improves air quality and climate control, among many other benefits.

The WG works in order to monitor the Green Areas and Ecological Reserves to promote change in the form of human interaction with the vegetation cover of the University. For this, it is necessary to not only identify and separate the two, but also to establish environmental sustainability goals. In addition to the conservation of existing areas, WG seeks to encourage recovery, restoration and renaturation.

Some of the means to achieve these objectives are:

- social and environmental formation of USP community;
- urban plans;
- afforestation plans;
- inventories and maps, including indicators;
- computerized corporate system;

The governing principles of this policy are inclusion and community participation in management, shared responsibilities, access to information, cooperation, encouraging new forms of management of green areas, the appreciation of the environmental heritage of the University and sustainable landscaping.

13 Sustainable Buildings Policy

The Sustainable Buildings WG was created in view of the urgent need to adopt actions for the sustainability of the buildings of the University, saving natural resources such as water and energy, and financial resources. This rationalization

should be adopted in the maintenance, renovation, restoration or expansion of existing buildings, as well as in new builds.

The WG works in order to promote architectural designs using natural local conditions in order to reduce energy demand and water. Moreover, the WG promotes the use of recycled or recyclable materials (provided it does not compromise the durability of the building), minimizes soil sealing, and ensures universal accessibility as well as functionality and safety. The objective is to consider the health, productivity, environmental comfort and air quality for occupants.

Some of the means to achieve these objectives are:

- preparation of USP's environmental performance certification;
- formulation of indicators to assess thermal performance, natural lighting, noise and energy, as well as the durability of the physical structure; and
- use of technical standards that are nationally or internationally recognized;

The governing principles of this policy are respect for contextual diversity of campuses, the search for environmentally friendly buildings that are economically viable, culturally accepted and socially just, democratic, practical, proportional, take into account health protection, comfort and safety of users and the preference for refurbishment of existing buildings over the construction of new ones.

14 Environmental Education Policy

The Environmental Education WG was created considering the Law of the National Environmental Education Policy, which prescribes that environmental education should be present at all levels of formal education, as well as its value noted in other legal documents, including the Federal Constitution. In addition, the University of São Paulo is committed to social and environmental issues and should be a role model for society and help to form critical citizens capable of facing the global environmental crisis.

The GT works in order to institutionalize the concepts of environmental sustainability and environmental education in all areas of the University, promoting their environmental approach. The USP should promote the production of knowledge, planning and management in view of the environmental problems, and the issue should be rooted in teaching, research, culture, extension and academic management.

Some of the means to achieve these objectives are:

- formation of the USP community as a whole in environmental educational communication;
- fostering research and projects on the subject of environmental education, promoting the monitoring and evaluation of progress, as well as their valuation and disclosure;

- creation of specific courses that consider the methodological aspect of environmental education; and
- continuity of participatory strategies that promote the capillarity and rooting to improve the environmental education of USP servers.

The governing principles of this policy are cooperation and interdisciplinary collaboration, both actors, as theoretical and methodological languages of different knowledge. Additionally, the values of transforming education and forming citizens capable of acting responsibly guide this policy.

15 Land Use Policy

The Land Use WG was created in view of the need to comply with legislation and to promote proper land management on campus in order to safeguard natural areas.

The WG works in order to standardize the land situation of the University and guide management of the USP territory in an efficient, socially and environmentally responsible, and financially sustainable way. Moreover, it is essential to prevent, mitigate and restore environmental damage caused by land use changes on campus.

Some of the means to achieve these objectives are:

- monitoring of data in the computerized corporate system, resulting in a diagnosis of the issue of use and land occupation;
- environmental licensing;
- performance certifications and environmental quality;
- technical training of employees through environmental education; and
- encouraging research and technological innovation;

The governing principles of this policy are promoting interdisciplinary collaboration, considering several variables, such as environmental, cultural, social, public health and economic management of the university territory; democratization and participation and respect for diversity in the context of different campuses.

16 Sustainability Policy

The Sustainability Policy WG at the University was created by the need for a document that would legitimize and guide the environmental initiatives at the University of São Paulo, in order to promote more efficient sustainability management and in accordance with the principles of the University. The topics covered are: management, water and wastewater, green areas and ecological reserves, sustainable buildings, environmental education, greenhouse gas emissions, energy, fauna, mobility, waste, and land use.

Thus, USP's Environmental Policy will be the basis to guide the formulation of the Sustainability Policies, the Sustainability Issues Plan, the Sustainability Masterplans with 11 Thematic Chapters and the Sustainability Program of each school or department. Thus, by establishing objectives and targets stemming from the diagnosis, these documents establish a better-defined framework for environmental management within the University.

The general purpose of these documents is to encourage environmental education at the University, to protect health and the environment and to adopt sustainable patterns. In short, these documents aim to promote integrated environmental management at the University in order to improve the quality of life of its members and society in general.

Some of the means to achieve these objectives are:

- the computerized corporate system + data and environmental monitoring;
- monitoring and control of environmental performance;
- cooperation between units and society as a whole;
- continuous education processes;
- environmental certifications as well as the studies necessary to achieve them; and
- reallocating human and financial resources for environmental management.

The governing principles of this policy are the prevention and precaution, fairness and proportionality, the mainstreaming of education, interdisciplinary, transparency, participation, access to information, shared responsibility, respect for local conditions, the appreciation of the knowledge produced at the University and responsible action. Moreover, it applies the principle of proximity, by which all environmental problems should be resolved as close to the source as possible in order to stimulate local development.

17 Phase 02—Definition of Sustainability Issues Plans

With the completion of the first phase and the 12 documents, *Sustainability Issues Plans* for each Policy that contains the details of the actions, targets, goals and their objectives are being developed.

Schedule Phase 02—July 2016.

18 Phase 03—Sustainability Masterplans with 11 Thematic Chapters

These masterplans consider the ecological and urban diversity of each locality and will be related to urban master plans for each campus.

Schedule Phase 03—July 2017.

19 Phase 04—Sustainability Program of Each Faculty or Department

From the definition of Sustainable Policies, definitions of Sustainability Issues Plans, definitions of Sustainability Masterplans with 11 Thematic Chapters and definitions of Sustainability Programs, it will be possible to identify actions for each school or department.

Schedule Phase 04—July 2017.

20 Conclusions

The incorporation of the principles of sustainability by all actors in society has gained momentum over the past decade, reinforcing the need to promote deep structural changes in search of greater social equality, enhancement of cultural aspects, greater economic efficiency, environmental sustainability, the equitable distribution of raw materials, and ensuring the competitiveness of man and cities.

In this context, the mission of universities, which in their primary function of knowledge construction, have a duty to strengthen their role as an intermediary between local government and society, not only in promoting discussion, but mostly as an important agent towards these changes.

A significant tool in this context is a sustainability plan that provides a road map to guide the organization to work on sustainability efforts. A sustainability plan can strengthen partnerships and understanding of the efforts required to keep the project operating and improving. At universities, sustainability plans are not only useful for organizing collective actions and identifying issues but also in establishing short-, medium-, and long-term sustainability goals.

In Latin America, despite the importance of sustainability, the vast majority of universities have not developed sustainability policies.

Almost twenty years ago, USP started its actions in the area of sustainability in order to reduce its environmental impacts. Due to its immense size, and the presence of rural and urban fields with diversity of ecosystems, it was necessary to define environmental policies for all campuses prior to decision-making and the establishment of indicators and targets.

Although environmental and sustainable actions at USP started up in the 90s, it was only with the creation of the Superintendence of Environmental Management (SGA), that many actions related to sustainability became part of an official program for the entire University. Up until this point, sustainability actions had been compartmentalized, occurring separately at some of the USP's campuses. The USP Sustainability Policy organized the existing actions, the future actions and united a huge contingent of faculties and employees around the environmental cause. With the completion of the first phase it was possible to observe that:

- greater cohesion tis taking place among faculty and staff regarding sustainability issues;
- faculty and staff now have greater responsibility in their actions related to sustainability;
- after the creation of USP's sustainability policies, a clearer definition occurred, not only of the university's sustainability issues, but also in defining clear goals, targets and deadlines.

With the completion of the Environmental USP, the University of São Paulo hopes to achieve all goals by its centenary in 2034.

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Promoting a University Culture of Sustainability: The Role of Conscious Consumption

Madhavi Venkatesan

Abstract

This chapter will focus on the economic elements that both promote and enable a university culture of sustainability. The assessment provided differs from other research and evaluation in this area, as it does not view stakeholder motivations as differentiable from the standard consumer model. Instead, the establishment of a university cultural shift is assumed to be consistent with an economy-wide shift in paradigm from consumerism to sustainability. As a result institutional growth is not a focus, stakeholder understanding and capacity for sustainability are. Following a discussion of how the deployment of classical economic theory has contributed to the distancing of consumption from sustainability, this chapter will address how education programs targeted to defining responsible demand, along with an infrastructure inclusive of facilities, curriculum and business as usual operations, are a requisite foundation for the promotion of a university culture of sustainability.

1 Introduction

According to Govindarajan and Trimble (2010) leading a sustainable organization is dependent on two primary drivers: creating and maintaining awareness and facilitating shared ownership/purpose of continuous stable changes across an organization or institution. How sustainability is reached in a university requires

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holistic assessment of the university and the university relative to the community and the global environment. On a university level, it is enabled through a multi-channel approach that includes facilities management, procurement, curriculum and consumption choices, all along with an infrastructure that implicitly reinforces the development of unconscious sustainable habits (e.g. water stations, compost bins). However, given the present consumerism fostered economy, perhaps the most significant, powerful, and traction-inducing vehicle for instituting sustainability is found in implementing education focused on conscious consumption throughout the institutional framework, embedded within facilities, curriculum and the residential environment. O'Connell (2008), views the education of a social group as being significant to the traction of sustainability within a given geographical boundary. Education promotes the establishment and traction of a self-reinforcing culture of sustainability, through both enabling the capacity for sustainable personal decision-making along with acknowledgement and recognition of sustainability within the university infrastructure.

2 Significance of Educating for Sustainability

In the United States, consumption contributes to over 65 % of gross domestic product (GDP), which since the 1940s has been the international metric for economic progress. Given this linkage and the corresponding focus on GDP growth as a proxy for progress, consumption decisions can have a significant ripple effect as well as impact upon the finite global resource base. Consider for example the use of milk cartons. Wax lined, printed paper milk cartons have been created for the transport and preservation of milk from the production to the consumption stage. However, the components of the carton were not developed with waste disposal in mind, rather increasing distribution and sales were the rationale for the carton. As a result, largely related to the focused basis of its creation, the milk carton serves a consumption purpose without consideration to the impact to the environment and potential future human and animal health due to its non-biodegradable or re-usable composition. This illustration on a broader consumption scale provides a simplified perspective to evaluate the underlying values captured in consumption decisions. From this perspective, production for consumption may be expressed as a myopic activity, focused on near-term satiation of a need or want to the exclusion of the evaluation of the impact or ripple effect of the satiation. The lack of conscious consumption along with the implicit assumption that the price of a good is sufficient information to enable its consumption are then complicit in the unsustainable outcome encountered in the production to disposal life cycle of the good.

The values embedded and communicated within demand and supply, determine the manner in which a need or want is attained. To the extent that there is no discussion of the values and behavioral factors assumed and reflected in demand and supply, arguably, implicit values, the values and the subsequent behaviors become endogenous to the economic system. Therefore, explicit awareness of

present behavioral assumptions inclusive of the "unlimited wants" of consumers, profit maximization motivations of producers, and the understated resource depletion resulting from externalized costs, offer the potential to modify active and embedded behavior.

An understanding of economics specifically oriented toward enabling the development of rational economic agent behavior, can raise awareness of the significance of consumption behavior as the activity relates to sustainability. Awareness can then foster the development and implementation of conscious and unconscious reinforcement of sustainability, which are the needed elements in driving a culture of sustainability. This in turn, provides a foundational element for the traction of a university culture of sustainability. However, choice is based on a combination of both understanding of options and qualitative values. Arguably choices are not implicitly rational without education related to implementing choice and information that promotes a widening of bounded knowledge. The assumptions guiding decision making along with the significance of education related to the same are foundational to the implementation of a cultural shift to sustainability. The next section discusses the significance of rational choice theory and the importance of explicit education of rational economic agent behavior.

3 Rational Choice and Behavioral Theory: Enabling Education for Sustainability

The theory of rational choice is also referred to as the standard economic model (Gibbard and Varian 1978). It confers an assumption that defines human action as consistent with the attribution of *rational*. Though there is acknowledgement among economists that rational forces alone are not always represented in decisions (Stiglitz 2012), this has been consistently unaddressed in the economic literature. Instead, the assumption has been that rational behavior, albeit consistent with underlying neoclassical and arguably culturally specific assumptions of insatiable wants and benefit maximization (Venkatesan 2016), is an inherent characteristic of human behavioral choice. The benefit of the assumption of rationality is well stated by Kantor (1979, p. 1422) who notes, "the rational expectations approach can provide logically consistent and empirically verifiable answers to questions about what men can and do know and how they use their knowledge." In simple terms, the assumption of rational choice simplifies the assessment and categorization of expected outcomes, both of which are assumed to optimize individual benefits.

Rational economics assumes that individual decision-making is the result of an assessment of forgone opportunities and is singularly focused on the desire to maximize benefit, identified as *utility* in economic theory. Individuals, therefore make decisions subject to life constraints such as income to maximize their individual return. From this perspective each individual evaluates the cost to benefit of a choice and then seeks to maximize return by choosing the highest benefit-inducing alternative. The underlying assumption is significant, as it requires that individuals

both understand how to employ cost benefit decision-making as well as the importance of holistic evaluation as part of cost benefit framework. With respect to the latter this would equate to an individual's understanding of the impact of their actions on both present and future outcomes and choices. Additionally, it would preclude the potential for emotional, culturally or environmentally induced behaviors that would be inconsistent with the very concept of rational decision-making.

Fundamentally, rational agent behavior results in an individual's efficient maximization of return and concurrent minimization of adverse consequences. The assumption of rational behavior imposes the perspective that the characteristics defining rational behavior are inherent and therefore do not require instruction and characterization as *learned*. Further to the extent that the theory of rational choice assumes that social frameworks adopt rational behavior as the norm, there is limited to no acceptance of an alternative basis for decision-making.

The theory of rational choice has been adopted in sociology and has had significant influence on the modeling of social behavior. However, its adoption has not been without both debate and criticism. In economics the theory has been criticized due to its myopic cultural lens. Zafirovski (2003, p. 60) notes, "In sum, the rational choice model falls short of properly conceiving both 'rational' and 'choice' in human behavior. First, by neglecting the non-rational and over-stressing the rational, the model misconstrues the complexity and variety of human behavior by reducing it to a simple and seductive formula of economic super-rationality or materialism…Secondly, the model centers on individual choices, and minimizes their social, including institutional and cultural, constraints…" Goode (1997, p. 39) notes that sociology has adopted rational choice in part even though the discipline acknowledges that other societal elements dictate behavior. People "try to accomplish… goals, whether or not they are highly conscious about what they are doing, we are likely (as lay persons or as sociologists) to predict their behavior under the assumption that they are really aiming at those goals about as well as they can, given their constraints, resources, and alternatives."

Across disciplinary boundaries, in spite of the criticisms, the theory has garnered traction in explaining human behavioral motivation. To the extent that the understanding of cost benefit assessment related to utility maximization may be inconsistent within a society and the inconsistency even more pronounced across socio-economic boundaries, the assumption of rational choice may be problematic. It can be characterized as analogous to the provision of public schooling, which is available to all school age children in U.S. but at differential quality reflective of the tax base of the school system. On an aggregate level access and availability of public schooling thereby promotes a level of equality but only on a micro-level is the disparity between schools apparent.

Given these inconsistencies, behavioral economists have targeted the shortcomings in the explanatory effectiveness of rational economics. Thaler and Sunstein (2009, p. 7) have characterized rational economics as incorporating false assumptions of human behavior. The authors argue, "If you look at economics textbooks, you will learn that *homo economicus* can think like Albert Einstein, store as much

memory as IBM's Big Blue, and exercise willpower of Mahatma Gandhi." Kahnemann (2003, p. 1449) emphasizes that rational models are psychologically unrealistic.

Behavioral economists employ experimental methodologies and provide for the inclusion of interdisciplinary complexity, such as psychology. Further, most behavioral economic assessments focus on specific questions related to how humans are distracted from rational behavior. Behavioral economists distinguish between two systems that influence human cognition. The first system is intuition, the second is reasoning. Intuition is fast, automatic, effortless, associative, and may be emotionally charged; reasoning works slower, and can be described as requiring more effort, and being deliberate (Kahnemann 2003, 1451). The latter reasoning-based system is limited; as a result heuristics are employed in decision-making. However, heuristics might lead to irrational choices and can be categorized in representativeness heuristics, availability heuristics, and confirmation bias, as well as, optimism bias.

As a field, behavioral economics incorporates prospect theory. Prospect theory concludes that only the prospected changes matter; however, individual behavior is based on probability distortion. Probability distortion defines the skew in the attribution of probabilities to outweigh negative outcomes in favor of positive outcomes, Experiments in behavioral economics have supported the view that people weigh a prospected loss more than possible gain. In combination with probability distortion, behavioral economics also assumes that most people prefer a minimum of fairness. Moreover, individuals are willing to accept a personal disadvantage to enable punitive action against an unfair party. Finally and of significance, behavioral economics includes the attribution of bounded rationality and the further constraint of bounded will power. As a result, even if an individual would like to not engage in known unsustainable activities, the person sometimes just cannot manage to do so.

Some researchers support the view that behavioral economics does not negate rational choice, rather in their view the theory's caveats of bounded rationality, bounded will, and bounded self-interest promote the need for education to assimilate irrational preferences into the rational choice structure. Posner (1998, p. 1575) states, "that efforts should be made through education and perhaps psychiatry to cure the cognitive quirks and weakness of will that prevent people from acting rationally with no offsetting gains." In effect, Posner posits the same sentiment shared by many researchers and social commentators, namely that individuals can be taught to be rational agents. Arguably, this perception has promoted the reality of the same. For example, rational agency though theorized as an inherent behavior requires cognition of cost benefit assessment to attain optimality. However, to the extent that the *reality* of rational choice is learned and presumably tied to socio-economic factors, rational choice may be a more accessible evaluative decision-making tool to some but not all in a society.

4 Economics in Cultural Context, Explaining and Promoting Sustainability

Economics evaluates human behavior relative to wants, needs and resource allocation within a natural environment. By definition, the parameters of the discipline include other life forms and physical resources needed to maintain both life and environmental regeneration. To the extent that a human culture incorporates non-human elements in decision-making, the economic system includes an understanding of the holistic inter-dependence of living and non-living elements of the planet.

Culture is a significant contributor to what is perceived as valuable and is the determining parameter in the designations that ultimately yield to resource allocation within a society. The shift in paradigm from consumerism to sustainability is posited on the ability to modify culture. A threshold response rate within a specific organization, institution, or society, enables the tipping point for absorption of a given change. Feldman (1994) attributes this to human nature. In his text, *Beyond Universals in Cognitive Development,* he notes that the desire to change is largely motivated by the intrinsic desire to communicate with and have the acceptance of others. Feldman states, "The facilitating effect of social interaction has been confirmed by recent research on moral judgment and conservation."

Given that culture is a learned behavior, culture can either promote or diminish any given society's understanding of the interconnectedness of human and planetary life, thereby determining the extent of the anthropocentric, or human-centered, perspective. The United Nations Educational, Scientific and Cultural Organization, UNESCO, defined culture as a significant component to attaining global sustainability:

> Culture shapes the way we see the world. It therefore has the capacity to bring about the change of attitudes needed to ensure peace and sustainable development which, we know, form the only possible way forward for life on planet Earth. Today, that goal is still a long way off. A global crisis faces humanity at the dawn of the 21st century, marked by increasing poverty in our asymmetrical world, environmental degradation and shortsightedness in policy-making. Culture is a crucial key to solving this crisis (UNESCO 2000).

The inputs and outputs of economic systems are dependent on the value structures of a society and to the extent that economics explains observable phenomena and proposes optimal outcomes, the discipline can be both responsible for the maintenance of an economic framework and also the catalyst for a change. Economic outcomes in essence mimic the values of the participants in an economic system.

5 Consumerism, Conscious Consumption and the Culture of Sustainability

The explicit discussion of the embedded assumptions guiding the behavior of the decision-maker is typically not a part of the economic education process. As a result, to the extent that individual economic agents, producers or consumers of a good or service, are bounded by rationality that does not include addressing the impact of externalized or non-quantified costs, the economic discussion does not promote or position the assessment of alternative outcomes. Implicitly and endogenously, the economic discussion establishes and maintains consumption to production circular flow, focusing on the gratification of consumption and return to production, seemingly eliminating assessment of externalities and holistic dynamics. Returning to the milk carton example provided in the **Introduction**, the economic discussion would be limited to the utility gained from consuming the milk and the corresponding profit maximization of the producer. Waste would be regarded as an externality rather than an endogenous aspect of the decision making process. Additionally, costs are priced into the product through efficient market assumptions. In net consumers would expect that the purchase price is indicative of the holistic cost of the product and producers would view production costs as being related to market priced inputs not environmental impacts during or as part of the life cycle of the good.

The factors that are included in an economic evaluation have been limited to the tangible quantifiable costs and costs are overlooked where either a market or regulatory oversight has not provided a monetary justification. From this perspective, the impact of consumption decisions on the environment, economic disparity, or endangerment of other species is not an issue. The market mechanism disenfranchises the consumer from the responsibility towards the welfare of those impacted by his/her consumption and promotes the perception that price alone is indicative of the true cost of a good. Nelson (1995) notes, "The possibility that consumption should be reduced because the act of consumption is not good for the soul, or is not what actually makes people happy, has no place within the economic value system." The underlying assumption is that consumers are driven to want more. As a result, economic modeling assumes that reduction in consumption in the current period is only addressed through the lens of an increase in consumption in a later period. That the assumption of insatiable want may be taught a learned behavior, reinforced through a market model is not even addressed in economics (Knoedler and Underwood 2003).

A general and seemingly applicable assumption is that consumers and producers maximize the benefit related to the opportunity accessible in their particular circumstance. The desire to reach an optimal outcome for a given point in time, as has been noted before, is subjective and specific to how these economic agents view the concept of maximization, which in turn is likely to be highly correlated with cultural values. For example, in Indigenous societies there is evidence that a

balance between present and future periods along with that of the environmental system, as a whole, was included in decision-making and optimization (Jennings 1975). In present consumerism fostered economies, the cultural values are less likely or unlikely to incorporate environmental and social justice parameters proactively. The focus of observable and marketed consumption is immediate gratification. However, as consumer awareness of both the impact of consumption and the power of consumption to modify and catalyze economic outcomes increases there is growing evidence of a shifting cultural paradigm to one of sustainability. This again promotes the rationale for education as a catalyst for sustainability integration.

To some extent cultural values dictate the significance of the adversity related to the creation of externalities or abuse of common goods. Consumerism fosters accumulation. Reliance on market mechanics to justify purchasing behavior without intertemporal or even present assessment of consumption choice fosters unsustainable outcomes to the extent that the drivers of the market (i.e. preferences, pricing of externalities) do not incorporate understanding of their sustainability footprint.

Market models have been the regulatory mechanism employed to modify socially non-optimal outcomes, but through relying on the market mechanism rather than simultaneously including mechanics to promote cultural change, the majority of interventions to date have had limited to questionable success. Education for rational agency is requisite in the holistic implementation of sustainability.

6 Sustainable Universities

Many educational institutions have started to integrate or create standalone sustainability programs. Specific to the intent of the inclusion of sustainability, it would appear that the primary channel for promoting viable sustainability initiatives would include both. Having a standalone program without a holistic support framework within the institution challenges the adoption of sustainability as an individual pursuit, while incorporating sustainability within the operational structure of an instruction establishes a cultural value. There are many methods of establishing sustainability initiatives on a campus-wide basis and these can include formation of an oversight function for facilities and institutional integration related to a defined Sustainability Mission Statement via the creation of a Director of Sustainability to establishment and funding of student-led Green Teams charged with developing and deploying initiatives targeted at the student body. Institutionalization of sustainability creates a self-reinforcing culture that supports both the operating environment and curriculum in which sustainability values are implicitly incorporated and explicitly addressed.

Bargh and Chartrand (1999) note that conscious choice and guidance are needed to perform new tasks, confirming that university culture has to engage its stakeholders on a conscious level in order to promote behavioral change. However, the authors also note that after some repetition, conscious choice quickly drops out and unconscious habit takes over, "freeing up precious reserves of conscious awareness."

A constituency with an understanding of the holistic relationship between consumption and sustainability and having engagement within their community and institution (O'Connell 2008), are foundational elements in the social policing and infrastructure of a sustainable university. Conscious consumption consistent with sustainability objectives and institutional strategies, on a large scale promotes an unconscious habit of sustainable activity. This can be a powerful means of implementation given that the findings of many studies suggest that the conscious self "plays a causal role only 5 % of the time" (Bargh and Chartrand 1999).

The defining of sustainability is in close alignment with the objective of the discipline of economics and the realization of sustainability is tied to economic outcomes. Education for sustainability, therefore, is crucial; however, implementation of sustainability should be institution-wide. Given the significance of consumption in the attainment of sustainability, rational consumption behavior should not be assumed as a given but should be taught and reinforced through the university from facilities operations to administration and curriculum. Traction in sustainability programs can be measured through economic channels and the economic framework itself promotes the values, conscious or unconscious that drive the economic cycle. Ultimately, conscious consumption is pivotal to establishing sustainability within a university and influencing its traction through a cultural norm of behavior (i.e. organic food choices, composting bins, water stations). In this manner the system of sustainability becomes in essence self-sustaining.

7 Next Steps

This chapter prompts further evaluation in the mechanics of sustainability focused education and also establishes the view that the measurement of the success of sustainability programs may not be captured in present, standardly used metrics. Quantified metrics related to resource use and waste creation though beneficial may either under- or overstate sustainability traction. Assessments of university sustainability programs are best measured through evaluation of conscious consumption and the traction of cultural norm of sustainability, as well as the correlation of the two. The creation of measurement tools to assess these attributions form the next steps in the process of sustainability integration and feedback for continuous improvement.

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Madhavi Venkatesan is a faculty member in the Department of Economics at Bridgewater State University. Her present academic interests are specific to the integration of sustainability into the economics curriculum and she is currently pursuing scholarly interests in sustainable development. Prior to re-entering academics, Madhavi held senior level positions in investor relations for three Fortune 250 companies. In this capacity she was a key point of contact for investors and stakeholders and was instrumental in the development of socially responsible investing strategies and corporate social responsibility reporting. Madhavi started her financial services career after completing her post-doctoral fellowship at Washington University in St. Louis. She earned a PhD, MA, and BA in Economics from Vanderbilt University, a Masters in Environmental Management from Harvard University and a Masters in Environmental Law and Policy from Vermont Law School. She is the author of *Economic Principles: A Primer, A Framework for Sustainable Practices*.